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SCHOOL GARDENS FOR CALIFORNIA SCHOOLS

A MANUAL FOR TEACHERS

BY
B. M. DAVIS

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SACRAMENTO

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PREFACE.

The present bulletin is an attempt to put the California teachers who wish to undertake school gardening in possession of what the writer has found useful in his own experience with school gardens. It is the product of several years' study and experiment in connection with his work at the Los Angeles and Chico State Normal Schools. The plans herein suggested have also been followed, during the present year, in the school-garden operations in Oakland and San Diego.

The subject covers such a wide field that it has been necessary to treat each phase in the briefest manner consistent with clearness. References, however, are given in connection with each subject, which will make fuller exposition accessible to the teacher.

The writer takes pleasure in acknowledging the helpful suggestions and assistance which he has received from Professors Elmer E. Brown, Eugene W. Hilgard, Edward J. Wickson, and C. W. Woodworth, of the University of California; Dr. Willard S. Small, of San Diego; and President C. C. Van Liew, of the Chico State Normal School.

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SCHOOL GARDENS FOR CALIFORNIA SCHOOLS.

INTRODUCTION.

History of school gardens. The first reference to gardens for purely educational purposes was made by Comenius (1592–1671) in his Didactica Magna. He says: "A school garden should be connected with every school, where children at times may feast their eyes on trees, flowers, and herbs, and be taught to enjoy them." Francke (1663–1727), at his orphan asylum in Halle, established a school garden, where the children were occupied during their leisure. A little later, Rousseau (1712–1778), in France, advocated school gardens as an important educational factor. Pestalozzi (1747–1827) was a farmer as well as an educator. He expressed a wish to make his farm the central point of his agricultural and educational efforts. Froebel (1782–1852), in his kindergarten in Thuringia, gave employment to the larger children in gardens.

From the time of Froebel on, interest in school gardens spread rapidly throughout western Europe. Through the efforts of Prof. Erasmus Schwab of Vienna, and of his colleague, Prof. Mell of Marburg, Dr. Langauer of Vienna, and others, the school-garden idea was taken up by the Austrian Government. In 1869 a law was passed prescribing the establishment of a garden and a place for experiments in agriculture in every rural school where practicable. The next year a further requirement was added whereby natural history was to be given, with an appropriately arranged school garden. In 1898 the number of school gardens in Austria-Hungary had reached 18,000.

The development of the school garden in Austria is typical of the movement in most of the European countries, including Germany, Prussia, Switzerland, Sweden, Belgium, France, and Russia.[1] The total number is now more than 100,000.

Instruction in agriculture in the public schools of Canada was tried as early as 1872, but proved a failure owing to the teachers' lack of

[1] For a complete historical account of school gardens in Europe, see E. Gang, 1899. (*Note:* The name of author and date refer to title in Bibliography.)

preparation for the work. The subject has recently been taken up again, with marked success, as the following will show: "In 1899 Canadian school children from Prince Edward Island to British Columbia began sowing oats and wheat from selected seed; in three years the gain was 27 per cent in weight for oats and 28 per cent for spring wheat." (Iles, 1903.)

The movement in the United States had its beginning in 1891, when Henry L. Clapp established a garden in connection with the George Putnam Grammar School, Roxbury district, Boston. The original purpose of the garden was to afford a more rational sort of physical culture for the children. (Clapp, 1903.) Its success in this and other respects led the Massachusetts Horticultural Society to encourage the establishment of school gardens in other places in New England by offering prizes for the best gardens entering competition and by giving prominence to the subject in its published proceedings. The movement has grown rapidly until at present school gardens are to be found in every State in the Union.[1]

Sources of movement in the United States. A study of the development of this movement shows that the chief promoters are not among the teachers, but among those interested in agricultural and those interested in social questions. The former are trying to make the school serve more practical ends in rural communities, while the latter wish to reach a class of children in the cities not interested in the regular school work. Development of the school-garden idea has been effected mainly through efforts in these two directions. Both have made substantial contributions to education, as evinced, on the one hand, by the tendency to make the garden part of the school equipment, and, on the other, by the results actually obtained in large cities. (Davis, 1903.)

Educational importance of school gardens. Aside from these special aims, the school garden has its justification from a more general educational standpoint. It combines many of the best features of nature study, elementary science, manual training, and physical exercise. It is also a valuable aid in teaching some of the other common school subjects, such as arithmetic, language, geography, history, and drawing. The special significance and use of the school garden with reference to these subjects will be considered in another connection (p. 41). "A school without a garden is like a stag without water," is the first sentence in the first book written on school gardens. (Georgens, 1873.) This sentiment has been justified by experience wherever the school garden has been properly instituted. Its practicability and usefulness have been thoroughly demonstrated in most European countries. In France, for example, since 1885, no plan for a

[1] For full account of the school-garden movement in United States, see Crosby, 1902.

school receiving state aid is accepted that does not include provision for a garden.

The practical difficulty of handling large numbers of children and the expense of securing suitable ground stand in the way of establishing and maintaining school gardens in cities. In spite of these difficulties their feasibility has been demonstrated, even in the most unpromising districts of large cities. (Putnam, 1901; Parsons, 1903; Bennett, 1904.) The greatest value of these gardens lies in making up to the city child somewhat for the fact that contact with nature is almost wholly left out of his life. They form the basis for the most practical sort of nature study possible in cities. In many cases, no doubt, the amount of money spent for charts and other so-called aids to study would be sufficient to cover the expense of a garden. But such an investment in a garden would be a clear educational gain, because much of the illustrative material for geography and other subjects would be prepared by the pupil himself.

The function of the school garden in rural schools is not to give new experiences and illustrations, but rather to help make the child's environment more significant to him. Its educational application is even more important here than in the city. European countries have long since recognized its value in the rural districts. In Canada an important educational experiment for the improvement of rural schools was initiated in each of five provinces at the beginning of the school year of 1903–04. The plan is under the general direction of Prof. James W. Robertson, Commissioner of Agriculture and Dairying for Canada, and receives financial assistance from Sir William C. Macdonald. The following quotations from the "memorandum" (Robertson, 1902) of the plan will indicate its scope and character:

"*Part 1 of the plan* is intended to give object lessons of improvements in education from the consolidation of five, six, or more small rural schools into one central graded school, with a school garden and a manual training room as part of its equipment."

"*Part 2 of the plan* is for the purpose of giving object-lessons of the value of school gardens and nature studies at individual rural schools, as part of general education, to be begun by means of a traveling instructor, who would visit and spend one-half day per week with the children and teacher at each school of a group, for a term of three years, or until a considerable number of suitably trained and qualified teachers would be available to carry on such work themselves at rural schools."

"*Part 3 of the plan* has for its object to assist in providing short courses of instruction and training for teachers for rural schools, who desire to qualify themselves in these newer subjects and methods of education."

"*Part 4 of the plan* is intended to assist in providing courses of instruction and training in domestic economy or household science for young women from country homes, in order that they may have opportunities for acquiring practical and advanced education not less suitable and helpful to them than the present courses at the Ontario Agricultural College are beneficial to young men, who take them with earnestness and cheerfulness."

No such systematic attempt has been made to solve the rural-school problem in this country. The problem is quite as important here as in

Canada, but the conditions for success are much more favorable here—especially in California.

California conditions. The agricultural population in California is increasingly important. The total value of farm products now amounts annually to $131,690,606; the next greatest source of income is mineral production, amounting annually to about $30,000,000. These figures are significant in themselves, but still more so when we consider that the rate of increase in population for the last decade is 12.7 per cent, while the increase in the number of farms is 37.1 per cent. (Twelfth Census.) The first step toward the improvement of rural schools has already been taken. An Act was passed by the State Legislature of 1903 making the consolidation of rural schools possible. Important as this step is, it will not have the desired effect so long as these schools continue to be fashioned after the city type. Indeed, if this is done the real aim of the law will be defeated. The schools themselves must be reorganized and adapted to meet rural conditions just as the city schools have been organized to meet city conditions.

The value of the school garden, as shown by the experience of European countries, and as is being demonstrated in Canada, lies in its being a working center for much of the instruction adapted to children of a rural population. It not only aids in vitalizing the formal subjects of instruction, but also gives significance to the environment of the child; and, best of all, leads him to see that he can do something worth while right where he lives.

