Boston University

OpenBU **http://open.bu.edu**

Boston University Theses & Dissertations Dissertations and Theses (pre-1964)

1956

A solution of the problem in the elementary school grades of broadening the base for the study of plants and their importance to civilization.

https://hdl.handle.net/2144/13445

Downloaded from DSpace Repository, DSpace Institution's institutional repository

Thesis
Talmage, L. H.
1956

BOSTON UNIVERSITY

SCHOOL OF EDUCATION

Thesis

A SOLUTION OF THE PROBLEM IN THE ELEMENTARY SCHOOL GRADES OF BROADENING THE BASE FOR THE STUDY OF PLANTS AND THEIR IMPORTANCE TO CIVILIZATION

Submitted by

Lucille H. Talmage

In Partial Fulfillment of the Requirements for
the Degree of Master of Education
1956

Boston University
School of Education
Library

First Reader: Dr. Read

Second Reader: Dr. Crossley

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Hypothesis.-- The need of developing, even in the mind of the young child, a concept of the importance and usefulness of plants, and the necessity for the conservation of plant life is becoming more urgent every day. Every reasonable effort should be made to impress the child from time to time with the significance of such basic facts as: mankind is dependent upon plants not only for food, but for most of the necessities as well as the comforts which make modern civilization today; and without the process of photosynthesis, which takes place in green plants, no living thing could exist.

It is believed that such a concept can be developed in the upper elementary grades, and that the basis for the study of plants in those grades should be broadened. This thesis will present units to evolve that idea and to emphasize its consequence.

Correlations will be made with geography, language, arts, arithmetic, and art to show that the units herein presented will not interfere with the regular course of study. It is believed that better results may be expected in the teaching of elementary science if the foregoing plans are applied.

Justification.-- A wider knowledge of the part plants play in our lives must be acquired by our citizenry to appreciate the importance of their conservation. According to courses of study and textbooks in use today, the small portion of space allotted to the study of plants is not

Boston University
School of Education
Library

designed to emphasize either their importance or the necessity for their conservation. The general aim seems to be to give pupils a general knowledge of plants, to identify the more common ones, and to become acquainted with the general habits of growth of typical specimens. The brief section under conservation approaches that problem through animal life and how that would be destroyed if there were no plants.

While the above knowledge is not to be deprecated, it is believed by this author that as the preservation of green plants is the basis for all conservation, therefore conservation should be approached through the study of green plants.

Pupils in the upper elementary grades are at the most impressionable age, and a concept gained then will form a foundation for an appreciation of the necessity for conservation. It will also open vistas of further exploration and experimentation in higher grades, and stimulate the questing nature in possible future scientists. It is hoped that the demonstrations, experiments, other visual aids, and problem solving will provide an operational approach which will uncover the beginning of any high level ability in science.

It is hoped that this plan will be an aid to the teacher who is untrained in science and who does not teach science because she feels she doesn't know anything about it. Plant specimens are much easier to bring into the classroom than live animals or birds and they can be experimented with without violating any squeamish tendencies of pupils or teachers.

Scope.-- The plan is to carry on this work with fourth, fifth, and sixth grades, comprising about thirty pupils to the grade. The scope of the study is shown by the following outline set forth on the accompanying flow sheet.

The test is to be given to all three grades, the fourth and sixth as well as the fifth, to prove that pupils of the three grades at the upper elementary level are able to grasp the concepts herein developed.

The activity procedure is to be used, the class being divided into six groups. Each group in turn will demonstrate a different experiment, plan and present an exhibit, or construct a chart. Every member of the different groups will participate in the respective assignment in some way.

A sociogram will be made to aid in the selection of the various groups. At the beginning of the program, the leaders will be as indicated by the sociometric test, and later changed to others in the group if it seems advisable.

Two thirty-minute periods a week are to be used as regular science lessons. Many of the activities will be accomplished during extra time for those who finish the regular assignments quickly, and in the fifteen minutes before school.

Correlation with geography, language, arts, arithmetic, and art will be according to the grade curriculum. The test will be only on the science work.

CHAPTER II

RESEARCH

Research relevant to the problem.-- Each of us, at the time he or she picks an apple from the tree or a vegetable from the ground, by such an act and others similar to it, acquires a consciousness, however indistinct it may be, that a plant is of importance in our lives. But it is essential that the larger majority of our citizens, which is found only in the elementary grades, be presented with a course of organized study showing the importance of plants, to enable them to appreciate and digest such generally accepted facts as are set forth by Dr. Wilson in his book on Botany, wherein he writes:

> "Plants of the past, buried, altered, preserved, and yielding coal, oil, and natural gas, and plants of the present, available to us in many forms for many uses, are key materials in our world today. The clothes we wear, the fuels which warm our homes and operate our industries, the lumber which builds our houses, the vitamins which maintain our health -- these are only a few of the many plant products upon which man depends.
>
> "There is little possibility that in the future we can free ourselves from this dependence upon plants. Despite all our technological advances, agriculture will continue to be the most important of man's activities. All the energy required to keep us alive, and most of the energy required to run our industries, comes directly or indirectly from plants.
>
> "Chemists, it is true, have synthesized many substances useful to man--vitamins, rubber, and a host of others. But the raw materials for these transformations are still organic compounds synthesized by plants. The fundamental source for all living things will probably always be supplied by green plants. It is all the more necessary, therefore, that greater efforts be made to increase agriculture production, to utilize plant products as fully as possible, and to attain a greater understanding of the mechanisms by which plants operate." 1/

1/ Carl L. Wilson, BOTANY, The Dryden Press, New York, N. Y., p. 21.

The foregoing quotation expresses the type of concept of the importance and usefulness of plants which this thesis will hold should be acquired by elementary grade pupils in order to establish the background for the study of conservation.

An all important and most impressive subject of study exemplifying the importance of plants is the process of photosynthesis. A much better appreciation of this is acquired by the elementary grade pupil if he is brought face to face, by discussion and presentation of experiments, with such accepted facts as:

> "Green plants possess the ability to manufacture food from raw materials derived from the soil and the air, and upon this activity depends not only the life of plants, but of all animals, including man. Photosynthesis is the manufacture of sugar from carbon dioxide and water in the presence of chlorophyll, with sunlight as the source of energy. All living things require energy, not only for growth and reproduction, but for the very maintenance of life itself. This energy comes from the chemical energy of the food consumed, and the food has its origin in photosynthesis. Hence, through the agency of green plants, the radiant energy of the sun is trapped and made available to all kinds of living things. Photosynthesis is one of the most important chemical processes on earth, and its extent is so vast that it is staggering in its proportions. For example, the total production of sugar by the world's plants is estimated at approximately 270 billion tons each year. The quantity of energy accumulated annually by plant life is equal to the energy released by the burning of all the coal mined on earth during a year.
>
> "The synthetic processes of green plants is responsible for the manufacture of starch, protein, oils, and vitamins. These foods are used and stored by plants and in turn harvested by man and animals for food.
>
> "Many basis materials of industry are directly or indirectly of photosynthetic origin. The manufacture of alcohol and its many derivative products depends on cereal grains and molasses. Textile fibers, both plant and animal, lumber, pulp products, vegetable fats, gums and resins, all depend upon the photosynthetic activities of green plants. All coal, petroleum, and natural gas were produced from chemical changes in the bodies of plants and animals that fed on plants.

> "The significance of oxygen as a by-product of photosynthesis should not be overlooked. Green plants and animals cannot survive on the food produced by photosynthesis unless they also have oxygen released in the process. The present abundance of oxygen in the air (21 percent by volume) is believed to be due to the contribution of plants. Green plants constitute the only significant source that must be operating to replenish the supply of oxygen to the atmosphere which is constantly being depleted by the respiration of living things and by the uniting with other elements to form rocks and minerals."1/

The process of photosynthesis also generates heat. When water is separated into oxygen and hydrogen, latent energy is stored in the gases. As they are reunited the equivalent of heat is given off.

> "It is theoretically possible to carry on this kind of process by photo-chemistry, but no one has yet found just the right substances to make it work. The fact that nature already does this on an enormous scale should be a pace setter and a challenge to our young scientists."2/

This author suggests that the word "young" should be read to include the youngest scientist.

As an exemplary effort on the part of the press to supply this recognized need to teach the importance of plants is the following excerpt from the New York Times: "Such an appreciation of the importance of plants is absolutely necessary if we are going to inspire our young citizenry to be interested in conserving them."3/

There is much agreement among leading educators upon the importance of inculcating in the minds of young children the fundamental concepts of conservation.

> "Children should be taught to appreciate that a nation's prosperity, economic stability, happiness, and cultural advancement are greatly influenced by its supply of natural and human

---

1/ Carl L. Wilson, BOTANY, The Dryden Press, New York, N.Y., pp. 61 and 62.

2/ Farrington Daniels, Chairman of the Department of Chemistry, University of Wisconsin, in The New York Times, March 18, 1956.

3/ Ibid.

resources. Even a nation's independence is affected by this supply. They should know how these resources have been depleted and unwisely exploited and mismanaged. They should be taught to realize the part natural resources play in furnishing the necessities of life and in contributing to the aesthetic and recreational life of people, that a nation's prosperity, economic stability, happiness, and cultural advancement depend on natural resources."1/

"It is the task of the schools to help insure that we have an intelligent, enlightened public opinion. We will conserve our natural resources when the schools present the facts which show its necessity, for then when our children become voters they will demand conservation legislation."2/

"Until a new generation is taught in schools man's utter dependence upon natural resources, until we have a majority of the American public schooled in the fundamental principles of conservation, criminal waste will continue to reduce our heritage of natural resources."3/

"The wave of enthusiasm for the conservation of our natural resources must reach the children, or it will expend much of its force uselessly. It is from the education of the children in right ways of looking at nature that everything is to be expected in years to come. If they learn to understand the value of the things about them, as well as their beauties, the carrying on and enlarging of the conservation program which is now so well under way can be safely left to their care."4/

That the pupils of the upper elementary grades are not too young to assimilate these concepts is substantiated by Helen Markham in her thesis on "The Development of a Program for Teaching Conservation in Grades 4, 5, and 6." She says in part:

1/ Frank Gorham, Head of the Department of Elementary Education, Indianapolis, Indiana, "Teaching Conservation in the Elementary Schools." Social Education Magazine, Volume 12, p. 73 (February, 1948).

2/ Edwin H. Reeder, Professor of Education, Teachers' College, Columbia University, New York, "Conservation and Democracy", Social Education, Vol. 4, No. 7, p. 455 (Nov. 1940).

3/ Jay N. Darling, Hon. President of National Wildlife Federation, POVERTY OR CONSERVATION, YOUR NATIONAL PROBLEM, P. 28 "National Wildlife Federation," 1949.

4/ Harold Fairbanks, CONSERVATION READER, p. 28, Harr Wagner Publishing Company, San Francisco, California, 1927.

"Children cannot begin too young to be active conservationists. Primitive interest in young children aids in establishing the fundamental elements in conservation. If it is left to the high school, this primitive interest has been largely inhibited by misinformation, superstitions, and other activities. There should be no separate course. The sounder approach should be taken -- that of weaving conservation into the warp and woof of the entire curriculum. We must guide children toward a realization that whether man will live longer, healthier, and more comfortable lives will be determined by how he manipulates this natural environment, and by how he controls and directs the natural forces at work therein."1/

It is the conviction of this author that if the fundamental concepts of conservation are gained in the elementary grades, the junior and senior high schools can work on problems where these fundamentals are applied, starting with class and group work, and finally allowing students who are able to work on individual projects. This conviction is based on forty years of teaching science in both elementary and junior high school grades.

The main problem seems to be to interest teachers to correlate science with the other subjects. Teachers who do not teach science in the elementary schools claim that they do not know anything about it, so that is why they do not include it with their lessons. Dr. Frank Thorne says:

"Failure to practice the principles of conservation is largely due to the failure of our educational institutions to teach conservation, and the reason for this deficiency is that teachers have not been taught how to teach conservation."2/

1/ Helen Markham, Thesis, "The Development of a Program for the Teaching of Conservation in Grades 4, 5, and 6," written at the New York State College for Teachers, 1952.

2/ Dr. Frank Thorne, Conservation Commentator of "Science News Letter," POVERTY OR CONSERVATION, YOUR NATIONAL PROBLEM, p. 39, Washington, D.C., National Wildlife Federation, 1949.

Helen Markham adds: "Many teachers have taught little conservation because of lack of definite assembled material."1/

The Report of the Conference on Nationwide Problems of Science Teaching in the Secondary Schools states that:

> "When a teacher with the desired qualifications is not available, someone with lesser qualifications is hired. Ill-qualified teachers can be assisted through a supervised program carefully designed to present new ideas and information to all."2/

It is the aim of this thesis to present a method which an ill-qualified teacher (or any teacher) can follow to teach conservation.

Helen Markham from the New York State College for Teachers has a thesis on "The Development of a Program for the Teaching of Conservation in Grades 4, 5, and 6" which was useful to this author. Her primary objective is to "explore the possibilities of teaching conservation in the elementary grades. Units are suggestive in nature, and should be adapted to local conditions. A sound program in conservation teaching begins with community needs, then evolves into a consideration of state, regional, national, and international aspects."3/

She plans to meet the need of definite assembled material. The thesis includes water, soil, plant, and mineral conservation. In the plant section she concentrates on trees, and has assembled most of the important facts about them in outline form. There are five problems:

1. What things are necessary for the growth of trees.
2. Why forests are important to us.

1/ Helen Markham, op. cit., p. 3.