It is hardly necessary to point out the fact that climatic and soil conditions are especially favorable in California for the establishment and successful operation of school gardens.

The discussion which follows is intended primarily to help teachers in rural schools who may wish to make use of school gardens. It will also find application in city schools, for the same general principles and methods obtain in both places.[1]

[1] Oakland and San José have already successfully established gardens in connection with their schools. In the former during 1904 over one thousand children had gardens.

THE PLANT AND ITS RELATIONS.

The plant and its needs. Any intelligent effort to grow plants must, first of all, take into consideration the needs of the plant. In order to understand these needs, the work of the plant in all of its most important relations to sunshine, air, soil, and water must be known.

For the plant to live and thrive it must have sunshine, oxygen, food, and protection from its enemies. The problem of plant-rearing is to provide these essentials for its growth.

The animal must rely on food already elaborated into complex compounds, such as proteids, starch-like substances, and fats. The plant, on the other hand, by using the energy of the sun, is able to make these substances for itself from the raw materials such as carbon dioxid, water, and mineral salts.

The work of the plant is divided among the plant organs: leaves, stem, and roots. The leaves make most of the food; the stem supports the leaves and carries material to and from the leaves; the roots hold the plant in place, absorb water and the mineral salts dissolved in the water, and receive in return food from the leaves.

Water exists in the soil in thin films around the soil particles; that is, apparently dry soil may contain enough water in this state to support a plant. A special set of organs for removing water from these surface films is found on all the smaller rootlets of the plant. These organs are called root-hairs.

As far as supplying the plant's needs is concerned, the most important part of the problem is to secure proper soil relations for the root. In most cases if the plant is not shaded the proper light relation is secured without further attention. There are, however, special cases where the leaf exposure of larger plants needs to be modified by pruning, or where delicate plants need to be protected from too strong sunlight by partial shade.

Securing proper soil relations for the roots of the plant being the chief problem in plant-rearing, it will be necessary to notice what this means. The most important factors are as follows:

The soil must contain sufficient mineral salts for the plant's use. The most important of these are the ones containing nitrogen, phosphorus, and potash. The use of fertilizers is intended to supply these salts where they are not in sufficient quantities in the soil.

There must be plenty of water accessible to the roots in the form of

films around the soil particles. The amount of water which a given area of soil will hold depends upon the surface extent of these particles. The extent of this surface, in turn, depends upon the size or state of division of these particles—the more finely divided, the more surface, and consequently the greater water-holding capacity. Too finely divided soil particles, however, will not leave enough space for oxygen to supply the roots, for roots, like all other parts of the plant, must

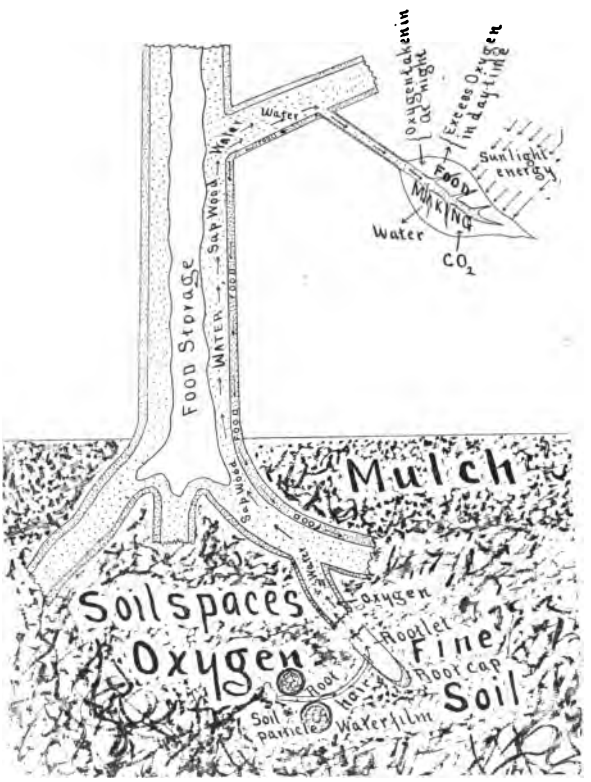

FIG. 1. Diagram of plant showing its most important life-processes.

have a constant supply of oxygen. Too much water will also cut off the supply of oxygen from the root. The soil in this condition is said to be water-logged. The subject of proper soil conditions will be considered more in detail under the head of propagation, page 23.

The living plant in its various relations may be seen more clearly by a study of fig. 1. The direction of movement of the various substances in the plant and to and from the plant are indicated by arrows.

The soil. It would be straying too far away from our present purpose to consider the origin of the soil and how it comes to be what it is.[1]

With respect to the needs of the plant the soil does five things: holds the plant in place, serves as an original source of plant-food, acts as a reservoir for moisture, becomes a storehouse for applied plant-food, and holds the heat from the sun. An ideal soil is one that performs all these functions perfectly. The problem of handling the soil is to make it as perfect as possible. To do this attention must be paid to its texture, moisture-content, plant-food, and temperature.

By soil-texture is meant the physical condition of the soil; that is, the relation of the soil particles to each other. Productivity depends largely on this condition. To secure the best results the soil should be fine, loose, and easily worked. The roots must be able to push their way through and establish a large feeding area. Each soil particle must be free to give up its film of moisture and with it the food it holds in the form of dissolved mineral salts. In California there are three types of soils: adobe, silty, and sandy or light.[2] The two latter are characterized by a predominance of silt or sand with but little clay.

Adobe soils, which are pretty well distributed over the State, are characteristically difficult to work. The difficulty is due to the fact that the soil particles are largely clay, therefore small, and tend consequently to hold together with great persistence. This fact indicates the method of improvement of texture. The particles must be separated and kept apart by interposition of coarser grains. The most practicable method is to cover the ground, before the fall rains, with all kinds of organic material subject to decay, such as straw, barnyard manure, etc. After the first rains this material should be worked into the soil by plowing or spading. This procedure, together with persistent working the soil, will soon make the texture all that need be desired. Plants having a large fibrous root-system, such as chrysanthemums, will do much toward permanently separating the soil particles and improving the soil-texture.

Silt or sediment soils are found in or near river bottoms. They are usually deep and well drained. Their texture is such as to require very little if any improvement.

The texture of sandy or light soils requires the opposite treatment to that applied to adobe soils. Small particles must be supplied in order that the soil may retain moisture. These may be supplied in the form of fine compost or well-rotted manure, which absorbs and retains moisture abundantly.

[1] A good account of this subject will be found in Burkett et al., 1903, pp. 1-6.

[2] Alkali soils might be added as a fourth type. For full discussion of such soils see ref. VIII, no. 128. (References to list of useful reference books, p. 50, will always be made in this form.)

Next in importance to soil-texture is the moisture-content of the soil. Water is supplied partly by rains and partly by irrigation.

Soils having proper texture are at the same time in the most favorable condition for receiving and retaining moisture.

As has already been indicated in another connection, water is available for the plant only when held as films around the soil particles. Irrigation and subsequent cultivation are for the purpose of maintaining the water supply in this form. When the water around the soil particles at the surface of the ground evaporates, the moisture tends to rise to restore the water equilibrium. There is thus a constant passage from below into the air. This waste of water by evaporation must be prevented by keeping the surface soil loose to a depth of three or more inches. The loose surface soil is called a mulch, and acts as a sort of blanket to prevent loss of water through evaporation by breaking the connection between the moisture below and the air above.

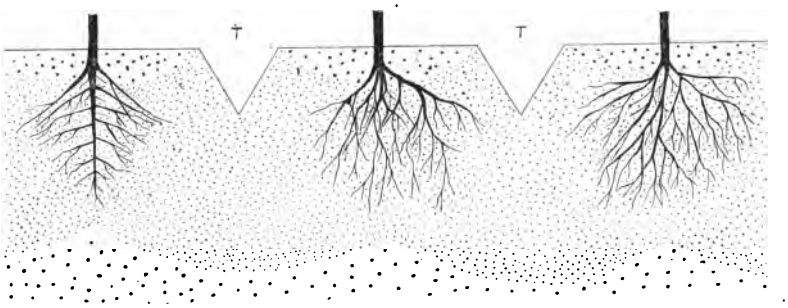

FIG. 2. Diagram showing proper method of irrigation. Finely dotted portion indicates distribution of water from trenches (T).

Plants should be supplied with water by irrigation, *i. e.* by thoroughly soaking the ground from deep furrows and afterwards conserving the water by surface cultivation. (Fig. 2.) Water should never be supplied by sprinkling, if it can be avoided: moreover, this method permits great waste of moisture through evaporation, and causes the ground to bake around the plant so as to weaken, if not destroy it.

The soil must also be well aërated in order that the roots of the plant may be supplied with oxygen. The same process of tillage which secures proper soil-texture and moisture conditions usually will serve to give the soil sufficient aëration.

Fertilizers. Most California soils are naturally well supplied with plant-food. Except for improving soil-texture there is ordinarily little use, at first, for fertilizers. Reference has already been made to compost. By compost is meant a mixture of all kinds of organic refuse in the last stages of decomposition. As the compost heap is a very practical means for providing a fertilizer, it will be worth while to consider the process. All sorts of refuse subject to decay, such as weeds, straw, road sweepings, animal

refuse, etc., should be collected into a heap several feet in depth. This should then be thoroughly wetted and allowed to decompose for several weeks. After a few weeks of decomposition it should be torn down and thoroughly mixed; then heaped up again and the wetting repeated. If the organic matter at the beginning is very fresh the heap will require a second mixing and wetting. The compost is ready for use when it is thoroughly decomposed. Instead of burning weeds and discarded vegetables they should be added to the compost heap. As soon as the compost is about ready for use, a second heap should be prepared. In this way a constant supply will always be on hand. Keeping the compost heap moist, thoroughly stirring and ventilating the mass, are the essentials in the process. In selecting a location for a compost heap two things should be kept in mind: It should be easily accessible from the garden, and it should be so situated as not to give offense on account of its odors or unsightliness.

Temperature. Temperature is an important soil factor even in California. In most places there is little likelihood of the temperature being too high, except perhaps during the summer months. As in temperate climates, the danger is in the other direction. Warmth not only facilitates the solution of soil minerals, but also hastens the diffusion of these substances after being dissolved. Soil-warmth is also necessary for rapid germination of seed. When the seed is placed in cold, wet soil it is apt to be attacked and destroyed by the micro-organisms of the soil which are able to do their work at low temperatures. (Appendix, ex. XI.)

Some of the factors affecting soil-warmth are: kind of soil, sandy soil being warmer than clay; drainage, well-drained soil being warmer than undrained soil; slope of land surface and direction of slope, a south exposure being warmer than a north slope; color, dark soils being warmer than light-colored soils; character of surface, soils with smooth surfaces being more likely to be warmer than soils with rough or uneven surfaces. The most effective means for controlling and modifying soil-warmth is by tillage, for securing proper soil-texture also increases soil-warmth. Developing a deep, loose mulch by preventing loss of moisture also prevents loss of heat by radiation.

The factors which affect soil-warmth should be kept in mind in selecting time for seed-planting. For example, seed may be planted with safety in well-drained, sandy loam even in the coldest months of the year, but not in poorly drained soil where clay predominates.

Plant enemies. Attention has already been called to the fact that protection against plant enemies is an important factor in plant culture. These enemies are either animals, chiefly insects, or other plants which are parasitic, such as bacteria or other fungi. Insects are usually far more destructive than all other enemies. The subject of

insects injurious to vegetation is too large a one to discuss here, even in outline. Its importance, however, demands a brief consideration.

In dealing with insect enemies to plants, it must be borne in mind that these insects themselves have enemies, such as other insects or birds. When trying to help the plants, therefore, it is obviously unwise to destroy insects indiscriminately or to drive away the birds.

No general principle can be laid down for control of injurious insects, but a method of study may be followed which will often indicate the means to adopt for their destruction. After the insect has been discovered, careful study must then follow; first, with reference to its habits; second, its life history; third, its natural enemies at different periods of its life cycle. A knowledge of the insect's habits as to method of getting food will determine whether to use a spray or some other means of destruction. If it is a biting insect it will be easily killed by applying poison to the leaves. If it is a sucking insect, as for example the scale, this method will be useless. A knowledge of the insect's life history is important to determine the best time to apply destructive remedies. The insect's natural enemies may often do us a great service, but we need to know what these enemies are and something about each of them in order to give them proper encouragement.

Much of this study has already been done in the case of the most destructive insects of our State by the corps of entomologists at the State University and the result of these studies has been published in bulletins and circulars. These publications may be obtained on application to this department. (See ref. VIII, and also list of references on common insects of California, pp. 54–56.)

Injuries caused by parasitic fungi are of two types: One may be recognized by distinct spots on the leaves or stem of the plant, and a gradual weakening or death of the parts affected. Often the leaves show signs of rust or mildew. They finally shrivel up and fall off. The other type of injury, which is caused by bacteria, affects the whole plant. Diseases of this kind may be recognized by absence of mildew or rust, and by the general weakened condition of the plant. (See ref. II, pp. 94–117.)

The most effective remedy for most of these parasitic diseases is in the use of sprays containing copper salts in solution, and by general cleanliness as to rubbish, such as dead leaves, about the garden. Sunshine is a great preventive of the diseases, a fact which probably explains why they cause so little trouble in California.[1]

[1] Information in regard to spraying as a protection against insects and parasitic fungi will be found in ref. VIII, no. 115.

ANNOTATED LIST OF SOME OF THE MOST COMMON AND IMPORTANT INSECTS OF CALIFORNIA, WITH REFERENCES TO LITERATURE.[1]

It is obviously impossible, in the limits of a few pages, to make more than a very brief annotated list of our most common and important insects. Fortunately these insects have been more or less fully described in our State and Government publications. Annotations will consist, therefore, for the most part, in giving references by number to these special publications, a list of which is appended. This list also includes two books which every teacher should own or have in the school library:

A Manual for the Study of Insects. J. H. Comstock.

Nature Study and Life. C. F. Hodge.

The former gives the necessary general information as to classification, so that the family of any insect may be determined; the latter deals with methods of successful study in the schools.

The chief facts to be observed in the study of insects are: Where they live (habitat); How they live (habits); How they develop and grow (life history). It is important to know all we can about them in order, if they are injurious, to direct our energy against them to the best advantage or assist their natural enemies (other insects, birds, toads, lizards, etc.); or if they are useful, to help and encourage them.

INSECTS WHICH MAY BE IN OR ABOUT THE HOME.

Ants (various species). **2,**[2] pp. 86–88; How to study ants, pp. 415–419; **17,** pp. 95–99.

Bedbug (*Cimex lectularius*). **2,** pp. 82–84; **17,** pp. 32–38; **24.**

Book-louse (*Atropos divinatoria*). **17,** pp. 79–81. The California species is *Leptonotus piceus*, but *A. divinatoria* may also occur.

Clothes-moth (*Tinia pellionella*, et al.). **2,** pp. 71–78; **17,** pp. 32–38; **22.**

Cockroach (*Phyllodromia germanica*, et al.). **2,** pp. 84–86; **17,** pp. 84–95; **25.**

Flea (*Pulex irritans*, *Ctenocephalus canis*). **2,** pp. 79–81; **16,** p. 16; **17,** pp. 24–31.

House fly (*Musca domestica*, et al.). **2,** pp. 62–63; **14; 16,** pp. 12–13; **17,** pp. 43–47.

Mosquito (*Culicidæ*, spp.). **2,** pp. 64–71; **7,** pp. 104–114; **15; 16,** pp. 7–12; **17,** pp. 9–24.

Paper wasp or yellow jacket (*Vespa*, sp.). **17,** pp. 56–57.

Silver fish or slider (*Lepisma reticulata*). **17,** pp. 76–79; **23.**

[1] In this list are mentioned several kinds of insects that have nothing to do with the garden. The importance, however, of a knowledge of some of these very common insects is sufficient justification for extending the list so as to include the household and domesticated insects.

[2] Figures in black type refer to references on pp. 54–56.

BENEFICIAL INSECTS.