2/ CRITICAL YEARS AHEAD IN SCIENCE TEACHING, Report of the Conference on Nationwide Problems of Science Teaching in the Secondary Schools, p. 37.

3/ Helen Markham, op. cit.

3. By what means one can tell a tree from a plant.

4. Characteristics of trees.

5. What seasonal changes take place in trees.

She uses six experiments, and gives a short list of activities. Notation is made of available motion picture films and film strips with their sources, as well as a long list of helpful pamphlets and books. The thesis is an excellent review of the necessary facts to teach conservation.

This author has used some of Miss Markham's experiments, for which due credit is given, in chapter three. Selections have been made from her list of pamphlets and books, as well as some of her source material from educators for authority to back up some statements made. In this author's thesis the study has been limited to plants, with their importance and usefulness; also the lessons have been developed in detail. More attention is given to the correlation of the plant study with other subjects.

"Using Community Resources to Develop an Attitude Toward the Conservation of Natural Resources in Intermediate Grade Children" is a thesis written by Kathleen Granger, at Boston University for a Master's Degree in 1950. Her purpose is to show how a teacher of intermediate grade children may use community resources in developing an attitude toward conservation while teaching a unit on natural resources.1/

Her experimental group included twenty-nine intermediate grade children, ages 10 to 11 years. She lists ten concepts on plants, with

1/ Kathleen Granger, Thesis, "Using Community Resources to Develop an Attitude Toward the Conservation of Natural Resources in Intermediate Grade Children," written at Boston University in 1950.

an overview to present these concepts, the vocabulary, questions, activities and test. The same procedure is followed in teaching the conservation of soil, water, minerals, and animals.

Field trips were made to a museum, a bird sanctuary, the park, the reservoir, a greenhouse, a pond, and the seashore. A community Resource File was made not only of the natural resources available, but of interesting citizens as well. Some of these citizens were invited to the classroom to give lecture demonstrations to the pupils. Lecture demonstrations were made on snakes, feeding birds, precious minerals, and how to identify trees. Kodachrome slides were shown of the different places visited, and other resources of the community. A tape recording was made of a conservation play the pupils wrote.

Many useful ideas were gained from this thesis. The author has used a number of the activities listed by Miss Granger, as well as the ideas on field trips and lecture demonstrations, although the lectures used in this study were confined to plants and trees.

Charles A. Haner has a thesis on "Inexpensive Equipment and Demonstrations for the Biology Laboratory and Classroom" written at Adams State College, Alamosa, Colorado, for Master in Education Degree. The purpose of the study is to prepare a handbook of ideas which the teacher can use to vitalize the teaching of biology. He notices that much of the published material takes for granted an equipped laboratory. Many small schools are not equipped, so he has collected suggestions for simple, inexpensive, and easily built apparatus which would serve the teaching purpose. He also shows how to culture, preserve, find, and use some of the biological specimens that may be found in any community.

He gives plans and directions for making a microscope using a drop of water for a lens, a balance scale, a bunsen burner, a ring stand, insect nets and traps, animal traps, bird feeders, plant vivarium, terrarium, and an aquarium. The criteria for making these models is that each must be easy and simple to build, the materials must be available in most communities, simple household tools can be used, the cost is low, the model must be safe to use, and it must be useful in the work.

This author used some of the ideas and experiments from Mr. Haner's thesis, and made a microscope from his directions, using a drop of water for a lens. Some additions were made to the microscope as it was constructed, and the directions were simplified so that children could also construct one. It is hoped that some pupils might be inspired to make one for their own use and enjoyment. It is also known that many schools, especially elementary ones, are not equipped with microscopes, and a microscope is very useful in the study of plants. The water lens magnifies to a much greater degree than the toy ones some of the pupils possess.[1/]

BOTANY, by Carl L. Wilson, Professor of Botany, Dartmouth College, is a college textbook which has been most helpful in giving facts about the growth, structure, and reproduction of each class of plants. Professor Wilson stresses particularly the value and use of the plants, as well as the movement of water, gases, and minerals in and out of plants. He lays much emphasis upon photosynthesis. This author has been guided by

1/ Charles A. Haner, Thesis, "Inexpensive Equipment and Demonstrations from the Biology Laboratory and Classroom," for Ed. M. degree at Adams State College, Alamosa, Colorado.

the information gained from Professor Wilson, and has quoted from his book at the beginning of this chapter.1/

TEXTBOOK OF INTERMEDIATE PLANT SCIENCE, by George B. Cummins, George A. Gries, Samuel N. Postlethwait, and Forest W. Stearns, Department of Botany and Plant Pathology, Purdue University, is a college textbook, but serves as an excellent reference book for the teacher. It covers the structures and classification of plants, their environment, diseases, and use. This author has used it for an authoritative reference.2/

WORKBOOK IN FUNDAMENTALS OF PLANT SCIENCE, by the same authors, is full of illustrations and experiments with the varieties, growth, work, and use of plants. Some of the experiments were easy enough for elementary grade children to use, and a few of these were used in this thesis.2/

LABORATORY PROBLEMS IN PLANT SCIENCE, by the same authors, is more advanced than the workbook and therefore more difficult. It takes up more about fungi and plant diseases. There are excellent sections on grasses, grains, and weeds.

The three books listed above were used mostly for reference and to give the author the necessary review for a background and general understanding of the subject.2/

1/ Carl L. Wilson, Professor of Botany at Dartmouth College, BOTANY, The Dryden Press, New York, N. Y.

2/ George B. Cummins, George A. Gries, Jesse Lafforge, Samuel N. Postlethwait, and Forest W. Stearns, Department of Plant Pathology and Botany, School of Agriculture, Purdue University, Burgess Publishing Company, Minneapolis, Minnesota, 1955.

"Teaching Conservation Through Present School Subjects" is an article by Dr. William W. Reitz, Head, Educational Relations Section, United States Department of Agriculture, Northeast Region. He says in part:

"The future welfare of our country will depend upon proper conservation of our renewal resources. Renewable organic resources will have to substitute for many non-renewable resources. The replacing and maintenance of these resources is a long term and continuous process. It cannot be accomplished in this generation. That is why it is necessary to teach conservation to our young people.

"The best way to teach conservation to students of any age is to have them practice it. This may be done by individual or group projects; by promoting wise use of paper and school supplies; in the home, by salvaging materials which can be used again; in the community, by proper care of yards, streets, and parks. Field trips are absolutely essential.

"The teaching of the principles of conservation can be taught in the grades as well as the high school. If possible the specimens should be brought into the classroom to be studied first hand rather than from books. Pupils should acquire some understanding of the value that plants and animals have in their own lives, the relation that the resources have to each other, their dependence upon each other, and the uses which they serve in man's life. Useful also is an elemental knowledge of the natural forces, such as sunshine, heat, gravity, capillarity, evaporation, transpiration, and osmosis. While this knowledge serves as only a motive for further study, it is fundamental to successful conservation of natural resources.1/

"Geography is a school subject admirably suited to the teaching of conservation, since it deals with practically all of the natural resources. The student will learn that the supply of important metals can be prolonged by substituting products made wholly or partially from organic products, such as plastics. The supply of coal, oil, and natural gas may be prolonged by greater use of water power or wood as fuel. Alcohol and other wood and vegetable extracts may some day be substituted for gasoline. There are many other possibilities for future scientists to discover. Since natural resource planning and conservation are so important, it is necessary that both should be taught in every subject matter area

---

1/ William W. Reitz, Head, Educational Relations Section, United States Department of Agriculture, Soil Conservation Service, Northeast Region. From article in the Metropolitan Detroit Science Review, Feb. 1948.

in the school program."[1]

1/ Ibid. Dr. Reitz, from article in The Journal of Geography, Sept., 1947, Vol. XLVI, Number 6.

CHAPTER III

PROCEDURE

The attention of the reader is now drawn to the outline and diagram of the unit of study being proposed hereby as a base for the study of plants in the elementary grades. The diagram will be found following page 2a and should help greatly in understanding the structural set up necessary to demonstrate the practical aspects and significance of such a unit. The specific objectives to be achieved are:-

Specific Objectives.

1. Plants take in water and minerals through their root hairs.

2. The minerals must be in liquid form before the plant can absorb them.

3. When the water and liquid minerals soak through the root hairs, the process is called osmosis.

4. The root hairs swell when the liquid is taken in. This is called imbibition.

5. The water and minerals go up through the stem into the veins. This is called capillarity.

6. Good soil must contain humus to make plants grow better.

7. Trees are our largest plants.

8. The trunk of the tree is the same as the stalk or stem of the plant.

9. Every part of the plant is made up of cells which may be compared to rooms.

10. In the stem and trunk, some cells form tubes which carry the

water and minerals up to the leaves, while other tubes carry the food down to the roots to be stored.

11. The food factory of the plant is in the leaf.

12. Chloroplasts are cells in the leaf which make up what may be called the engine of the plant.

13. Sunlight acts as the power that runs the engine.

14. Green chlorophyll in the chloroplast makes the leaf green.

15. Chromoplasts are cells in the leaf which contain red and yellow color.

16. Stomata are little holes in the underside of the leaf.

17. Through these holes, or stomata, plants take in carbon dioxide from the air.

18. The leaf factory makes sugar and starch out of the carbon dioxide and water, in the presence of sunlight.

19. Green plants also make protein, fat or oil, and vitamins.

20. The process of making food in green plants is called photosynthesis.

21. Green plants are the most important factories in the world because only green plants can make food.

22. The leaves of plants give out oxygen and water.

23. Plants help to purify the air by giving out oxygen.

24. Through the process of transpiration (loss of water) the plant completes the water cycle.

25. Plants use their roots, stems, leaves, and flower buds as storehouses for food.

26. Seeds are started in the flower.

27. The process of making seeds is called reproduction.

28. Plants make new plants by seeds, by budding, by bulbs, and by corms.

29. Man can make new plants by making cuttings, by budding, and by grafting.

30. Hybridization is a method of improving plants and making new ones.

31. The raising of plants for food, for clothing, for building, for transportation, for medicine, and for beauty gives jobs to millions of people.

32. Cotton, linen, rayon, and rubber are made directly from plants.

33. Lumber, lumber products, and paper are made from plants.

34. Some of the spices we use from plants are pepper, cloves, nutmeg, and cinnamon.

35. Trees are tapped to get rubber, resin, turpentine, and sugar.

36. Chives, mace, and mint are some of the herbs which come from plants and are used in cooking.

37. Plastics are made from plants.

38. Some of the medicines we get from plants are penicillin, opium, and atropine.

39. Grass is the first plant to grow on a sand dune.

40. If grass is planted or some cover crop after the crops are harvested, the top soil will not blow away.

41. Plants help to prevent floods and water erosion.

42. Forests can be conserved by planting new trees to replace those cut down.

43. Fire, animals, and plant diseases are three important enemies of our forests. Fire destroys the most.

44. One can prevent forest fires by putting out cigarettes and camp fires.

I. How Plants Obtain Food and Grow.

Preface.-- These lessons were given to a fifth-grade class of thirty pupils having two half-hour periods of General Science per week. The extra activities were done either before school, or when the pupils finished their regular work. The same lessons were given to a fourth-grade class and a sixth-grade class averaging about the same number of pupils. The same test and retest were given to all three grades.

Lesson 1:-- The teacher should have two potted plants, one well watered, and one dry on top - a plant with a tap root, such as a dandelion, a fibrous root, such as a clump of grass, and a storage root, such as a beet or carrot. She should also have different kinds of stems, as ivy, honeysuckle, cactus, gladiolus corm, iris rhizome, and an onion bulb. Encourage the pupils to bring these in if possible.

Presentation.-- Show the two potted plants, one well watered and the other dry. Which is the best plant? Why? What does the other plant need? How does the plant get water? Does the plant need anything else besides water? How do the water and the fertilizer get into the plant? How do they get into the roots? We all need food in order to live and grow, but plants manufacture their own food. You see, plants are really factories. The water and minerals dissolved in the water are the raw materials that plants use in their factories. Do you know some of the food that they make? Yes, starch, sugar, and oil are some of the food plants make. How does a plant make this food? This film-strip will show how it is done.

Show the film-strip "Plant Factories" Publishers: Row, Peterson & Company, 1911 Ridge Avenue, Evanston, Illinois.

Have pupils read the captions under each frame. Discuss the pictures as you turn the film. How does the tap root differ from the fibrous root? Show me, among the specimens on the table, a plant with a tap root and one with a fibrous root. Are tap roots and storage roots the same? Notice the tiny brush-like hairs that come out each side of the root. Those are the root hairs. They are the doors of the root because that is where the water comes in. Why aren't the hairs coming out at the end of the root? Feel the tip of the root hairs on the plants on the table. Are they stiff? Why? Would the end have to be stiff in order to push through the ground? The end of the root is called the cap. Inside the root are little cells which are like rooms. All the cells are filled with a liquid called protoplasm which is continually moving around. The water and dissolved mineral matter soaks through the cell wall and is added to the protoplasm. Some of the cells are used to store extra grains of starch and sugar which the plant has made. You see, plants store food in the cellar just as we do.

Test:-- Give the test that is on the film strip. Add these questions: What is the difference between these types of roots? What would you find in the cells of the root? This finishes Lesson 1, which would take thirty minutes. If it is not finished in that period, the test can be given during the following "Before School" period.