(Insects that destroy, in various ways, the eggs, larvæ, or adults of injurious species.)

Dragon fly and damsel fly (Order, *Odonata*). The larvæ of these insects are aquatic and may be considered useful, inasmuch as they destroy large numbers of mosquito larvæ.

The larvæ of both the dragon fly and damsel fly may be easily kept in aquaria and are large enough to be observed in the schoolroom. They are found in almost all permanent pools of water. They are easily caught by raking the weeds and other trash ashore. The larvæ (nymphs) may then be picked up as they endeavor to reach the water. In keeping them in aquaria, three things must be observed: (*a*) there must be means of reaching the surface of the water during transformation; (*b*) they must have plenty of sunshine; (*c*) they must be fed mosquito larvæ or other insects once or twice a week. The water must be kept reasonably clear. **2,** pp. 257–258.

Lace-wing fly, aphis lion, or golden-eye fly (*Chrysopa californica*, et al.). The larva is known as aphis lion and is very destructive to plant lice. The adult is pale green, with finely reticulated wings, long antennæ, and prominent golden-brown eyes. Eggs are laid in vicinity of plant lice, being deposited on slender supports. Several eggs are usually laid in one spot, appearing as a tiny "grove of eggs on stilts." **7,** pp. 136–137.

Closely related to the aphis lion is the ant lion, or "doodle-bug" (*Myrmeleon* sp.). It is very common in the sandy regions of southern California. The larvæ are concealed at the bottom of funnel-shaped pits in the sand. They are easily kept indoors in a box of sand, where their habits may be observed.

Chalcid fly (Fam. *Chalcididæ*). Very small, fly-like insect; some common forms about $\frac{1}{8}$ in. long. Nearly always black, with metallic lustre. Head large in proportion to rest of body. It preys upon a variety of insects and is an important enemy of scale insects. **2,** p. 251; **7,** p. 135.

Ladybird or ladybug (Fam. *Coccinellidæ*).

Australian ladybird (*Vedalia cardinalis*) has saved the State several million dollars by destroying the cottony-cushion scale (*Icerya purchasi*).

Rhizobius ventralis, another imported species, is an important enemy of the black scale (*Saissetia oleæ*).

Twice-stabbed ladybird (*Chilocorus bivulnerus*) is perhaps next in importance.

2, pp. 254–255; **7,** pp. 135–136; **20,** pp. 222–227. In addition to these references, a good, illustrated account of our common ladybirds will be found in the report of the State Board of Horticulture of California for 1890, pp. 279–286.

Ichneumon fly (Fam. *Ichneumonidæ*). Insect with nerved wings and long slender body. It lays eggs on or in the bodies of other insects. The larvæ live as parasites within the bodies of their victims. **2,** pp. 246–250.

Syrphus fly or flower fly (*Laiophthicus pyrastri*, et al.). It resembles somewhat the yellow-jacket by having bright yellow bands on the abdomen. It is called "angel" sometimes by children. It hovers in a very characteristic way above where it wishes to deposit eggs. Its larvæ are very destructive to all kinds of plant lice. **2,** pp. 251–252; **7,** p. 135.

DOMESTICATED INSECTS.

Bee (various species or varieties). **2,** pp. 228–245; **4.**

Silkworm (*Bombyx mori*). **18; 35.**

INJURIOUS INSECTS.

Plant lice (Fam. *Aphides*). Very common. All kinds of plants affected. Injury made by puncturing plant and sucking juices. Tender leaves and twigs usually attacked, but some kinds attack roots: e. g., Grapevine Phylloxera, which attacks both roots and leaves. Most individuals are wingless, but some are winged. A sweetish secretion comes from the alimentary canal through tubes. This is called honey dew and is very attractive to ants—hence name "ant-cows" sometimes given to certain kinds of plant lice. **2,** pp. 210–215; **3,** pp. 23–28; **7,** pp. 126–134.

Among the most important and destructive aphids are the following:

Grapevine phylloxera (*Phylloxera vastatrix*). **21,** pp. 4–9; also Bulletin No. 131, University of California, College of Agriculture.

Woolly aphis (*Schizoneura lanigera*). Destructive to apple trees. Characterized by cottony secretion. **7,** pp. 127–129.

Cabbage louse (*Aphis brassicæ*). **7,** p. 130.

Wheat aphis (*Nectarophora avenæ*). **7,** pp. 130–131.

Hop louse (*Phorodon humili*). **7,** pp. 131–132.

Several other species are common; e. g., *A. brassicæ* on mustard, *N. rosæ* on roses, etc.

Scale insects (Fam. *Coccidæ*). These are the most common and destructive of all the California insects. The wingless female dies after laying the eggs, covering them with her scale-like body.

There are two groups: (*a*) Scale-formers, (*b*) Naked scale insects.

The following list includes the most common and injurious ones (general references 1 and 33; other references give complete descriptions with illustrations):

Scale insects—*continued.*

(*a*) SCALE-FORMERS.

1. Genus[1] *Aspidiotus.* Scale (both sexes) roundish:

Greedy scale (*A. rapax*). Scale of female convex, with exuviæ[2] between center and one side, and usually covered with secretion; color gray; partly transparent; diameter, $\frac{3}{16}$ in. Habitat, almost all trees and shrubs. **3,** p. 20; **5,** pp. 173–174.

Red orange scale (*Chrysomphalus* [*Aspidiotus*] *aurantii*). Scale of female nearly round, with exuviæ prominent and near center; color varies from light yellow to bright reddish-brown, with central part much darker than rest of scale. Habitat, orange and lemon. **5,** pp. 163–166; **26,** p. 24.

San Jose scale (*A. perniciosus*). Scale of female circular and flat; exuviæ nearly central; color gray, but sometimes pale yellow; diameter, $\frac{1}{8}$ in. Habitat, apple, pear, plum, apricot, etc. **3,** pp. 15–18; **5,** pp. 170–172; **13.**

Oleander scale (*A. hedreæ* [*nerii*]). Female similar to orange scale, but lighter in color and with exuviæ less prominent. Habitat, oleander, olive, lemon. **26,** p. 25.

2. Genus *Lepidosaphes.* Scale (both sexes) long and narrow:

Long scale (*L. gloveri*). Scale of female narrow; color light brown. Habitat, orange and lemon. **26,** p. 21.

Oyster-shell bark louse (*L. ulmi*). Female scale long, narrow and much curved; color brown. Habitat, apple and pear. **3,** pp. 12–13.

Purple scale (*L. beckii*). Scale of female long, somewhat curved and broadened posteriorly; length, $\frac{1}{8}$ in.; color brownish-purple. Habitat, lemon and orange. **26,** pp. 22–23.

3. Genus *Diaspis.* Scale, female rounded, male elongate:

Juniper scale (*D. carueli*). Scale of female circular; white; diameter, $\frac{1}{16}$ in. Habitat, very common, juniper, Arbor vitæ, etc. **5,** pp. 175–176.

Rose scale (*Aulacaspis* [*Diaspis*] *rosæ*). Scale of female similar to *D. carueli*, except larger and exuviæ generally to one side of center. Habitat, rose, blackberry, raspberry, etc. **3,** p. 23.

4. Genus *Chionaspis.* Similar to *Mytilaspis.* Scale long, sometimes widened entire length, exuviæ at one extremity:

Oak scale (*C. quercus*). Scale of female long; narrow at anterior and widened at posterior; color whitish with brown exuviæ; length, $\frac{1}{16}$ in. Habitat, various kinds of oak. **5,** pp. 178–179.

Pine scale (*C. pinifoliæ*). Scale of female snowy white, with yellow exuviæ; length, $\frac{1}{16}$ in. Habitat, pine and spruce. **5,** pp. 177–178.

[1] Genera are numbered to avoid confusion.

[2] Exuviæ refers to the old skins, which remain as part of scale.

Scale insects—*continued.*

(*b*) NAKED SCALE INSECTS.

1. Genus *Saissetia* (*Lecanium* in some descriptions):

Black or olive scale (*S. oleæ*). Black or brownish, with ridges on top forming letter H. Habitat, very common, except hot interior. **5,** pp. 195–197; **26,** pp. 27–30.