Activity 1:-- Ask pupils to bring in old plant and nursery catalogues. Divide the class into three groups. In each group, some pupils cut out pictures of the plants assigned to their group, others paste them on the charts, and others print the names of the plants on the charts. Make three charts, one showing plants with tap roots, one showing plants with fibrous roots, and one showing plants with storage roots. Pupils also bring in real plants to show the type of root they are exhibiting. This can be done in two or three "Before School" periods if the work is divided, or they can work on this after the regular work is done.

Activity 2:-- This is to be done before school or in extra time. Pupils are divided into six groups, each group to research for experiments, in their school science books or encyclopedias, on osmosis, imbibition, growing root hairs, geotropism, hydrotropism, plant food, and different kinds of roots. Encourage pupils to bring in their own materials, but if they cannot, the teacher must help them to get them. Pupils start their experiments in the science period, check them each day, report to the class, and report on the results.

Lesson 2:-- Each group presents the experiment assigned to it, explaining the procedure as it is done. If time is needed to finish the experiment, the pupils set it where they can watch it from day to day. Try to have each pupil in the group take part in this presentation, i.e., one lists the materials, one does the work while another explains, one records the steps, one tells what is expected to happen, and another gives the actual results. This is an excellent oral English lesson and could well be taken in oral English time. For those experiments which take time to develop, the group should check them each day, and report orally to the class on the progress. The recorder for the group should keep a log and make a written entry of the progress. This gives the recorders practice in written English.

Experiment 1. by Group 1. "Growing Root Hairs in Test Tubes."

Materials: 6 test tubes, cardboard, corn or beans which have germinated, cotton, pins, piece of cloth.

Method: Roll the seeds in a cloth and tie with a string or rubber band. Wet the cloth and stand it in a little water until the seeds germinate. Cut strips of cardboard to fit into the test tubes with 1/16" on each side for expansion. Attach the germinating seeds to the center of the cardboard. Pins should be on one side of the kernels to prevent injury to the embryo. Place the seed with the point of attachment downward to make possible the best seedling development. Pour in about an inch of water. Plug the test tube with cotton. Keep test tubes stationary and do not allow the water to touch the root hairs. Place some tubes where it is cold, and some in a warm place to note temperature effect. Study a root hair under a microscope to see how the tip differs from the rest of the root. Pin some kernels with the pumule down to note how pumule turns up. This is geotropism.

Place one tube in the dark and one in the light. When you take the work on stems, examine each for stem development. When doing the work on leaves, test each leaf for chlorophyl.

The group checks each test tube daily and reports to the class on the results. This can be done in the Opening Exercise period, as it takes only a few minutes. The recorder keeps a daily log of the experiment.[1]

Conclusion: We found that plants grow root hairs on their roots. Plants take in water and minerals through their root hairs. The minerals have to be in liquid form before the plant can take them in. The tip of the root is stiff.

<u>Activity 3</u>:-- Construct a Microscope. See pages 24 to 27.

1/ Joseph W. Rhodes, "Root Hairs Via the Test Tubes," in SCHOOL SCIENCE AND MATHEMATICS, XLII (February 1942, pp. 215-17) from Charles A. Haner thesis "Inexpensive Equipment and Demonstrations for the Biology Laboratory and Classroom."

PARTS TO BE ASSEMBLED IN CONSTRUCTION OF MICROSCOPE

Platform--A--7"x4"x3/4"----soft wood

Uprights--B,B'--6"x1½" x 3/4" -----soft wood

Top--------C----5 3/4" x 1½" x 3/4"-----soft wood

Back Support--D--2" x 4" x 3/4"------soft wood

Block for mirror--E--3"x1½"x2"----See J of drawing for 45° cut----
soft wood

Mirror-----3"x2"x3/32"--To fit on Block E--glass--
Cover back of mirror with electric tape

Tubing---H---4"x3/4" diameter--copper piping

Eye piece---F and G---2½" x 6-- shaped as in G--any soft metal

Stove Bolts--2¼"--to support eye piece

1 square nut---to act as guide for metal piece

1 wing nut---to hold metal piece in adjustment

2 pin curl type clips--K, K'

DIRECTIONS FOR ASSEMBLING MICROSCOPE PARTS

1. Place Base A on level surface and locate central position for block E. Attach mirror to E before mounting. Establishing base for mirror may be aided by use of electric tape.

2. Mount block E on standards, such as proposed window shade brackets, being especially careful to have center line of holes parallel with base and in line with each other.

3. Mount set screw on small block, as shown in J, by gluing same in position. (It will be found that when placing one nut on each side of small block to give power of thrust and pull to screw, the nuts must not be too tight, but close enough to sides of block to be maintained in position with glue.)

4. Now attach shaped metal piece F to squared wood piece D, as appears in G, by drilling hole the size of bolt to be used about 1 1/8 inches from the top end of wood piece. Drill second hole of the same size about 2 1/8 inches from the top of the wood piece. Use nut on end of upper bolt to serve as a guide for metal piece during focusing. Attach wing nut.

5. Drill hole in center of wood piece C to accommodate pipe H and attach one to the other. Attach C assembly to assembly of F and D, centralizing carefully.

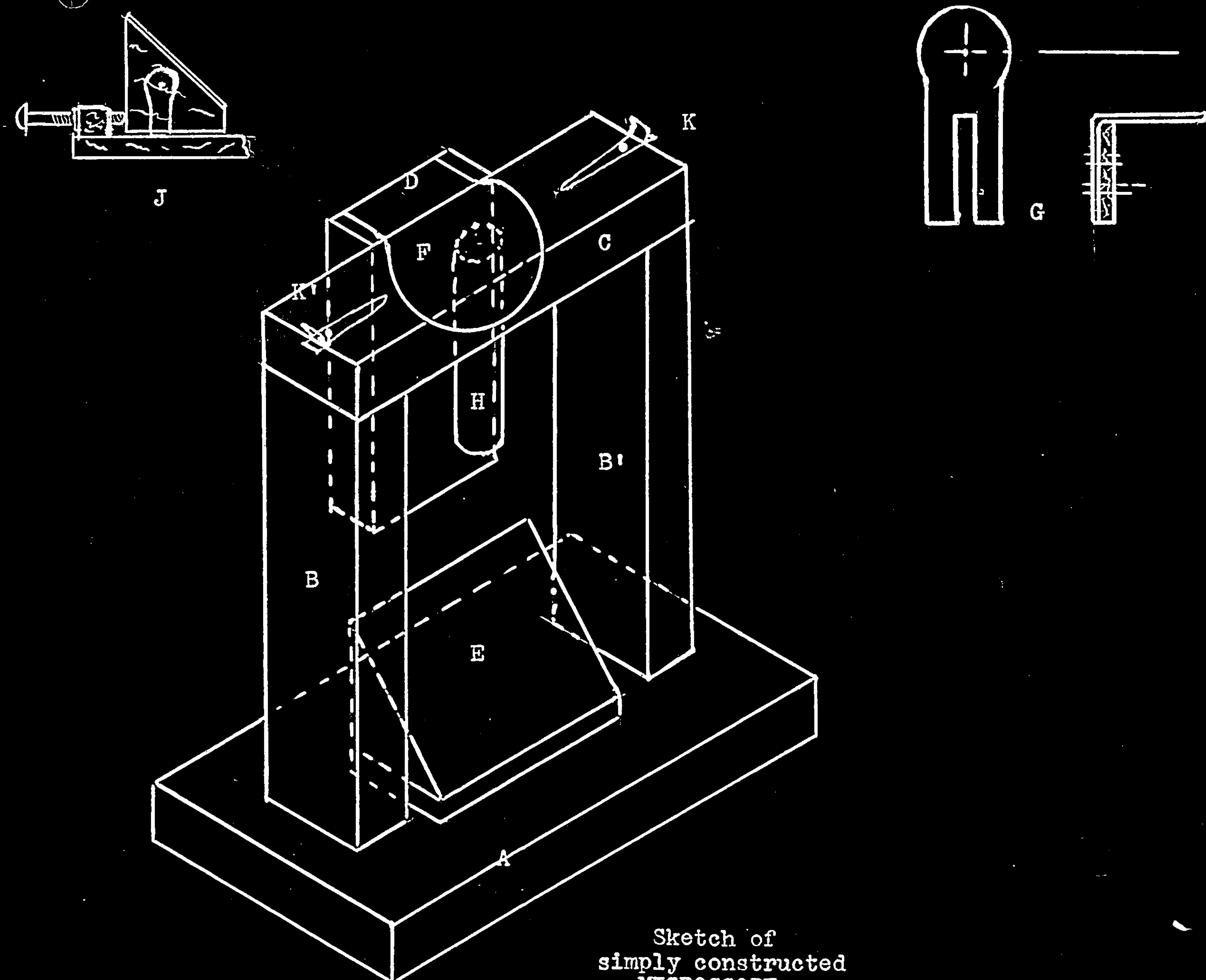
6. Attach by nailing, gluing, or by both, the pieces B,B' and the assembled pieces C, taking care to center same properly over block E so that mirror on E will reflect through pipe in all adjusted positions of E.

7. Now if the specimen is placed on a piece of glass and adjusted

to proper position between surface of C and hole in F so that specimen may be seen to best advantage, then, when a drop of water is placed in the hole in F, a much enlarged reflection of the specimen will be seen.

8. K,K' represent pin curl type of clip which may well be adapted to serve as a means of holding the glass in position. Clips may be found in department stores and adapted according to type.[1]

1/ Op. Cit. Charles A. Haner with some adaptations and additions.



Sketch of
simply constructed
MICROSCOPE

Experiment 2 by Group 2. "Hydrotropism"

Materials: Seeds, large glass tube, cork, square glass dish, good soil.

Method: Use some of the seeds which were germinated in the last experiment. Place the seeds near the edge of the glass dish so the roots may be easily seen through the glass. Also put them near the end of the dish. Insert a perforated cork at the other end of the glass dish. At the other end of the cork, insert a glass tube and fill this tube with water.

Conclusion: Small amounts of water will seep through the soil. Most of the root hairs will be on the side of the water. This shows that roots will seek water. The process is called hydrotropism.[1]

Experiment 3 by Group 3. "Osmosis"

There are many ways of showing osmosis. Different pupils may show different experiments for it or all work on one. One way to demonstrate osmosis may be as follows:

Materials: Potato, glass tumbler, dark blue or purple food coloring.

Method: Peel the potato and cut off a piece on the bottom so it will stand alone. Gauge-out the inside of the potato, leaving just a narrow shell. Stand the potato in the tumbler and pour colored water inside the potato to about

---

1/ Charles A. Haner Thesis on "Inexpensive Equipment and Demonstrations for the Biology Laboratory and Classroom." Adams State College, Alamosa, Colorado.

one half inch from the top. Pour plain water into the glass, outside the potato, to the same level that the water is inside the potato. Let this stand for two hours. Mark the water level on the glass and in the potato, when you begin, and after two hours.1/

Another way is to place a stalk of celery in colored water.2/

Conclusion: You have found that the water and liquid minerals soak through the sides of the potato. This process is called osmosis. This is the way the plant gets food from the soil. The liquid minerals and water soak through the root hairs into the root just as they soaked through the sides of the potato.

Experiment 4 by Group 4. "Imbibition"

Materials: A sponge that is dry, water, dry beans, plaster of Paris, cardboard.

Method: Make 2 cardboard cones about 2 inches in diameter. Pour plaster mix into one of the cones and plaster mix with beans into the other cone. Allow the plaster to set, and remove it from the cone when dry. Place both cones in a dish of water with the bases down. Add water as the supply is absorbed. In a few days the cone will burst by the force of the swelling beans. This swelling

1/ Op. cit., p. 6.

2/ Thomas L. Dowling, Kenneth Freeman, Nan Lacy, James S. Tippett, DISCOVERING WHY, The John C. Winston Co.

of seeds and roots is called Imbibition.[1]

Notice the thickness of the dry sponge. Put it in water and let it stand for a few mintues. Notice the thickness of the sponge then.

Conclusion: The sponge swelled when it was wet. In the same way the root hairs swell when the liquid minerals and water soak in. This is called Imbibition.

Experiment 5 with Group 5. Growth takes place at the tip of the root hair.

Materials: Use root hairs grown in the test tubes.

Method: Measure the length of the root hair by placing a mark on the glass of the test tube each day for a week.[2]

Conclusion: The root hair grows at the tip. The tip of the root hair is stiff so it can push through the ground.

Experiment 6 with Group 6. Plant Food.

Materials: Different kinds of fertilizers, opaque projector. Illustrations of leaves showing malnutrition.

Method: Exhibit types of fertilizers. List the elements a plant needs. Show on the opaque projector the effect of lack of different elements as shown from Horticulture magazine.

Conclusion: You have seen that plants take in water and liquid minerals through the tiny root hairs. The liquid minerals make up the plant food. The minerals have to be in liquid

---

1/ Mr. Haner. Op. cit., p. 6

2/ Op. Cit., Mr. Haner.

form or they cannot soak into the tiny spong-like hairs. That is why it is so necessary to water a plant because the water dissolves the minerals so that the root hairs can take them in.

Lesson 3 with teacher. "Stem and Leaf Structure.":-- Now we have seen what part the roots play in the growth of a plant. Let us see what the stems and leaves do.

Materials: Opaque projector. Stalk of celery, asparagus, rhubarb, stem of a pea or bean, branch of a tree. Picture of a cross section of the trunk of a tree. A leaf and the picture of the cross section of a leaf.

Method: Show these on the opaque projector. Note the position of the fiber or vascular bundles. Use celery or asparagus for monocots, and stems of beans, peas, or rhubarb to illustrate dicots. Note that it is these fibers that are used in making cloth, straw hats, and baskets. The tree is also a dicot. Show illustration of a cross section of a tree trunk.[1/] Be sure to note the cambium layer. If possible, show a cross section of a living branch. Note the cells and veins. Show a cross section of a leaf.[2/] Note the cells and veins. Show the underside of a real leaf so that pupils can see the stomata and veins. Have pupils see the leaf under the microscope.

1/ Bertha Morris Parker, PLANT FACTORIES, Row Peterson & Co., Evanston, Illinois., p. 10.
2/ Op. cit., p. 9., Miss Parker.

Experiment 7 with Group 1. "Capillarity." 1/

Materials: A lamp wick, three glass tubes with small bores of different sizes, two plates of glass, a stalk of celery, a flat bottom dish, red coloring matter.

Method: Hang the wick with one end in the colored water. Stand the stalk of celery also in the water. Place the glass tubes upright in the dish of colored water. Place two glass plates in some colored water with the edges of the plates together at one side, and the other open like a book. Open and close the glass plates while watching the water between them. After 24 hours notice what has happened in the glass tubes and the celery. Cut the celery stalk lengthwise to see the tissues and tubes. Examine through the microscope. 2/

Activity 4:-- Make a diagram of a plant labeling the parts. Make a diagram of a tree labeling the parts. This may be done before school or in extra time.

Experiment 8 with Group 2. "Making Leaf Skeletons."

Materials: A leaf, a piece of soft cloth or felt, a stiff brush, 4 ounces of household lye, 1 pint of water, an old enamel or glass pot or dish.

Method: Boil the leaf for a couple of minutes in the solution of lye and water. Wash thoroughly in clean water. Tap

---

1/ Harry A. Carpenter and George C. Wood, OUR ENVIRONMENT, Allyn and Bacon, Boston, Mass. pp. 108-109.

2/ Op. cit., Mr. Carpenter.

the bristles of the brush firmly and repeatedly against the leaf. The bristles will slowly pick out the fleshy part of the leaf. When all fleshy part is removed, dry and press the skeleton under thick paper and mount between cellophane.1/

Experiment 9 with Group 3. "Phototropism:

Materials: A box, a few seedlings.

Method: Place seedlings under the box and cut a small hole in one side of the box. After a few hours, the plants will lean toward the light.2/

Also see experiment, page 167, in DISCOVERING WHY.3/

Experiment 10 with Group 4. "Thigmotropism"

Materials: Flower pot, small sweet pea seedlings, a rod or stick.

Method: Plant the sweet peas in the flower pot. After they have some growth, place the rod beside the plants in the pot. The plant will climb the rod.

Experiment 11 with Group 5. To Make Oxygen: "To prove that there is Oxygen in the Air."

Materials: Hydrogen Peroxide, $\frac{1}{4}$ teaspoon of baking soda, a

---

1/ William Hillcourt, FIELD BOOK OF NATURE ACTIVITIES, G. B. Putnam's Sons, New York, N. Y. p. 309.

2/ Mr. Haner, Op. cit.

3/ Thomas Dowling, Kenneth Freeman, Nan Lacy, James S. Tippett, DISCOVERING WHY, The John C. Winston Co., p. 167.

test tube, a stopper to fit the test tube, a candle, and a glass jar.

Method: Put the baking soda in the test tube. Add the hydrogen peroxide until the test tube is $\frac{1}{4}$ full. Place the cork loosely in the mouth of the tube. Heat the tube until the liquid begins to boil. Light a match and blow out the flame. While it is still glowing, remove the stopper from the test tube and lower the glowing match into the tube.

Conclusion: The match will burst into flame again. The gas in the tube is oxygen. The element oxygen makes things burn. Now light the candle and place a glass jar over it. It will burn as long as there is oxygen in the jar. This proves that there is oxygen in the air.1/

Experiment 12 with Group 6. "To make carbon dioxide and to prove that there is carbon dioxide in the air."

Materials: Some baking soda, vinegar, a wood splinter or match, lime water, two drinking glasses, a test tube.

Method: Place a quarter of a teaspoon of baking soda in the test tube and pour vinegar into it slowly. After the bubbles have burst, lower the burning splinter into it. Now hold the test tube over the glass which has a little lime water in it. Put some lime water in another glass and let it stand uncovered for an hour or so.

1/ Warren Knox, George Stone, Morris Meister, Dorothy Wheatley, THE WONDER WORLD OF SCIENCE, Charles Scribner's Sons, New York, N. Y., pp. 91-92.

Conclusion: The carbon dioxide turns the lime water milky and the air turned it milky, which proves that there must be carbon dioxide in the air.[1]

Experiment 13 with Group 1. To Make Hydrogen.

Materials: Pieces of zinc from and old flash light, scissors, a test tube, a one-hole stopper, a piece of glass tubing to fit in the hole of the stopper, vinegar.

Method: Cut the zinc into small pieces and place them in the test tube. Slip the glass tubing into the hole of the stopper. Pour strong vinegar into the test tube over the zinc until the tube is about one third full. Put the stopper on the test tube. Heat until the liquid begins to boil. Remove the test tube from the fire and shake it. Now light the wood splinter and while it is still burning, remove the cork and quickly lower the burning splinter into the test tube.

Conclusion: The gas in the tube will explode. That gas is hydrogen. There is hydrogen in the air.

Experiment 14 with Group 2. "Photosynthesis"-the process by which sugar and starch are made in green leaves.

Materials: An electric plate (or canned heat), pan, water, test tube, alcohol, green leaves, iodine, Fehling's solution, three glass dishes.

1/ Op. cit. p. 92., Mr. Knox.

Method: Boil some water in the pan. Place some green leaves in a test tube and fill the tube almost full of alcohol. Place the test tube in the hot water, and boil the alcohol a few minutes until all the green chlorophyll comes out. Wash the leaves in clear water in one dish. Put some of the leaves in each of the other two dishes. Drop some Fehling's solution on the leaves in one dish. If they turn brownish green with orange red spots, there is sugar. Now place some iodine on the leaves in the other dish. If they turn a dark blue or purple, there is starch.[1/]

Experiment 15 with Group 3. Plants cannot make food unless they have sunlight.

Materials: A geranium plant (or one with good-sized leaves), two milk bottle tops, heat, pan, water, iodine, Fehling's solution, pins, alcohol.

Method: Pin some milk bottle tops on each side of several leaves of the growing plant. Put the plant in the sunlight for several days. Break off the leaves with the milk bottle covers on, and remove the covers. Boil the leaves in alcohol as in the last experiment. Test for sugar with the Fehling's solution, and for starch with the iodine.

1/ George Willard Frasier, Helen Dolman MacCracken, Donald G. Decker, Daniel C. McNaughton, HOW AND WHY EXPERIMENTS, p. 240.

George B. Cummins, George A. Gries, Samuel Postlethwait, Forest W. Stearns, WORKBOOK IN PLANT SCIENCE, p. 37.

Test some leaves that did not have milk bottle covers on.

Conclusion: This experiment proves that sunlight is necessary for the plant to make starch and sugar.1/

Experiment 16 with Group 4. Plants need sunlight, air, and water.

Materials: Four seedlings, four flower pots, a glass jar, wax paper to cover jar, string to fasten it, paraffin, heat, pan to heat paraffin.

Method: Plant the seedlings in each of the four flower pots. Place one pot in the dark, but give it water. Place the second in the glass jar, but give it a little water. Seal the jar with paraffin. Give the third plant air and sunlight, but do not water it. Give the fourth plant air, sunlight and water. Keep all the plants at the same temperature. Do this for a week or two.2/

Which grows the best? Which grows the least?

Conclusion: This proves that green plants need air, sunlight, and water.

Experiment 17 with Group 5. To show that green plants give off oxygen during photosynthesis. This is called "Respiration."

Materials: An aquarium, a wide-mouthed jar, water, plants, a splinter of wood, a match.

Method: Fill a jar with water. Turn it upside down over some plants in the aquarium. Put the aquarium in the sun for

---

1/ HOW AND WHY EXPERIMENTS, Op. Cit, p. 241.

2/ Alice Dickinson, FIRST BOOK OF PLANTS, Franklin Watts, Inc., 699 Madison Ave., New York, N. Y.

a few days. Some of the water will flow out of the jar into the aquarium. Lift the jar and quickly put a glowing wood splinter into it. If the flame flares and brightens, there is oxygen in the jar.1/

Conclusion: What pushed the water out of the jar? Where did the oxygen come from? This proves that the oxygen must have come from the green plants. You know it is oxygen because it made the flame burn brighter.

The oxygen comes into the leaf through the stomata when air goes in. Some oxygen is also taken from the water. There is more oxygen than the plant needs so it gives out the rest of the oxygen.

Experiment 18 with Group 6. To show that growing seeds give off heat. This is "Respiration."

Materials: Pea or bean seeds. Two collecting jars, two one-hole stoppers, two thermometers, a piece of cloth.

Method: Fill one of the jars half full of germinating seeds. Place the thermometers in the stoppers. Stopper the jar, but do not have the thermometer touch the seeds. Wrap the jar with cloth to retain the heat. Put the other thermometer and stopper in the other jar but omit the seeds. Check the temperature of each thermometer several days.2/

1/ HOW AND WHY EXPERIMENTS, Op. cit., p. 245.

2/ John W. Ritchie, BIOLOGY AND HUMAN AFFAIRS, World Book Co., New York, 1948, p. 527.

Conclusion: The seed uses some oxygen in growing and this chemical action releases heat energy.

Experiment 19 with Group 1. Plants give out some carbon dioxide. This, too, is "Respiration."

Materials: Small dish, large test tube, potassium hydroxide solution, germinating seeds.

Method: Place the seeds in the bottom of the test tube and hold in place with cotton. Invert the test tube in a dish containing potassium hydroxide solution. The oxygen in the test tube is absorbed and replaced by carbon dioxide which is given off by the germinating seeds. As the oxygen is used by the germinating seeds, the solution rises in the test tube.1/

Conclusion: These two experiments show that there is a chemical reaction going on in germinating seeds during their growth. This same chemical action goes on in the leaf during photosynthesis. But when a plant makes food, it does not use all the oxygen and carbon dioxide it takes in through the stomata and water. The waste oxygen and carbon dioxide goes back into the air through the stomata. This process is called respiration or breathing, and is the way plants help to keep the balance of nature. More oxygen is given off than carbon dioxide and that is how plants purify the air.

1/ W. H. Brown, THE PLANT KINGDOM, Ginn & Co., New York, N. Y., 1935, p. 78.

Experiment 19 with Group 2. To show that plants give out water during the process of Photosynthesis.

Materials: Two small potted plants of the same size, aluminum foil, two large wide-mouthed jars.

Method: Water the plants well. Place one aluminum foil around the stem and over all of the pot so that no moisture can escape. Do this with each plant. Now put the jars over each plant. Place one plant in the sun and the other where it will receive no sunlight. Let them stand all day. Notice the drops of moisture on the jars. Does the one in the shade have any moisture?

Conclusion: The plant in the sun had drops of moisture on the inside of the jar. The one in the shade had none. This shows that the moisture must have come from the plant, and that it was produced during photosynthesis. The moisture is first in the form of water vapor. This escape of moisture from the plant is called "Transpiration." The vapor condensed to form the drops of water.

A considerable part of the water vapor in the air comes from plants through transpiration. The water vapor rises as it becomes heated. As it reaches cool air above, it condenses into drops of rain, or snowflakes if it is cold enough. The rain soaks into the ground and is taken into the roots again. The water goes up through the stems and into the leaves where it comes out again as water vapor. Thus it makes a circle which is called the water cycle.

Activity 5:-- Make a chart showing The Water Cycle.

Now you have seen how plants obtain the raw materials by which they can manufacture food, not only for themselves, but for all animals and other plants which do not have green leaves, and for people as well.

Here are some of the plants which live on green plants. You see they do not have green leaves so they cannot make chlorophyll.

Activity 6:-- Make a chart of fungi of different kinds.

Green plants not only make sugar and starch, but they also make fat in the form of oil. Sometimes the oil is in the fruit, as in olives, or it may be in the seed, as in cotton seed, soybean, or peanut.

Activity 7:-- Make a chart of plants which give us oil.

Another kind of food that green plants make is protein. Milk, eggs, lean meat, beans, peas, and peanuts have a great deal of protein in them. The green plant uses the minerals in the water to make the protein. Nitrogen is the most important element it uses for making protein.

Experiment 20 with Group 3. Test for Protein.

Materials: White of a hard-boiled egg, lean meat, beans, concentrated nitric acid, test tubes, heat, ammonia water (ammonium hydroxide).

Method: Put the hard-boiled egg in one test tube and the lean meat in the other. Add enough nitric acid to cover each. Heat carefully. Notice if color changes. Pour the acid off into a waste jar and add a little ammonia water. Heat again. See if it changes color again. Do the same with the beans.[1]

Conclusion: Proteins are needed by our bodies to build muscle and repair worn-out tissues. You get protein directly from vegetables, and indirectly from eggs and meat. While plants need sunlight to make sugar and starch, they can make protein without sunlight, at night.