Hemispherical scale (*S. hemisphericum*). Scale dark brown; hemispherical in outline. Habitat, citrus and ornamental shrubs and trees. **5,** pp. 192–193; **26,** p. 31.

2. Genus *Coccus* (*Lecanium* in some descriptions):

Soft orange scale (*C. hesperidum*). Scale more flattened than *S. oleæ;* elongated oval; color yellow to brown. Habitat, citrus trees and ornamental plants. **5,** pp. 193–194; **26,** pp. 30–31.

3. Genus *Eriococcus:*

Norfolk-island pine scale (*E. araucariæ*). Scale appears near end of branches as flat, oblong, whitish patches about $\frac{1}{8}$ in. long; immature insects found near base of leaves. **5,** p. 201.

4. Genus *Icerya.* Body covered with cottony matter:

Cottony cushion scale or fluted scale (*I. purchasi*). Large egg-sac longitudinally ribbed and filled with loose white cottony mass containing eggs. Habitat, variety of trees and shrubs. **5,** p. 207; **20,** p. 222; **26,** pp. 33–36.

Grasshoppers and crickets (Order, *Orthoptera*). **7,** pp. 115–126; **31,** pp. 1–36.

Harlequin cabbage bug (*Murgantia histrionica*). **9,** p. 82.

Grape-leaf hopper or vine hopper (*Typholocyba comes*). Feeds on grape-vine in summer and on other plants in winter. The winter adult lays eggs in the spring on the leaves of the grape and the larvæ feed on the leaves, preventing large leaf setting, thereby decreasing yield. **21,** pp. 19–21; **30.**

Moths and butterflies (Order, *Lepidoptera*).

(*a*) MOTHS:

Armyworm (several species). **2,** p. 225; **7,** pp. 138–146; **8,** p. 12.

Cankerworm or measuring-worm (two especially injurious species: *Paleacrita vernata* and *Alsophila pometaria*). Male has wings; female wingless. **2,** pp. 196–197; **3,** p. 35; **6,** pp. 11–12.

Codling-moth (*Carpocapsa pomonella*). **2,** pp. 181–187; **6,** pp. 14–18; **27; 28; 29.**

Peachworm or peach-twig borer (*Anarsia lineatella*). **3,** pp. 36–37; **6,** pp. 12–13; **11;** also Farmers' Bulletin No. 80, U. S. Dept. of Agriculture.

Peach-tree borer (Fam. *Sesiidæ*). The most injurious species is *Sanninoidea opalescens.* **2,** pp. 187–191; **32.**

Moths and butterflies—*continued.*

(*a*) MOTHS—*continued.*

Sphinx moth or humming-bird moth (*Protoparce quinquemaculata*). Most conspicuous and beautiful of all our moths. Single eggs are laid on food plant, e. g., tomato. Larva is large (called sometimes tomato-worm). It does not rest at its feeding place. Enters ground to form pupa. Easy to rear in schoolroom if given plenty of food and access to moist earth for pupation. Larva lives in fall; moth appears in spring. Another form (*Pholas achemon*) feeds on grape. It is about same size as the tomato-worm, but is marked with black and golden stripes. A smaller species (white-lined moth) feeds on purslane, but may attack beets and other vegetables. **2,** pp. 207–210; **10,** pp. 40–41.

(*b*) BUTTERFLIES:

There are over three hundred and fifty species of butterflies recorded for California. Professor Woodworth has prepared a bulletin on butterflies of California, especially for use in public schools. Only a few, therefore, of our most common butterflies will be mentioned. For further information as to classification, method of study, etc., see this bulletin: **36.**

Agraulis vanillae. The larvæ feed on passion-vine and are easy to rear in schoolroom.

Cabbage-worm (*Pontia rapæ*). Lives on cabbage and other members of the mustard family.

Euvannessa antiopa. The larvæ are found in great numbers; feed on leaves of willow and elm. It is easy to rear.

Swallow-tail butterfly (*Papilio* spp.). Several kinds. Popular name a good description. Larvæ feed on the parsley family of plants. One kind may nearly always be found on the sweet anise. It is easy to rear and well adapted for schoolroom study.

PLANT PROPAGATION.

Classification of plants as to their soil needs. Garden plants may be classified, according to their soil needs, into three groups: those requiring very rich soil; those requiring moderately rich soil; and those thriving on comparatively poor soil. This classification is based on garden experience with soils long under cultivation and requiring application of fertilizers. The practical method of application is known as the three-field system. Although such a system is not necessary in the ordinary school garden where the soil needs no improvement except for texture, a knowledge of its application is valuable. The system can easily be worked on a small scale to illustrate its possibilities.

In practice, a certain area is divided into three divisions: the first is richly fertilized with fresh fertilizer; the second is sparingly fertilized with finely divided, well-rotted compost; the third is left unfertilized. On the first division are grown plants of the first group, such as cabbage, cucumbers, squash, celery, spinach, tomatoes, etc. On the second division are grown plants of the second group, including all plants with edible roots, bulbs or tubers, such as carrots, turnips, parsnips, beets, onions, potatoes, etc. These plants grow deep in the ground and need light soil. If the soil is too rich the roots become forked and badly flavored. On the third division are grown plants of the third group, including the legumes, such as peas and beans. In rich soil these plants develop luxuriant foliage but scanty fruit. They are adapted for getting most of their nitrogen from the air through the action of nitrifying bacteria living at their roots.

The division which, during the first year, bore plants of the first group, is planted in the second year to plants of the second group, and in the third year to plants of the third group. In the fourth year it is richly fertilized as in the first and planted to plants of the first group. The division which, during the first year, bore plants of the second group is planted in the second year to plants of the third group, and so on. Thus, by rotating crops, the three divisions may be kept indefinitely in condition best adapted to these three groups of plants.

Preparation of ground and seed-sowing. The ground should be thoroughly worked up so as to have as nearly as possible perfect soil conditions in respect to texture and moisture-content. (See pp. 13–15; also figs. 3 and 4.) When in such condition it is ready for the seed.

Special information as to the time of planting, time of maturity, etc., of each plant will be found in the "plant calendar" at end of chapter (p. 29). Special directions will also be found printed on the back of seed packages, if seed is bought in this way. The following general directions are adapted from Wickson (ref. VI):

There is often advantage in soaking seed over night in tepid water, especially if soil in which the seed is to be planted is very light. When the seed is planted it should be carefully covered. This is primarily to assist the seedling in its anchorage and root penetration, and to insure it moisture. In California the depth of planting may be roughly stated

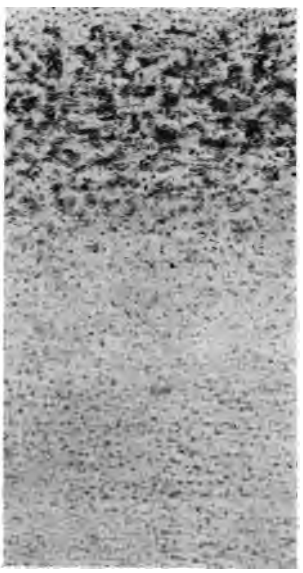

FIG. 3. Proper preparation of soil.

FIG. 4. Improper preparation of soil.

(These figures are adapted from Bailey's "Garden-making," pp. 9 and 11.)

as five times the diameter of the seed. While this is a safe rule under average conditions, it must be modified according to circumstances. On all soils the rule must be shallow sowing if large rainfall is characteristic of the region; deep sowing if scant rainfall; shallow sowing early in the rainy season; deep sowing near its close; shallow sowing in heavier soils; deep sowing in light soils. Depth must be counted from the beginning of the moist layer and not from the dry surface.

When the seed has been covered the ground above it should be firmed. By this is meant pressing the soil particles together around the seed. The object is to force the particles into capillary connection, thereby bringing moisture to the seed. This is done by pressing on the

earth above the seed with some flat surface, *e. g.* by tramping on a narrow board placed over the row of seeds, or by patting down the soil with the back of a hoe.

In light soils where the moist layer is much beneath the surface narrow trenches may be dug to the required depth of the seeds. The trench should then be partly filled with water. As soon as the water is taken up by the soil, seeds are then sown and covered up.