Another kind of food that green plants make is called vitamins. Plants make the vitamins for themselves as well as for us, because we get the vitamins by eating the green plants.

Lesson 4:-- Film Strip. "How Plants Live."[2]

Discuss the film as it is shown. Give the test that is on the film.

Lesson 5:-- Reproduction. Flowers are the part of the plant which might be called the seed-making machines. Plants must produce young plants so their special kind can be carried on. On the outside of the bud are some green leaves which form a cup. When the flower opens, these green leaves are next to the stem and are called sepals. Inside the sepals are the petals which make up the corolla. The corolla is usually white or a bright color to attract the insects. Inside this corollà are several stamens which are thick at the tip and are covered with a powder called pollen. Inside the stamens, in the very center, is a hollow tube covered with a sticky liquid, and this is called the pistil. The stamens are the male part of the flower and the pistil is the female part. Usually they are both in the same flower, but sometimes there will be some flowers that have only stamens, while others have only pistils.

1/ Harry A. Carpenter, George C. Wood, OUR ENVIRONMENT, Bk I, Allyn and Bacon, Boston, Mass. p. 298.

2/ Society for Visual Education, Chicago, Ill, (1345 W. Diversey Parkway)

The pistil broadens out at the base to form a pod which is called the ovary. Inside the ovary are little pockets containing eggs. To form a seed, the powder, or pollen, must go down the tube of the pistil and join with the eggs in the ovary. How does the pollen get onto the pistil? Sometimes the wind blows it on to the sticky pistil. Sometimes the pollen rubs off onto the wings of bees, insects, or birds, and when they go to another flower, the pollen in turn rubs off onto the pistil.

Why do the insects and birds go from flower to flower? They are after nectar, which is a sweet liquid, way inside the flower near the ovary. So the bee has to push past the stamens and pistil to reach this nectar, and that is the way he carries pollen from flower to flower. Bees are the best helpers in carrying pollen from one flower to another. They use the nectar to make honey and bee bread to feed their young. The bright color of the corolla, lines on leaves and petals guiding the insect into the flower, and the odor help to attract the bees, humming birds, ants, and other insects.

Activity 8:-- Examine a simple flower, such as the tulip, to note the parts mentioned above. Draw a diagram of a simple flower and label the parts. If possible, examine more complicated flowers. Exhibit pictures of those not available. Use the opaque projector for this.

As soon as the pollen has joined with the egg in the ovary, the seed begins to develop, and roots, stem, and leaves of a tiny plant start to grow. This is called the embryo, or baby plant. In order that the tiny plant will have enough food to make it grow, starch and sugar are packed around it in a little bundle which we call the seed. Then the rest of the flower withers and drops off. If not picked, the seed will drop to the ground too.

Some ripened seeds are carried away by the wind, by the water, or stick to animals and people. They finally sink into the ground and rest a while, sometimes all winter. When the warm weather comes again in the spring, they start to grow again and become new plants.

Activity 9:-- Soak a dried lima bean over night. Split it open to show the embryo. If possible, dip it in red ink so the small plant will be stained a little. Wash off the excess ink.

Activity 10:-- Collect as many different kinds of plants as possible. Press, mount, and label.

Activity 11:-- Collect different kinds of seeds in cellophane bags. Mount and label. If possible, mount plant and seed together.

Activity 12:-- Follow the growth of several kinds of trees, especially the evergreens, through spring, summer, fall and winter. Collect and mount specimens of their buds, flowers, fruit, leaves, and twigs.

Activity 13:-- Examine as many different kinds of ferns as can be found. Note the fronds and spore cases. Grow some ferns.

Activity 14:-- Examine different kinds of mosses. Grow some moss in a terrarium. Dry and mount some mosses. Show samples of peat moss and peat. Note spore cases and spore dust.

Activity 15:-- Read about Luther Burbank's work in making changes in plants.[1/] Cut slips from a geranium plant, or a forsythia bush, and plant them in moist sand. Keep the sand moist until roots appear on the slips. If new leaves come on the slip you will know it is growing. To keep the

1/ Thomas I. Dowling, Kenneth Freeman, Nan Lacy, James S. Tippett, DISCOVERING WHY, The John C. Winston Co., Chicago, Ill. pp. 190-195.

sand moist, cover the box and plants with polyethaline. Do not stand the box in direct sunlight for too long. Keep it in the sun only part of the day.

Activity 16:-- Make a field trip to a garden ororchard. Demonstrate budding and grafting. This should be done in the Spring. Use fruit trees, Spring flowering shrubs, or rose bushes.

In case the pupils or teacher are unable to procure the actual specimens of the flowers, ferns, or mosses, the following film strips are very good.

Film Strips:

American Wildflowers -- 4 films.1/

Parts of a Flowering Plant.2/

Flowers.3/

Spermatophyta.4/

Only use selected parts of this film as it is too difficult for elementary pupils.

Seeds.5/

Flowers, Fruits, and Seeds.6/

How Plants Grow and Reproduce.7/

1/ Young America Films, Inc., 18 E. 41st St., New York 17, N. Y.

2/ Curriculum Films, Inc., Chicago, Ill.

3,5,6/ Row, Peterson & Co., Evanston, Ill.

4/ Visual Sciences, Suffern, N. Y.

7/ Society for Visual Education, Inc., Chicago, Ill.

Lesson 6:-- Algae. You have all seen seaweed at the beach, and the green scum on the side of the aquarium, as well as the green scum on a pond. These are all the same kind of plant called algae. The green scum is made up of tiny plants that you will have to see under a microscope, while some algae grows over one hundred feet long. Usually algae is green, but sometimes it is brown, red, yellow, orange, or blue. The color of the yellow, orange, red, and blue pools in Yellowstone Park is due to the algae that live in the high temperature of the pools. Blue algae lives at the highest temperature. They all contain chlorophyll in spite of their color, so they can manufacture food. Some have just one cell, while others, such as the seaweed, are thin sheets of many cells. Algae do not have any roots, or leaves, or flowers, or seeds. Each cell takes in minerals, carbon dioxide, and oxygen from the water and with sunlight makes chlorophyll and plant food.

Algae reproduce in many ways. Some make spores which are like dust; others make eggs which join with male cells to form new plants; and others just split into two parts, each part growing into a new plant.

Seaweeds have many shapes and sizes. They look as if they have leaves, but those are merely branching parts. They hold fast to the rocks by strong suction cups, and their swollen bladders act like water wings to keep them afloat. Seaweeds are rich in minerals and in many countries they are eaten as vegetables.

Lesson 7:-- Plants that do not make their own food.

Experiment 21 with Group 4: To make mold.

Materials: A slice of fresh bread, water, a tin box.

Method: Wet the bread slightly and put it in the tin box in a warm room. Put the cover on the box, and leave it there for a few days. If the mold has formed, place some of it on a slide and examine it under a microscope, or show it on the opaque projector.

Conclusion: The warmth and moisture caused the mold to grow on the bread. The mold is a tiny plant. It is white or gray, so does not have any chlorophyll in it.

Experiment 22 with Group 5. To make a spore print.

Materials: Mushrooms, toadstools, puffballs, white or light blue paper, microscope.

Method: Place the mushrooms, toadstools, and puffballs on pieces of white or blue paper with the gills down toward the paper. Tap lightly in several ways and lift the fungi off carefully. Note that each kind has a different pattern in the spore print. Put the spore prints on the opaque projector and some spores under the microscope.

Conclusion: Under the microscope it will be seen that these spores are little plants. Molds, mushrooms, mildew, and yeast are like this and are called fungi. The part of the plant which gets the food is a white, threadlike net that grows through the other plant upon which the fungus is living. As the fungus cannot make its own food, it has to get it from another green plant, or a decayed plant, which is called the host. The threadlike net spreads through the green plant, using the chlorophyll that it is making, until finally the host is destroyed. The fungus will live inside the plant for some time before anyone knows it is there. When it is ready to make a new plant it sends up the mushroom or mildew, etc., that is seen. On these growths are the tiny spores which blow into the air with the slightest breeze. When the spores land in a favorable place, they start to grow new fungi.

Yeast plants grow by forming buds. Each bud breaks off and forms a new plant. As the yeast, grows, it gives off carbon dioxide in bubbles.

Experiment 23 with Group 6. To show yeast budding.

Put some yeast in sugar water. Let it stand in a warm place. Put a drop or two under a microscope to see the yeast budding.

<u>Lesson 7</u>:-- Bacteria.

Experiment 24. To grow bacteria.

Materials: Five jars that can be sealed, a pan of water, a potato, microscope, a fly.

Method: Boil the jars in the water bath for fifteen minutes. Put a slice of raw potato in each one. Put the tops on the jars and boil in the water bath for thirty minutes. Seal one jar without opening it. Open another jar and shake some dust on the potato. Open another jar and touch the potato with your fingers. In another jar place a hair on the potato. Open the last jar and let a fly walk over the potato. Cover the jars again and let them stand in a warm dark place for a few days. Notice the spots on the potato. Place one of the spots under the microscope.

Conclusion: The yellowish white spots are groups of bacteria. The spores from the dust, on your fingers, on the hair, and on the fly's feet, when exposed to moisture, darkness, and heat, absorbed food from the potato and grew.

Bacteria may be round, or shaped like rods, or spiral. (Show pictures of enlarged bacteria through microscope, or opaque projector). Some bacteria are harmful and cause diseases, such as diphtheria, typhoid fever, tuberculosis, and influenza. Bacteria cause decay which may be harmful when they cause food to spoil, but helpful when they cause leaves and dead trees to change into humus. Bacteria in the soil help green plants by making nitrates which give the plant nitrogen.

(Show a clover plant with the roots exposed). Notice the little lumps on the roots. In such plants as clover, alfalfa, and peas, bacteria have gone into partnership with the plant. The bacteria take the food from the green plant, but in turn make nitrates, which are stored in these lumps. The plant uses some of these nitrates and when plowed under, gives nitrates to the soil so that other plants can get them.

Lesson 8:--Lichens. (Show examples of the three kinds, either with actual specimens, or pictures.)

Another example of plants that form partnerships is the lichen. A lichen consists of an alga and a fungus that grow together. The fungus part makes a weak acid which breaks up the rock so the plant can anchor there. This threadlike network spreads over the rock. In between and all through the network grow little one-celled algae. The algae take carbon dioxide and water from the air and make chlorophyll, enough for themselves and their partners, the fungi. The fungi, in turn, store water so that the algae do not dry out. They form spores, too, for new plants, but also parts break off with the algae and fungi together, and are carried by the wind or water to a new place.

There are three kinds of lichens, crust-like, leaf-like, such as rock tripe, and shrub-like, such as reindeer moss and old man's beard. Reindeer moss is not a moss at all, but a lichen. The old man's beard grows on living trees, such as the spruce trees in northern evergreen forests. This lichen can endure great cold and long periods of dryness. When dry, it is brittle, but as soon as moisture comes, it becomes green and spongy.

Film Strip To Supplement the Lesson:

Thallophyta.[1/]

Activities 17, 18, 19:--

Field Trips Recommended:

To a beach to collect seaweed.

To a pond to collect algae.

To the Krimco Corporation to see how gelatin and other products are obtained from seaweed, Irish moss, and kelp, to make puddings, etc. Also to note chemicals extracted from these materials.

1/ Visual Sciences, Suffern, N. Y.

II. Man's Use of Plants.

A. Uses of Parts of Plants.

Activity 20:-- Using actual specimens or pictures, make exhibits and charts showing plants you use as food. Emphasize the part of the plant used.

Roots--carrot, turnip, beet, radish, parsnip, sweet potato.

Stems--onion, asparagus, potato, peanut, celery, taro, rhubarb.

Flowers and buds--broccoli, cauliflower.

Sap--maple sugar.

Fruit--grain (wheat, corn, barley, oats, rye),
nuts (walnut, chestnut, brazil nut, etc.)
olives, tomatoes, oranges, lemons, grapefruit, apples,
pears, peaches, beans, peas, squash, pumpkin, cherries,
coffee, tea, cocoa, chocolate.

Leaves--lettuce, celery, cabbage, spinach, dandelion,
water cress.

Show the parts of plants used for clothing either by pictures and charts or specimens.

Fibers--cotton, linen, hemp, henequen, corn.

Cellulose--cotton, wood.

Sap--rubber, latex.

Bark and Fruit--Juice for dyes and tanning leather.

Black walnut--furniture, cabinets, gunstocks.

Butternut--furniture, interior finish, ornament.

Birch--furniture, spools, clothespins, wood pulp, ornament.

Beech--ornament, furniture, woodenware, fuel.

Boston University
School of Education
Library

Oak--interior finish, floors, furniture, ornament.

Willow--ornament, baskets, pulp.

Aspen--pulp, boxes, matches, fuel, excelsior.

Mahogany--fine furniture, most valuable timber tree.

Pine--ornament, house finishing, construction.

Spruce--valuable timber, floors, sounding boards for musical instruments, ornament.

Cedar--shingles, chests, posts, pencils, oil.

Fir--ornament, resin.[1/]

Activity 21:-- Divide the school district into sections and have pupils make a census of the district to see the different kinds of trees.

Activity 22:-- Field trip to a park to make a map of the park, locating the different trees.

Activity 23:-- Parts of plants used for building.

Show the chart "What We Get From Trees".[2/] List the parts of the tree used for building. Illustrate with pictures, showing the part of the plant used and the product made from it.