Cultivation. As soon as the seedlings appear the ground should be raked or stirred so as to form a mulch of finely divided soil particles to a depth of three or more inches. Such cultivation should be repeated at least once a week, or as often as it is necessary to keep the connection broken between the moisture below and the air above.

After a rain or after irrigation, as soon as the soil is dry enough to be worked, it should be cultivated. The object of this cultivation is to conserve the moisture.

When the plants are well started it is advisable to cultivate somewhat deeper between the rows so as to aërate the soil. This is particularly important after heavy rains, for after the rain the soil particles have run together and crowded out the air spaces.

Irrigation. As has already been stated, water should not be applied by sprinkling if it can be avoided. In school-garden practice, as soon as the soil becomes dry some distance below the surface, trenches should be dug between the rows and water applied by irrigation methods. If no hose is available water may be poured into the trenches by means of buckets. The best time for irrigation is in the afternoon. By the next morning the soil will have taken up the water and will be ready for cultivation.

Tools. From the foregoing it will be seen that two kinds of tools are required for the work of garden-making: one kind for doing the heavy work of preparation, the other kind for cultivation.

It is important, in providing a garden equipment for a school, to make it as simple and as inexpensive as possible consistent with good service. For ordinary purposes the spading fork is the most desirable tool for spading the ground, applying and working in the fertilizer, etc. A ten- or twelve-toothed rake of some kind is needed to level off the surface and finish the soil preparation. The rake is also the most useful tool for cultivation.

Another valuable and almost indispensable tool for children is the weeding fork. After the soil has been prepared, all the rest of the work —making trenches, covering the seed, and subsequent cultivation—can be done with this simple tool.

The necessary tools, then, are: spading fork, rake, and weeding fork. Other tools, such as hoe, spade, etc., are occasionally useful, but are

luxuries rather than necessities. In humid climates cultivation carries with it the idea of hoeing and killing weeds. In California, cultivation is almost solely for the purpose of conserving moisture and aërating the soil, hence there is little use for the hoe. If this is done properly, weeds will give no trouble.

It is economy to buy tools of good quality. The ordinary garden sets for children are worthless for any real use. Two sizes of spading forks are on the market: the ordinary size for adults and a smaller size for children. The former costs $1.00; the latter, from 50 to 75 cents. There are several sizes of rakes. The smaller size which is durable and well made is the most useful, and can be bought for about 40 cents. There are many kinds of weeding forks, ranging in price from 10 to 50 cents. The cheap ones are made of cast iron and break easily, so it is economy to buy the more expensive kind. There is on the market a combination rake and hoe which serves most purposes of both. It is somewhat lighter than a small rake and makes an excellent tool. The small size costs 35 cents.

For irrigation, a long hose is desirable, but not absolutely necessary unless the garden area is very large. Sufficient water can be carried in buckets or sprinklers. If sprinklers are used the sprinkling attachment should be taken off so as to remove any temptation to sprinkle the ground. In practice, preparation for irrigation should be made by each individual child. But the actual work of supplying water should be left to the larger children—preferably the boys. Cultivation after irrigation should, as in the case of preparation, be done by each individual for himself.

Tools should be carefully cleaned after use, and then put away in order in some designated place. If the garden is enclosed, the most convenient method for keeping tools when not in use is in strong lockers along the garden walls. Such an arrangement is almost indispensable, if there is a large number of tools. If the gardening is done on a small scale and there are but few tools, they can be kept in some convenient place in the schoolhouse.

Provision should be made for laying off the garden into suitable divisions according to a plan worked out by teacher and pupils before work is begun. Some strong cord, a tape-line, plenty of stakes, and some small hatchets or mallets for driving stakes, should be provided.

A small wheelbarrow will be found convenient for many purposes. One suited to the needs of a school garden can be bought for $2.00.

Plan of garden. There are two types of school garden: one known as the group garden, and the other as the individual garden. The former is cared for in common by several children. Where but small garden space can be obtained it is often the only way gardens can be provided for children. The objection is obvious, for in any group of

children there will be some who will do most of the work, and some who will do very little. This type of garden, however, fails to give the most

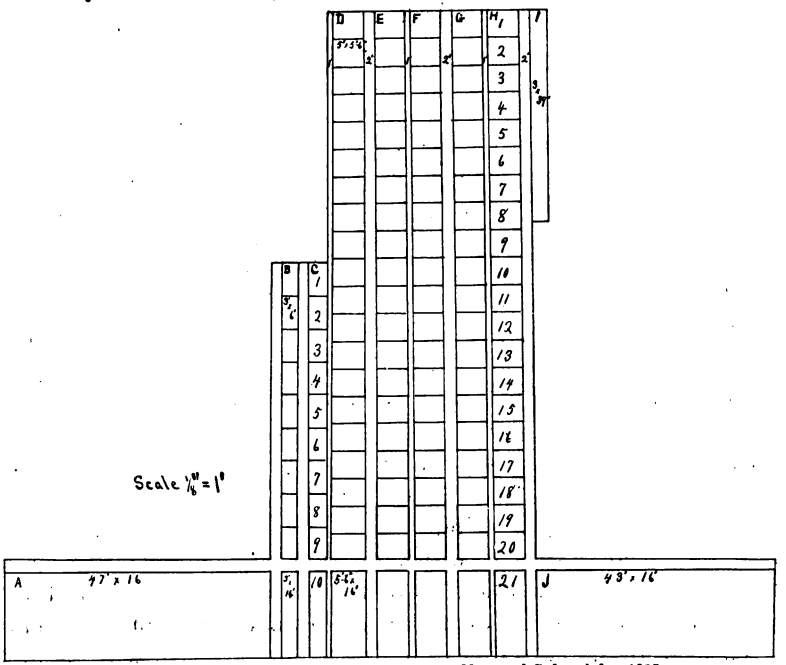

FIG. 5. Plan of gardens of Chico State Normal School for 1905.

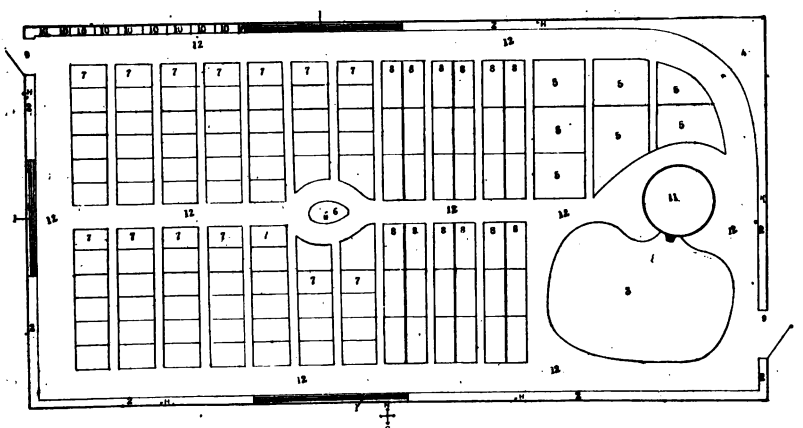

FIG. 6. Plan, somewhat modified, of gardens of Los Angeles State Normal School.

1, bench; 2, strip for climbing plants; 3, botanical garden; 4, corner for shrubs; 5, plats for experiments; 6, plat for flowers; 7, gardens, 3 x 6 ft ; 8, gardens, 6 x 3 ft.; 9, gates; 10, lockers for tools; 11, pond; 12, walks; H, hydrants.

important incentive to interests, viz., individual ownership and responsibility. The desirable thing, then, is the second or individual type.

If the site for the garden is optional, it should be chosen so as to

receive the morning and midday sun. This, however, is not so important in most places in California as it is in colder climates.

When the dimensions of the ground at the disposal of the teacher for school-garden purposes have been ascertained by actual measurements, a general plan should be prepared. The character of the plan will depend entirely upon the work undertaken. In general, it should include walks, individual gardens, and plats for experimentation.

A convenient arrangement is to divide the ground into long areas, separated by walks. These long strips should be as wide as the individual gardens are long. The best size for individual gardens and plats for experiment is 4 or 5 feet in width by 6 feet in length. These plats should be slightly separated by narrow walks.