Make illustrated booklets showing each kind of tree, with the leaf, flower, seed, and full-grown tree, and, if possible, the twig and bark. Tell what the wood is used for in building. Include at least the following trees and their uses:

Maple--woodworking, furniture.

Linden--shade trees in cities.

1/ Valerie Swenson, A CHILD'S BOOK OF TREES, Maxton Publishers, Inc., New York, N. Y., 1953, pp. 1-29.

2/ Forest Service, United States Department of Agriculture, Washington, D. C.

Horsechestnut--shade trees in cities and parks.

Chestnut--railroad ties, posts, telephone poles.

Tulip--manufactured lumber, airplanes, boxes, woodenware,

Black Locust--parks and lawns.

Honey Locust--building, fuel.

Cherry--furniture, ornament.

Ash--tool handles, athletic goods.

Mountain Ash--ornament.

Sweet Gum--furniture, veneer, boxes, crates, ornament.

Dogwood--ornament, cabinetmaking, tool handles.

Sycamore--furniture, boxes, woodenware.

Lessons 9, 10, 11, 12:--

Film Strips Recommended:

Telling Trees Apart.1/

Buttonwood Park, New Bedford--5 films.2/

Logging.3/

Forests of the United States.4/

Rubber.5/

Rubber in South America.6/

A Class Studies Rubber.7/

1/ Eye Gate House, Inc., 2716 42nd Ave., Long Island City 1, New York.

2/ Audio Visual Dept., New Bedford School Dept.

3, 4/ Office of Coordinator of Inter-American Affairs, Washington, D. C.

5, 6, 7/ Visual Aids Dept., Wayne University.

Movies:

Strength of the Hills.[1]

Trees and Homes #17.[2]

Activity 24:-- Parts of plants used for Communication.

Boats--

Hull--cedar or black locust.

Ribs--spruce or fir.

Keel--ash, hard pine, or oak.

Deck--teak or oak.

Mast--fir.

Rudder--ash.

Center board--ash or hard pine or oak.

Airplanes--

spruce.

tulip veneer.

Activity 25:-- Other products from plants.

Paper and Paper products.

List and exhibit.

Wall board and insulation.

Exhibit.

Spices:

Spices are not really food, but they are used to make our food taste better.

Show collection of spices and pictures from which they come. Pepper comes from the seeds of a plant; mustard

1,2/ Eye Gate House.

from seeds; nutmeg from the seeds of a tree; cloves from dried buds of a tree; cinnamon from the bark of a tree; ginger from the rootlike underground stems of a plant.

Herbs:

Herbs are used in cooking to flavor food. They are all parts of plants. The most common herbs are thyme, mace, rosemary, anise, sweet marjoram, parsley, bay leaves, curry, sweet fennel, chives, and mint.

Exhibit collection of herbs with plants or pictures of plants from which they come.

Chewing gum:

From chicle, the sap of the bully tree.

Activity 26:-- Parts of plants used for medicine.

Penicillin--from penicillium of mold.

The green color in the mold is not chlorophyll.

Digitalis--from leaves of the foxglove.

Camphor--from the wood of the camphor tree.

Quinine--from the bark of the cinchona tree.

Opium--from the milky juice of the poppy plant.

Atrophine--from the root of the belladonna or deadly nightshade plant.

Nicotine--from the leaves of the tobacco.

Caffein--from the coffee bean.

Cocain--from the leaves of the coca shrub.

Lesson 13:--

Parts of plants used for paints and varnishes:

Linseed oil from flax seeds.

Tung oil from tung nuts.

Wood alcohol from stumps of trees.

Turpentine from pine and fir trees.

Resin from pine and fir trees.

Parts of plants which produce chemicals:

From wood by distillation -

wood alcohol.

acetate of lime.

acetic acid.

wood creosote.

cellophane.

celluloid and celluloid products, such as photofilm, etc.

heptane for drugs and gasoline knock.

storax for drugs, incense, flavoring extracts, and adhesives.

cellulose.

Experiment 25: To demonstrate distillation.

Materials: A flask, a test tube, a glass J tube, wire gauze, electric plate or canned heat, ring stand, ink, one-hole stopper, cold water, beaker.

Method: Fill the flask about one quarter full with ink. Stand the flask on the wire gauze on the ring stand. Fasten the short end of the J tube in the one-hole stopper and put the stopper in the flask. Allow the long end of the J tube to lead into the test tube which stands in a glass bottle or jar. Now heat the ink and let it boil in the flask. Pour cold water over the glass tube near where it enters the test tube.

Conclusion: Notice the clear water that drops down in the test tube. The water in the ink changed to a gas which rose through the glass tube, and when cooled by the cold water pouring over the tube, it condensed into clear water. This process is called "Distillation."

That is the way alcohol and other chemicals are obtained from wood. The wood is ground to a powder, mixed with either water or a chemical, and distilled. The different acids or chemicals condense at different temperatures.

Activity 27:-- Plants used for ornamentation and beauty.

Exhibit on charts, bulletin board, or flannel board pictures of ornamental trees, shrubs, and flowers. List flowers as annuals, biennials, and perennials.

Make a census of those in the neighborhood.

Make a map of those in the park.

B. States Raising Such Plants in Quantity.

Correlation with Geography and Arithmetic:

In geography period, make maps of the states in the United States which raise such plants in quantity. Do the same with the other countries of the western hemisphere. This is for the fifth grade.

In the sixth grade make maps of countries of the world which raise plants in quantities.

Exhibit these two types of maps in the fourth grade.

C. Number of People Employed.

In arithmetic periods, make graphs showing the number of people employed.

Exhibit these graphs in the fourth grade.

III. Business Connected With Plants.

Correlation with Geography and Arithmetic.

Food--Questions and recitations on the geography and supplementary texts. Discussion of film strips.

Film Strips Recommended:

Agriculture in Our Southern States.1/

Golden Secret (Wheat). 2/

The Corn Belt.2/

Valley and Coast Lands of California.1/

Maple Syrup Industry.1/

Sugar Cane in Hawaii.3/

Wheat Regions in Canada.2/

1/ Curriculum Films, Inc., Education Projections, Inc., 10 E. 40th St., N. Y.

2/ Creative Art Studio, 1200 Eye St., N.W., Washington 6, D. C.

3/ Pat Dowling Pictures, 1056 So. Robertson Blvd., Los Angeles, Calif.

Agriculture in South America.1/

Farmers in Mexico.1/

Story of Coffee Regions.2/

Rice-Basic Crop of the East.3/

Agriculture of Eastern Mediterranean.3/

Japanese Farmers.3/

Clothing--Questions and recitations on the geography and supplementary texts.

Film Strips:Recommended:

Spinning and Weaving.4/

Cotton-From Mill to Finished Product.5/

Weaving in South America.5/

Industrial Workers of Europe.6/

Manufacturing Industries in our Southern States.6/

Valley Regions of Northeastern United States.4/

Then and Now in the Cotton Belt.5/

Northeastern States.6/

Resources and Manufacturing Industries of the South.6/

Yucatan.1/

Weaving in the Highlands of South America.1/

1/ Office of Coordinator of Inter-American Affairs, Washington, D.C.

2/ Pan American Coffee Bureau, Wall St., New York.

3/ Pat Dowling Pictures, op. cit.

4/ Curriculum, op. cit.

5/ Encyclopedia Brittanica.

6/ Society for Visual Education, op. cit.

Building.

Film Strips Recommended:

Forests of the United States.[1]

Logging.[1]

Coast Lands of North Western United States.[2]

Building a House.[3]

Southeastern States.[2]

Transportation.

Film Strips Recommended:

Railroads as Buyers.

Railroads and the Food We Eat.

Airplanes at Work.

The Tug Boat.

The Passenger Boat.

The Harbor Boat.

Let's Visit an Ocean Liner.

Medicine.

List all the different kinds of business which produce or distribute medinine. Include research workers and how the vitamins were discovered.

Beauty.

Show colored slides of landscaping and flowers in the community.

1/ Inter-American Affairs, *op. cit.*

2/ Curriculum, *op. cit.*

3/ Encyclopedia Brittanica, *op. cit.*

Field trip to a nursery to see how plants are propagated.

The plant nursery business.

Field Trips Recommended:

Trip to a cotton or rayon factory -- Hathaway Manufacturing Company, New Bedford.

Trip to the Krimco Corporation to see how gelatin is extracted from seaweed.

Trip to the Acushnet Sawmill to see how lumber products are made.

Trip to Vander Pol's Nursery.

Trip to Palmer Scott & Company, Boat Builders.

A. Maps showing cities engaged in such business.

B. Graphs showing number of people employed.

IV. Inter-relation Between Plants and Other Living Things.

A. Food Chains from Plants.

Have each group of pupils make one or more of the following food chains, using pictures, if possible, or by graphs and diagrams. Starting with some kind of green plants, each living thing mentioned furnishes food for the next, etc.

Green plants--grass--cows--cattle--milk--meat--leather--man.

Green plants--corn--poultry--eggs--meat--man.

Green plants--lambs and sheep--meat--clothing--man.

Green plants--pigs and hogs--meat--leather, etc.--man.

Green plants--algae--plankton--larvae of clams and oysters,--limpets, periwinkles, sea urchins, sea cucumbers--crabs, lobsters, squid, star fish, octopus, sea anemone, jellyfish, whelk--tuna, killer whale, porpoise, sea lion, harbor seal--man.

Green plants--plankton--algae--mackerel, herring, small fish--loon, cormorant, osprey, eagle--food--clothing--man.

Green plants--grasses and reeds--ducks--man.

Green plants--rabbit--fox--clothing--man.

Show film strip "Balance Among Living Things."1/

B. Balance in Nature (Give and Take)

All through nature there is a constant giving and taking. In exchange for the carbon dioxide and oxygen which it takes from the air, the plant gives back oxygen and water to the air. For the minerals and water it takes from the soil, the plant gives back roots to hold the soil together, leaves to decay and make humus to enrich the soil. Fungi and bacteria cause decay and give back carbon dioxide, nitrogen and other chemicals to the soil. Insects gather nectar from plants and in turn carry pollen to fertilize other plants. Trees cannot move, but they give food and shelter to birds and squirrels, who in return scatter the fruit and seeds. People depend upon animals for meat, but they protect and care for the animals. So one kind depends upon the other and could not live without the other. Such interdependence upon each other binds certain plants and animals together like links in a chain. They are called food chains, which you have just made. Notice, though, that they all start with green plants, for none of them could live without green plants.

Plants also need to live in regions where the soil and climate are suitable to their growth. That is why some plants thrive in the shade,

1/ Society for Visual Education, op. cit.

while others do better in the sun; some like to live in swamps, and others in deserts; some pick out cold regions, while others can only live where they find it is hot. So we have plant communities where plants and animals, which depend upon each other and like certain climate and soil, live together. Let us make some plant communities, called habitats.

Have each group make one of the following plant communities. Show the Film Strip "Communities of Living Things."[1] Use large corrugated boxes with top and one side cut away. Paint or paste pictures of typical plants on the sides for a background. Cut out pictures of plants and animals and stiffen with cardboard to stand up in the foreground.

Swamp Community

Tall grass, sedges, cattails, reeds, small willows, swamp oaks, bulrushes, water hyacinths, pond lillies, blue flags, red-wing blackbirds, wood ducks, swans, frogs, water snakes, turtles, rock bass, sunfish, and perch if the swamp is on the edge of a pond, and muskrats.

Forest Community

Trees--beech, maple, oak, elm, hickory, walnut, pine, hemlock, spruce, fir.

Smaller plants--ferns, small dogwood bushes, trilliums, violets, lilies-of-the-valley, gentians, anemones, fungi, mushrooms, puffballs.

Bluebirds, orioles, thrushes, catbird, waxwing, woodpeckers, owls, squirrels, chipmunks, mink, fox, rabbit,

Show Film Strip "A Home for Water Plants and Animals."[1]

[1] Society for Visual Education, op. cit.

deer, snakes, lady slippers, etc.

Meadow Community

Daisies, buttercups, cornflowers, goldenrod, sunflowers, tiger lilies, clover, mustard, vetch, wild sweet peas, wild morning glory, etc., mice, chipmunks, meadow larks, crows, blackbirds, bob-o-links, robins, swallows, gophers.

Desert Communities

Show film strips "The Living Desert" 1, 2, 3, 4. 1/

Sagebrush, creosote bush, burro weed, Joshua tree, acacia, chaparral (small oaks and shrubs), scrub oak, pine, and juniper, manzanita, etc. Woodchucks, gophers, coyotes, rabbits, burros.

Grassland Community

Tall grass prairie--tall grass 5-10 feet high, Indian grass, spear grass, peas, beans, wild oats, indigo, lead plant, goldenrod, gophers, coyotes, woodchucks, moles, cardinals, sparrows, swallows, bob-o-links, blackbirds, crows.

Mixed grass region--wheat, rye, oats, legumes, goldenrod, compass plant, same animals and birds.

Short grass region--grama grass, buffalo grass, sagebrush, wheat grass, snakes, coyotes, gophers

Tundra Communities

Lichens, mosses, sedges, grasses, shrubby willows, alpine flowers, such as iceland poppies, scillas, lupines, etc.,

1/ Encyclopedia Brittanica, op. cit.

reindeer, muskox, mink, otter, etc.