Another arrangement, which takes up somewhat less space and is also more convenient for irrigation, is often more desirable: The ground is divided into long strips, 7 to 10 feet wide, separated by walks as in the first plan. Each strip is divided along the middle by a furrow or trench into two narrow strips. These narrow strips are marked off into individual gardens, each 5 or 6 feet in length. Water is supplied by filling the division furrow and distributing it to the individual gardens. Such a plan is illustrated in fig. 5, which is of the Chico State Normal School gardens. Fig. 6 is a modification of the plan in actual use at the Los Angeles State Normal School, and combines both kinds of arrangement. References to these plans and to figs. 7, 8, and 9, which are pictures of three stages of garden-making at the Chico State Normal School, will give a clear idea of the general scheme of a garden plan and method of carrying it out.

The foregoing embodies all the features necessary for gardens of the individual type, and is sufficiently general to be modified and adapted to the conditions of any school.

A third type of garden may be added: Where the schoolyard space is inadequate for group gardens, narrow strips will be found sufficient for demonstrating the life history of many of the common plants of commercial importance, and also for rearing a few vines and flowers. Where yards are paved and no ground is available, these plants may be grown in deep window-boxes. (Miller, 1904.)

Plant calendar. A complete list of vegetables and flowers suitable for a California school garden has been carefully prepared. It is arranged as a table of reference, giving the most important information required for each plant. Further information may be secured by consulting refs. VI and IX. The times indicated for planting are adapted to all parts of California except those having heavy rains and cold winters. In such regions the time of planting will, of course, have to be later.

PLANT CALENDAR.

VEGETABLES.

Name.	When to Plant.	Amount of Water.	When Mature.	Remarks.
Asparagus	Seed—February to March Roots—March	Much Much	2 to 3 years 1 year	Best to get roots. Have rich sandy soil with a sub-drainage.
Beets	Jan. to May; Aug. to Nov.	Moderate	3 to 5 months.	
Beans, String	Mar. to June; Sept. to Oct. (where no frost).	Moderate	2 mos., pole bean 3 months.	Will not stand frost. "Kentucky Wonder" the best pole bean—4 mos. Lima bean in May and June.
Cabbage—Early	Jan., Feb., March	Plenty	5 to 7 months	Transplant small plants.
Late	March to June	Plenty	3 to 4 months	Richly fertilized soil.
Carrot	Any time except July and August.	Plenty	4 to 6 months	Rich, deep soil.
Cauliflower	Same as cabbage	Plenty	4 to 6 months	Very rich soil. Runs to seed if not much water.
Corn (Sweet)	Mar. to June; Sept. to Oct.	Not much.	60 to 70 days.	
Cucumber	Mar. to June; Sept. to Oct.	Fair	2½ to 3½ months.	
Eggplant	May to June; Sept. to Oct.	Little	3 months	Easily killed by frost.
Garlic	Nov. and Dec.; Feb. and Mar.	Plenty	June and July	Plant sets.
Horseradish	January to March	Plenty	Oct. and Nov.	Plant sets in good, rich, deep soil.
Lettuce	Any time	Plenty	2 to 3 months	Does not thrive so well if planted in July and August.
Melons—Water	April to June	Not much.	3 to 3½ months	Good light soil.
Musk	April to June	Not much.	3½ to 4 months	Good light soil.
Onions (seeds)	Feb. to May; Aug. to Nov.	Plenty	9 mos. to 1 yr.	Takes one year to mature. Keep weeded and soil loose.
Parsley	Any except July and Aug.	Plenty	2 months	Soak seed in water. Cut plants down and they will grow up again.
Parsnip	All except summer months.	Plenty	8 to 10 months	Same soil as for carrot.

VEGETABLES—Continued.

Name.	When to Plant.	Amount of Water.	When Mature.	Remarks.
Peas	Every month (except where ground is cold and wet).	Plenty	2 to 5 months	Not too heavy soil. Winter Peas best. Spring Peas quicker.
Peppers	May, June, and July	Moderate	3 months	Transplant plants.
Potato (2 crops)	February to May; Sept.	Plenty	2 to 4 months.	
Potato, sweet	April to June; May the best.	Plenty	4 to 5 months	Plant sets. Good light soil.
Pumpkin	May the best; June	Fair	November	Stock Pumpkins need no water.
Spinach	Every month	Plenty	6 to 10 weeks	Grows up and may be cut off.
Squash (summer)	May to June	Not much.	Soon as large enough.	
Tomato	February and March	Moderate	3 to 4 months	Either plants or seeds. Transplant. Danger of giving too much water.
Turnip	All except summer months.	Moderate	2 to 4 months.	
Radish	Any time	Plenty	1 to 2 months	Grows quickly.

FLOWERS.

A = Annual. P = Perennial.

Name.	When to Plant.	Amount of Water.	When Blossoms.	Remarks.
Alyssum, Sweet (A)	October and November	Small	Winter and early spring.	May sow from October until May.
Aster (A)	February and March	Moderate	5 to 7 months	Sow seeds in boxes in fine rich soil. Transplant when about 3 inches high. Time depends on kinds.
Balsam	February and March	Moderate	4 months	Sow in boxes.
Calendula, "Pot Marigold" (common)	Almost any time. Fall or winter best. Oct. to May.	Small	3 to 4 months	Easy to grow. Very hardy.
Calliopsis	Oct. to May. Best in fall.	Moderate	3 to 4 months	Easy to grow.

Candy tuft	October to May	Small	3 to 4 months	Easy to grow.
Centaurea margaritæ, "Corn flowers"	Early spring, Feb. and Mar.	Moderate	Blooms through summer into fall. 3 mos.	Will not stand much cold. Sow in boxes and then transplant. Very beautiful.
Collinsia, wild flower called "Innocence"	Fall	Moderate	3 months.	
Cosmos	Oct., Jan. to May, July	Moderate		If planted in October Cosmos will be dwarfed and bloom at Christmas. If planted in January and February they will bloom in spring and be dwarfed. If in April and May they will be tall and bloom in fall. If in July, will bloom at same time but will not be as tall.
Castor Beans	March, April, May	Small		Grow best in sun. See also Perennials.
Eschscholtzia, California Poppy	October	Small	3 months	If planted in April will flower in July.
Godetia (wild), "Farewell-to-Spring." Color—lavender.	Fall	Not much	Late in spring	Blooms profusely and is good for borders and groups.
Gypsophila (A and P)	August and September	Moderate	Winter (A) Summer (P).	Good to mix in with bouquets.
Hibiscus (A)	Fall, winter, and spring	Moderate	4 months	Sow in boxes and transplant.
Ice-plant	Spring	Little		Needs a sunny place.
Larkspur (tame)	October	Moderate	3 months.	
Linum ("Crimson flax")	Fall	Little	3 months	"Unsurpassed for brilliancy and duration of bloom."
Lupins (see also Perennials)	Fall	Little	3 months.	
Marigold, African (see also Calendula)	January	Moderate	4 months	Very pretty French Marigolds grow low. Bloom sooner.
Mignonette (sweet)	Fall and winter	Moderate	2 to 3 months	Blooms quickly.
Mesembryanthemum. "Dew-plant" for edging or rockwork. Brilliant red.	Fall	Moderate	April to June	Plant cuttings.
Nasturtium, dwarf and climbing	Spring	Little	2 months	Will not stand much frost. May be planted almost any time.
Nemophila, "Baby-Blue-Eyes"	Fall	Plenty	3 months.	
Nigella, "Lose-in-a-Mist" or "Devil-in-the-Bush."	Fall or spring	Plenty	3 months	Easy to grow. Good for cutting. Lasts long in water.

FLOWERS—Continued.