Mountain Communities

Same plants as forest communities on lower slopes and tundra vegetation on upper slopes. Bears, wolves, elk, deer, moose instead of reindeer.

Show Film Strip "Plants and Animals of the Mountains."1/

V. Conservation.

Examples of Waste

Loss by fire. Read booklets "How Money Grows on Trees" and "How Money Goes Up In Smoke." 2/

Discuss and answer questions about them.

Class prepare a chart on "How To Prevent Forest Fires."

Work of the forest ranger. Show film "Forest Ranger."3/

Erosion. Show film on "Erosion".4/

Experiment 24 with Group 1. To demonstrate how a ground cover prevents erosion by wind and flood.

Materials: Two flat oblong boxes $1\frac{1}{2}$x$2\frac{1}{2}$ inches, 2 sprinkling cans, electric fans, rye grass seed, 2 pails, 2 pieces of tin or soft metal.

Method: Fill both boxes with soil, and plant one with rye grass. Cut a four-inch piece out of one end of each box. Fasten a strip of tin under the cut-out place and

---

1/ Society for Visual Education, op. cit.

2/ International Paper Co., Southern Kraft Division, Mobile, Alabama.

3/ Castle Films Division, United World Films, Inc., Russ Building, San Francisco, California.

4/ United World Films, op. cit.

bend it up like a trough. When the grass has grown, tip up the back end of the boxes and brace them. Allow the trough ends to lead into the empty buckets. Start the electric fan and hold it in back of the boxes. Note which box loses the most top soil. Now sprinkle each box with water from the sprinkling cans. Note the color of the water which runs off and which box loses the most top soil.

Conclusion: The electric fan represents the wind. The wind did not carry off nearly as much top soil from the box with the grass ground cover as from the box without any cover. The rain did not wash away so much soil from the box which had the grass ground cover. This shows the effect of a ground cover to prevent erosion by wind and rain. A dust storm occurs when there is no ground cover.

Show the film "Soil and Water Conservation,"[1/] which shows conservation farming methods, such as contouring, terracing, strip cropping, rotation, tree and grass planting, mulching.

Experiment 25 with Group 2. Capillary Attraction to show the effect of mulching, and cultivating.

Materials: Three lamp chimneys or glass bottles open at both ends, soil, humus or pine needles, flat-bottomed dish, water.

Method: Fill the three lamp chimneys with soil. Stand them in the flat-bottomed dish. Put humus at the top of one

1/ United World Films, *op. cit.*

the story which they depict. Each section of the story can be pasted upon separate cardboards. Use blue flannel for the pond, and green flannel for the grass. The words underlined in the story represent the pictures to put on. The words in parentheses represent the pictures to take off. Thus a composite scene is built, showing the progression of a plant community, its destruction, and consequent growth again. White paper cut in the shape of headstones mark the graves of the Joneses. This presents a vivid example of what happens when wrong conservation methods or no conservation is practiced.

Flannel Board Demonstration.

1. Once there was a nice little pond. Water lilies grew in it and pickerel weed grew around the edge. Fish swam in the water. Frogs and turtles lived there too. As old plants died and drifted in, the margins of the pond became shallow and made a marsh. The cattails made a place to hide so ducks came to the pond, and herons fished there. Muskrats found food and stalks for their homes. Kingfishers and redwings came to the pond, as well as cardinals, bobolinks, and many other birds.

2. Weeds grew back from the edge of the marsh and made the soil more firm so grass could grow. Meadowlarks lived in the grass and also bobwhites and partridges. The grass made the soil more firm so shrubs came in. Then rabbits found places to live and hide. Field sparrows and goldfinches lived in the shrubs, too.

3. The shrubs made the soil just right for trees to grow so it was not long before there was a forest. Deer lived in the forest and fed on the grass. Squirrels lived there and planted more trees. Robins, bluebirds, bluejays and wood thrushes lived high among the leaves. Mice used birds'

nests for their homes. Some redtails nested at the edge of the woods and ate the mice. They fed on grasshoppers, and caterpillars, as well as the mice.

4. The trees grew older and bigger around. Some had dead limbs, and some trees died. The old ones became quite hollow. The dead wood made places for woodpeckers to drill their homes. The woodpeckers ate insects from under the bark. Raccoons lived in the old hollow trees and fed on mice. Owls lived in them, too, and ate more mice.

5. This farm belonged to Farmer Jones. Besides the pond, the weeds, the grass, the shrubs, and the trees, Farmer Jones had lots of land for his crops. But one day he had a notion. "I'll clean my woodlands, take out the dead wood, and cut down the (trees)," he said. And he did. This meant that the (woodpeckers) had to leave because there was no place for them to live. The other (birds) had to find another place to live so they left, too. The (raccoons) and (owls) left also, and because the raccoons and owls had eaten the mice, there were no enemies for the mice so they multiplied. There were so many mice it was quite alarming.

6. Farmer Jones had another notion. He said, "I'll cut down my woodlands for I can get a good price for the wood. I'd better sell it while the selling is good." So he cut down all his (woodlands). He even rooted out the stumps to make it neat. All the (woodland creatures) except the mice and the bugs left for they had no place to live. With the hawks gone too, mice multiplied some more. Farmer Jones said, "I'll cut down the shrubs, too, along the fences. The shrubs take room and I like it neat. I'll plow up all the grass so I can farm more land." So he plowed to the edge of the marsh. He even drained the (marsh). The (rabbits) left and

the (meadowlarks) and also the (herons) and the (ducks). The (fish) and the (waterlilies) dies as well as the (frogs) and the (turtles).

7. "What good is a marsh!" said Farmer Jones. "I'll drain all of the marsh and the pond, so I can have bigger fields." So he drained all the marsh and the pond. The (ducks), (herons), and (muskrats) tried to find new places to live, but all the other ponds were full. The (fish), the (frogs), and the (turtles) died, too. When the rain fell down on the bare ground, it hit the ground too hard because there were no plants to break its fall. It hit so hard that it closed the soil so the rain could not soak in. The rain water ran away and carried the soil with it; that good top soil; good growing soil; the rain washed it all away.

8. And what did Farmer Jones have left? Nothing. He had nothing but a barren waste, land where nothing could grow and no creatures could live. Farmer Jones grew poorer and poorer and at last he died. This is the grave of Farmer Jones, and here lies his son, and here lies his grandson. Finally, after many years, one little plant came back and began to build up the farm. It was a weed. Weeds do not care much where they live. Their roots are long and strong. The weeds grabbed some soil and held it. That made soil firm so grass could grow. Meadowlarks came and lived in the grass. The grass made soil so shrubs could grow. Rabbits now had a place to live and hide.

9. The shrubs made soil that trees could grow in, so the trees grew up and made a forest. Deer came back, as well as squirrels, mice, and skunks. The red-tail and other birds came to live in the leaves. When the rain came down, plants softened its fall and the water soaked in. It followed the roots down deep and collected in the ground to make a fine water table.

10. In the low places, the marsh came back, and after a while the pond came back and the fish, frogs, turtles, muskrats, ducks, and herons. Some of the trees grew old and hollow so the woodpeckers came back. So did the raccoons and owls. The farm was just as it was before.

11. But how long did it take to restore this farm? Years and years. Farmer Jones and his sons had been dead many many years. His great-grandson now owned the farm and he worked very hard to build up the land. He rotated his crops and after they had been harvested, he planted ground covers, such as clover and winter rye, so that the wind couldn't blow away all the top soil. Then he plowed in the ground cover crop in the Spring, together with the leaves, to make good rich humus in the soil.

12. One day his son came home from the Audubon Camp. He held some soil in the palm of his hand and talked to his father about the land. He told all he had learned at the Audubon Camp -- how nothing lives by itself alone -- how all animals need plants and plants need animals -- how plants and animals both need soil and water -- how soil and water need plants and animals. He called it inter-relationship -- inter-dependence among all things in nature. He talked about conservation, the wise use of natural resources.

This great-grandson of Farmer Jones said, "I'm sure that is certainly true as true. I'll keep my woods and make a tree farm. That's a fine crop for steep hillsides. I'll cut down only a few trees each year and then plant new ones in the same place. The woods will save my soil, catch rain and snow, help build up my water table, and make homes for the wildlife, too. I'll keep strips across all my fields to help hold the soil and save more water, besides making homes for the meadowlarks and field birds.

I'll keep the shrubs along the fields where wildlife can live, and I'll keep my marsh and pond. They will be fine water reservoirs, provide fish for my table, and homes for my wildlife helpers." And so he did. So the great-grandson Farmer Jones and his son have a healthy, prosperous farm because they practice conservation.

Panel Discussion with sixth-grade pupils. "America's Forests and Us" 1/

A thirty-minute discussion between a Forester, Farmer, Industry Representative, and Moderator.

"Paul Bunyan Quiz" based on booklet "Trees for Tomorrow". 1/

Conservation Workers.

Research and oral reports on the following:

- Forest Rangers
- National Parks and Park Rangers
- Game and Bird Sanctuaries
- Work of the Biologist
- Work of Plant Hybridizers -- Luther Burbank
- Work of Civil Engineers with Irrigation Projects and Dams

What You Can Do

- Save paper and pencils in school.
- Form a KEEP AMERICA GREEN club. 1/
- Become a JACKIE DAVIS JUNIOR FOREST FIRE WARDEN. 2/
- Leave birds' nests alone until after birds have gone.
- When fishing, throw back small fish.

1/ American Forest Products Industries, Inc., 1319 Eighteenth Street, Washington, D. C.

2/ Jackie Davis, Chief Junior Forest Fire Warden. Southern Kraft Division, International Paper Co., Mobile, Alabama.

Never cut initials or make any cut on a living tree.

Put up a bird house in your yard.

Make a bird bath in your yard.

Have a bird feeder in your yard in the winter.

Learn the useful insects and protect them.

Destroy the harmful insects.

Plant grass where water washes away.

Plant young trees.

Learn how to burn brush -- 7 steps.[1/]

Learn what to do when fire gets out of control.[1/]

Activities:

Make posters to illustrate any of the above suggestions. Correlate with Art.

1/ International Paper Co., Southern Kraft Div., *op. cit.*

TEST

Directions for Giving the Test.

You have been doing experiments and seeing pictures about plants. Do you really know how important plants are? Now let us see how much you have learned about plants.

(Pass out the tests.)

Put your name and date on each of the four papers, and then put your pencils down. Look at the top of the first page and follow while I read the directions. I will read also the first question. What is the answer to the first question? Put a line under root hairs and put 2 in the bracket. Do you all understand what to do?

Ready. Start.

TEST ON THE IMPORTANCE OF PLANTS

Draw a line under the correct answer and place the number in the brackets at the right margin. No. 1 is the sample. We will do it together.

1. Green plants take in water and minerals through their

   1. roots 2. root hairs 3. stems 4. leaves ( )

2. Is the food factory of the plant in the

   1. root 2. stem 3. flower 4. leaf? ( )

3. The water passes to the different parts of the plant through the

   1. flower 2. fruit 3. veins 4. roots ( )

4. In what form are the minerals which the plant takes in?

   1. solids 2. liquids 3. gases 4. mixtures ( )

5. What is called the engine of the plant?

   1. vein 2. stem 3. chloroplast 4. root ( )

6. What makes the color of the leaf green?

   1. sunlight 2. water 3. chlorophyll 4. air ( )

7. What acts as the power that runs the engine?

   1. coal 2. electricity 3. sunlight 4. gas ( )

8. When the plant takes in water and minerals, what is the process called?

   1. Osmosis 2. Transpiration 3. Imbibition
   4. Condensation ( )

9. What are the cells in plants compared to?

   1. Doors 2. Stems 3. Rooms 4. Stairs ( )

10. What are the stomata?

    1. little holes 2. stems 3. roots 4. veins ( )

11. Where are the stomata?

 1. Under the leaf 2. At the base of the leaf

 3. On top of the leaf 4. On the flower ( )

12. Which of the following materials does the plant get from the air?

 1. Manganese 2. Phosphorus 3. Carbon dioxide

 4. Iron ( )

13. Which two of the following materials are given out by the leaf?

 1. Nitrogen 2. Boron 3. Oxygen 4. Carbon dioxide

 5. Water ( )

14. Underline two products which are made in the leaf factory.

 1. Iron 2. Starch 3. Phosphorus 4. Sugar

 5. Nitrogen ( ) ( )

15. Plants help to purify the air by giving out --

 1. Carbon dioxide 2. Nitrogen 3. Hydrogen ( )

16. Through what process do plants complete the water cycle?

 1. Osmosis 2. Transpiration 3. Condensation

 4. Diffusion ( )

17. Green plants are the most important factories in the world because only green plants can make --

 1. Minerals 2. Water 3. Food 4. Animals ( )

18. What are three other products which plants make?

 1. Fat 2. Oxygen 3. Protein 4. Iron

 5. Vitamins ( ) ( ) ( )

19. What do we call this process of making food in green plants?

1. Capillary Action 2. Respiration

3. Photosynthesis 4. Inhalation ( )

20. What does good top soil contain that makes plants grow better?

1. Vitamins 2. Sugar 3. Humus 4. Starch ( )

21. Underline four of the following parts of plants which are used as storehouses.

1. Roots 2. Bark 3. Stems 4. Flower buds

5. Sap 6. Veins 7. Root hair 8. Trunk 9. Leaves

( ) ( ) ( ) ( )

22. How can we conserve our forests?

1. Cut them down 2. Plant new trees to replace those we cut down 3. Use other things in place of trees

4. Learn more about trees ( )

23. What are three important enemies of our forests?

1. Fire 2. Animals 3. Lumber Companies

4. Plant diseases ( ) ( ) ( )

24. What can we plant to keep the top soil from blowing away after the crops are harvested?

1. Vegetables 2. Corn 3. Grass 4. Wheat ( )

25. Where are seeds produced in the plant?

1. Stem 2. Flower 3. Bud 4. Root ( )

26. What do we call this process?

1. Reproduction 2. Hybridization 3. Integration

4. Segregation ( )

27. Which three of these ways are new plants made by the plant itself?

1. By cuttings 2. By seeds 3. By budding

4. By bulbs 5. By grafting

6. By corms ( ) ( ) ( )

28. Which four of these ways do men use to make new plants?

1. Cuttings 2. Layering 3. Budding 4. Grafting

5. Bulbs 6. Seeds 7. Corms ( ) ( ) ( ) ( )

29. How can we prevent forest fires?

1. By throwing a match among dry leaves.

2. By throwing cigarettes along the roadside

3. By putting out campfires and cigarettes ( )

30. The raising of plants gives jobs to

1. A few people 2. Millions of people

3. Some people 4. Everybody ( )

31. Plants are improved and new kinds made by

1. Cultivation 2. Hybridization 3. Preparation ( )

32. Which three kinds of clothing are made directly from plants?

1. Wool 2. Cotton 3. Silk 4. Linen 5. Rayon

( ) ( ) ( )

33. Which three building materials are made from plants?

1. Lumber 2. Tile 3. Plastic 4. Paper 5. Cement

( ) ( ) ( )

34. Pepper, cinnamon, cloves, nutmeg come from plants and are used for --

1. Vegetables 2. Syrup 3. Spices 4. Nuts ( )

35. Which three products from plants are obtained by tapping trees?

1. Lumber 2. Rubber 3. Turpentine 4. Sugar 5. Oil ( ) ( ) ( )

36. Which three of the following products which we get from plants do we use for herbs?

1. Chives 2. Nuts 3. Mace 4. Mint 5. Lettuce ( ) ( ) ( )

37. How do you tell the age of a tree?

1. By its height 2. By its width 3. By the rings in the wood ( )

38. Plastic is made from --

1. Glue 2. Plants 3. Cotton ( )

39. Underline three drugs which come from plants.

1. Penicillin 2. Opium 3. Cloves 4. Atropine 5. Resin 6. Oil ( ) ( ) ( )

40. Which will grow first on a sand dune?

1. Small plants 2. Trees 3. Grass ( )

CHAPTER IV

CONCLUSION

This unit of study has been used by this author in the regular work of the fifth grade in the Clarence A. Cook School, New Bedford, Mass. The purposes in mind were to develop in the pupils a concept of the importance and usefulness of plants to mankind; to have them realize that only green plants can manufacture sugar, starch, protein and vitamins which form the basis of all food; to give them some understanding of the many necessities in our lives which are provided by green plants.

In that way pupils would learn to appreciate the value of plant life and would regard plants as a precious gift of Nature, not to be wasted, or even to be taken for granted, but to be valued and conserved.

It is to be believed that these purposes have been accomplished in some measure, as is evidenced by the results of the test. The reader will notice that the test covers only the Science part of the project, for otherwise the same test could not be given to all three grades, as the curriculum in the correlated studies of Geography, Language, Arts, Arithmetic, and Art differs in each grade. There is also a significant difference in the age between the fourth and the sixth grade. However, the median in each grade was high enough to warrant the application of this project as far as possible to the rest of the curriculum.

On page 83 is a listing of responses to the items in the test on pages 74-79. It will be noted that the re-test responses were very similar to those in the first test. When we consider that the second test was given a week later, as well as the fact that the multiple choice type of test was used, it is worthy of note that there was little guessing involved.

In the fifth grade the first pupil finished in 25 minutes and the last one in 50 minutes.

The difference in the time element in the other grades was due to the difference in age and reading ability.

This test has proved that the proposed unit of study is within the capabilities of the pupils of the fourth, fifth, and sixth grades insofar as the science study is concerned. It only remains for the teachers in each of those grades to correlate the science study with their particular grade curriculum.

As to the skills and abilities which the pupils have developed as a result of these studies, the following may all be considered:

Ability to appreciate and understand how a plant lives, breathes, and has its being.

Ability to restore, preserve, and aid in maintaining the sustenance of plants.

Ability to appreciate more readily the significance of the teachings of conservation to be met with in succeeding classes.

Ability to carry on an experiment to a conclusion in order to prove a scientific fact.

Ability to draw conclusions from facts established.

Ability to work more carefully and precisely.

Ability to discuss more logically and scientifically.

Ability to persevere on a problem until it is finished.

Ability to plan and keep a class log.

Ability to use reference material with added skill.

Ability to take notes.

Ability to outline material.

Ability to acquire a larger scientific vocabulary.

Ability to determine in some cases the type of experiment to use.

Ability to give constructive criticism.

Ability to follow directions.

Ability to construct models from given directions.

Ability to obtain, mount and display exhibits.

Ability to lead a group.

Ability to explain a demonstration clearly.

Ability to appreciate some simpler methods of fire fighting.

Ability to prevent fires.

Ability to exercise more self control.

Ability to cooperate better.

Ability to speak better.

Ability to use language more precisely.

Ability to work in school with greater interest.

Item Analysis for Test -- Incorrect Answers

Item	Grade 5		Grade 4		Grade 6	
	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
2	9	9	7	7	0	0
3	9	7	10	11	4	5
4	7	7	7	7	3	2
5	13	10	25	25	8	9
6	8	5	20	20	0	0
7	5	2	12	10	2	2
8	18	21	30	30	15	14
9	5	3	25	27	5	5
10	4	1	30	30	3	2
11	13	14	30	30	10	12
12	7	4	10	8	2	1
13	18	17	20	20	12	10
14	8	9	15	14	2	1
15	20	20	30	30	22	21
16	24	22	30	30	25	24
17	15	12	20	19	1	0
18	33	24	30	30	24	15
19	19	14	30	29	12	10
20	22	21	29	26	20	20
21	47	49	12	10	8	6
22	8	8	10	8	4	2
23	24	23	25	24	5	3
24	6	7	20	20	8	7

Item	Grade 5		Grade 4		Grade 6	
	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
25	21	20	18	15	12	10
26	22	22	30	30	20	20
27	43	40	30	30	25	24
28	36	36	30	30	27	26
29	1	1	4	4	0	0
30	7	8	10	9	7	8
31	23	22	30	30	24	20
32	20	20	15	14	10	10
33	15	15	30	30	20	20
34	5	5	3	2	5	5
35	26	26	20	20	12	10
36	26	26	12	10	6	2
37	6	5	8	8	1	2
38	3	3	5	4	0	0
39	23	23	28	27	5	4
40	17	40	18	19	3	2

Total Number of Responses Possible: 62

Class Median: Grade 5 -- 40 (Writer's Grade)

Grade 4 -- 30

Grade 6 -- 45

It will be found in practice that the elementary grades are well suited to correlating science work with other school subjects. In this case the importance of plants can be integrated with nearly every other school course, and the various activities suggested can be carried on as extra work or enrichment without depleting the time given to the major fields.

While one of the main purposes of this study is to establish a foundation of thoughts and ideas leading to the consideration of problems of conservation as they will be met with in succeeding grades, another purpose, equally important, is the introduction of the younger pupil to scientific practices and procedures. The hope should be justified by this study that the questing nature of these young pupils may be turned toward the production of future scientists.

An examination of this proposed unit of study should convince any teacher, who otherwise considers herself unprepared to teach science, that she can adopt this plan wholly, and, by following it, should be able to accomplish the purpose of the study.

Major and minor leaders throughout our nation and most of the world recognize the necessity for conserving our resources by means of some form of scientific planning; but a general attitude favoring conservation, based on a better understanding of its necessity, must be developed.

Only by the people at large acquiring a better understanding of the problem may they be expected to support with more enthusiasm the many suggestions for conserving our resources.

For educational purposes, access to the greatest number of the coming generation is to be had only in the grade schools, both public and private. This fact alone stamps these schools with the responsibility for the beginning of such education.

Our problem, then, is a matter of understanding the principles of conservation, and the study of plants being one of the easier ones, lends itself particularly to establishing a base for the understanding of those principles.

Many pupils at this age take little notice of plants, as something always available and not deserving of much thought. The foregoing study has attempted to arouse them out of such a matter-of-fact attitude to the importance of plant life, to man's utter dependence upon it, and to the consequent necessity for conserving it. This educational insight derived from experimentation, active participation, and first-hand observation of plants will serve well as a basic training so much needed in the consideration of conservation problems.

Bibliography

For Teachers

Brown, W. H., THE PLANT KINGDOM, Ginn & Co., New York, N.Y., 1935.

Conference on Nationwide Problems of Science Teaching in Secondary Schools, CRITICAL YEARS AHEAD IN SCIENCE TEACHING, 1953.

Cummins, George B., George A. Gries, Jessie Lafforge, Samuel Postlethwait, Forest W. Stearns, TEXTBOOK IN FUNDAMENTALS OF PLANT SCIENCE, WORKBOOK ON INTERMEDIATE PLANT SCIENCE, LABORATORY PROBLEMS IN PLANT SCIENCE, Burgess Publishing Co., Minneapolis, Minnesota, 1955.

Daniels, Farrington, Chairman Dept. of Chemistry, University of Wisconsin in New York Times article, March 18, 1956.

Darling, Jay N., Hon. Pres. National Wildlife Federation, POVERTY OR CONSERVATION, YOUR NATIONAL PROBLEM, National Wildlife Federation, 1949.

Dowling, Thomas L., Kenneth Freeman, Nan Lacey, James S. Tippet, DISCOVERING WHY, The John C. Winston Co.

Fairbanks, Harold, CONSERVATION READER, Harr Wagner Publishing Company, San Francisco, California, 1927.

Gorham, Frank, Head of the Dept. of Elementary Education, Indianapolis, Ind., "Teaching Conservation in the Elementary Schools," Social Education Magazine, Feb. 1948.

Granger, Kathleen, Thesis, "Using Community Resources to Develop an Attitude Toward the Conservation of Natural Resources in Intermediate Grade Children," from Boston University, 1950.

Hillcourt, William, FIELD BOOK OF NATURE ACTIVITIES, G. P. Putnam's Sons, New York.

Haner, Charles A., Thesis, "Inexpensive Equipment and Demonstrations for the Biology Laboratory and Classroom," from Adams State College, Alamosa, Colorado, 1952.

Markham, Helen, Thesis, "The Development of a Program for the Teaching of Conservation in Grades 4 and 5, and 6," from New York State College for Teachers, 1952.

Reeder, Edwin H., Prof. of Education, Columbia University, New York, "Conservation and Democracy," Social Education, 1940.

Reitz, William W., Head, Educational Relations Section, U. S. Dept. of Agriculture, Soil Conservation, N. E. Reg., in Metropolitan Science Review, Feb. 1948.

Ritchie, John W., BIOLOGY AND HUMAN AFFAIRS, World Book Co., New York, 1946.

Wilson, Carl L., BOTANY, The Dryden Press, New York. Textbook on Botany.

Bibliography

For Children

Carpenter, Harry A., George C. Wood, OUR ENVIRONMENT, Book I and II, Allyn & Bacon, Boston, Mass.

Craig, Gerald S., Katherine E. Hill, WORKING WITH SCIENCE, Ginn & Co., New York.

Dickenson, Alice, THE FIRST BOOK OF PLANTS, Franklin Watts, Inc., New York, 1953.

Dowling, Thomas I., Kenneth Freeman, Nan Lacy, James S. Tippett, DISCOVERING WHY, The John C. Winston Co., 1951.

Frasier, George Willard, Helen D. MacCracken, Donald G. Decker, Daniel C. McNaughton, HOW AND WHY EXPERIMENTS, L. W. Singer Co., Syracuse, New York.

International Paper Company, Southern Kraft Division, Mobile, Alabama, HOW MONEY GROWS ON TREES, HOW MONEY GOES UP IN SMOKE, 1950.

Knox, Warren, George Stone, Morris Meister, Dorothy Wheatley, THE WONDERWORLD OF SCIENCE, Book Five, Charles Scribner's Sons, New York, 1946.

Liljenberg, Gladys, SCIENCE SERIES, PRIMARY EXPERIMENTS, Book II, F. A. Owen Publishing Co., Dansville, N. Y., 1953.

Parker, Bertha Morris, Orlin D. Frank, PLANT FACTORIES, Row, Peterson & Co., Evanston, Ill., 1953.

Parker, Bertha M., Wilbur R. Matton, TREES, 1954.

Parker, Bertha M., Illa Podendorf, THE PLANT WORLD, Row, Peterson & Co., Evanston, Ill., 1954.

Persing, Ellis C., John A. Hollinger, ELEMENTARY SCIENCE BY GRADES, D. Appleton & Co., 1930.

Smith, F. C., THE FIRST BOOK OF CONSERVATION, Franklin Watts, Inc., 699 Madison Ave., New York 21, 1954.

Swenson, Valerie, A CHILD'S BOOK OF TREES, Maxton Publishers, Inc., New York, 1953.

Wilde, Irma, A CHILD'S BOOK OF FLOWERS, Maxton Publishers, Inc., New York, 1952.