Name.	When to Plant.	Amount of Water.	When Blossoms.	Remarks.
Pansy	September and October	Plenty	3 to 4 months	Really perennial, but always treated as an annual. Plant in boxes and transplant. Use very rich loam and leaf-mold. Make permanent bed very rich.
Phlox	Fall where it is warm	Moderate	3 months	Hard to grow the perennial from seed, so it is mainly treated as an annual.
Platystemon, "Cream Cups"	Fall after first rains	Moderate	3 to 3½ months.	
Poppy	October and November	Moderate	3 to 4 months	If given too much water they will grow too rank. They will grow on a very poor soil.
Portulaca, "Moss Rose"	Spring	Little	2½ months	Sunny place.
Salpiglossis (like Petunias)	Fall	Moderate	3 months	Sow and transplant.
Stocks, "Gilly flowers"	September	Moderate	3 months	Annuals are stocks. Perennials are "gilly flowers." Transplant.
Sunflower	Spring or any time	Little	3 months	Any where and any way.
Sweet Pea	October until March	Plenty	3 to 6 months	If planted in fall they make prettier flowers. Planted in October it takes 5 or 6 months; if in March, 3 months.
Zinnia, "Youth-and-Old-Age"	Spring	Moderate	3 months	Transplant. Showy.

CLIMBING PLANTS.

Name.	When to Plant.	Amount of Water.	When Blossoms.	Remarks.
Australian Pea Vine (P)	Spring or winter	Little	4 months	Soak seeds in water 12 to 24 hours before planting.
Balloon Vine (A)	Spring	Moderate	3 months.	
Cobæa (rapid-climbers)	Spring and winter	Moderate	5 months	Transplant.
Morning-glory	Spring	Moderate	3 to 4 months	Will not stand cold.
Hop Vine, Japanese	Spring, April and May	Moderate	4 to 5 months	Grown for foliage.
Moon Flower	Spring	Moderate	5 months	Soak seed in warm water.

Mina lobata	Spring	Moderate	6 months.	
Snail vine	Spring	Plenty	6 months	Transplant. Rather hard to start. Slow.
Smilax	Spring	Not much.		Soak seed.

PERENNIALS.

Name.	When to Plant.	Amount of Water.	When Blossoms.	Remarks.
Asparagus sprengeri	Any time			"A fine ornamental plant for hanging baskets"
Aster				Treat as annuals.
Columbine	September and October	Moderate	Next summer	Hardy. Decorative border plants.
Cactus				Easy to grow. Many varieties.
Canna	Spring	Moderate	2 months	Best raised from plants. If seed, soak for 24 hours.
Canterbury Bells	Fall	Moderate	Next summer.	
Carnation	September and October	Plenty	6 mos. to 1 yr.	Transplant.
Chrysanthemum	May	Plenty	Fall	Best grown by plants.
Coreopsis	September and October	Plenty	Next summer	Very showy and beautiful.
Cyclamen	Fall	Moderate	Same winter	Get bulbs.
Daisy	Fall, winter or spring	Moderate	3 months	Transplant.
Dahlia (roots)	March, April, and May	Plenty	July, Aug., Sept.	Roots are the best. Have rich ground.
Ferns	Fall or winter	Plenty		Cool, moist places. Shady. Slow.
Feverfew	Fall	Little		Good for bouquets.
Four-o'clocks	Spring	Little	2 to 3 months.	
Foxglove	Fall	Moderate	Next summer	Good for borders.

PERENNIALS—Continued.

Name.	When to Plant.	Amount of Water.	When Blossoms.	Remarks.
Forget-me-not (Myosotis)	September and October	Moderate	Spring	Easy to grow.
Gaillardia ("Blanket flower")	Fall, winter, and spring	Moderate	4 months	Very showy.
Geranium	Spring			Use plant cuttings. They grow easily.
Heliotrope	Fall	Plenty	Summer.	
Hibiscus	Winter	Moderate	Summer	Use plants.
Hollyhock	August, September, October	Moderate	Next year.	
Lavender	Fall	Not much	Summer	Very fragrant. Easy to grow. Use plant cuttings.
Pentstemon	Fall	Little	Summer	Showy.
Pansy. (See annuals.)				
Petunia	Fall	Little	Summer	Very ornamental.
Pinks (China)	Spring	Moderate	3 months.	
Pinks (plain)	Fall	Moderate	Summer.	
Primrose, Evening	Fall	Moderate	Summer.	
Phlox. (See annuals.)				
Salvia (scarlet)	Fall	Little	Summer.	
Snapdragon	Fall or winter	Plenty	3 months.	
Sweet William	Fall or winter	Little	Summer.	
Wallflower	Fall	Little	Summer.	
Verbena	Fall and spring	Little	4 to 5 months.	

INSTRUCTION.

Aim and scope. The garden must be regarded as a part of the school equipment to be used as a means of instruction, and of education through doing. The chief aim of school-garden instruction is to direct the child to the observation of the life, growth, and habits of living things, and at the same time to give him practice in the use of his resources for definite ends.

"In a school garden the boy (child) becomes aware, almost imperceptibly, of the conditions of growth of a plant, of its dependence on light, air, warmth, water, and soil. He learns to see the relation of the various organs of a plant to each other as a living whole, and the connection between plant and insect life. It is not the dead anatomy of the laboratory that is his first introduction to nature." (Rooper, 1902.)

The economic importance, especially in agricultural districts, of a practical knowledge of plants and how to care for them intelligently; the increased significance of the natural environment revealed to the child; the benefit of wholesome exercise in the open air, are, in themselves, sufficient justification for the school garden. But these are even less important than learning how to make use of one's resources for definite purposes.

Carlyle's definition of man as "a tool-using animal" has a fundamental educational application. Words in books, arithmetic, writing, the rule for exact measurements, and the garden rake are alike tools, or in other words resources for accomplishing certain life purposes. The common schools do furnish the tools, but they give little practice in using them in this way.

The value of a method of study which sets up an object of inquiry to be worked out by the child's own efforts can hardly be overestimated. It is the most important practical training that can be given. It prepares for life and gives ability to meet life conditions by doing things for definite ends. The garden presents an endless series of problems for such study, from the simple ones within the reach of the first-grade child to those whose complexity have thus far baffled the trained scientist.

The degree of success in carrying out this sort of instruction will be measured by the ability the pupils acquire to get results independently or with minimum assistance from the teacher, and not by the best vegetables or flowers produced. Failure, on the other hand, will be

recognized when results are obtained only through mechanical work at the teacher's bidding, although the garden may yield the finest vegetables and the most beautiful flowers.

The problem of school-garden instruction has been stated and the general aims presented. The most essential facts as to plant needs, soil preparation, propagation and cultivation of plants, plant enemies and method of their study, a plant calendar, and sources of further information have been given (pp. 11–35). These furnish data for the problem. It remains now to give definitely and somewhat in detail practical suggestions bearing on the solution of the problem.

Applying the principles just set forth to our task of helping the teacher to use the garden as an efficient means of instruction, it is clearly illogical to attempt to give a detailed plan which can be mechanically followed out. The scope of the school garden includes two phases of instruction, which may be designated as practical and correlative:

PRACTICAL WORK.

Practical garden work is of fundamental importance because it is the center of all garden instruction. It has for its aim the practice of the principles of plant-rearing which have already been outlined so that in time the pupils will learn these principles through actual experience. The task is a difficult one for the teacher, because the subject is new alike to teacher and to pupils. The general plan of procedure is the same on whatever scale the work is undertaken. It should proceed according to an intelligent understanding of the principles already indicated.

General preparation. If the school is a large one it is advisable to select one or two grades to begin with, and gradually to add other grades as experience warrants.

The area of ground needed may be roughly estimated by allowing 24 square feet of space for each child. This will provide for individual gardens 4 by 6 feet. Add to the total area needed for the children's gardens one third more for walks. There should also be provision for a number of extra plats 4 by 6 feet for special experiments, for the use of children especially skillful or interested, and for the teacher's use in demonstrating garden processes. The total area in square feet required will be the sum of these three estimates. The space thus estimated should be selected near the schoolhouse, but as remote as possible from the playground, *e. g.* on the opposite side of the house. It should also be convenient to the water-supply, within reach of a section of garden hose if possible. If there is any opportunity for choice after these conditions are fulfilled, the character of the soil and favorable location as to sunlight will be the determining factors as to location.

In most cases it will be an easy matter to get the ground plowed and

FIG. 7. Garden-site of Chico State Normal School.

FIG. 8. Gardens of Chico State Normal School in process of preparation.

harrowed by donation either of money to hire the work done or of the work itself.

Plan of garden. In the meantime the plan should be worked out in detail according to suggestions on page 26. The plan should then be presented to the pupils, or rather made over with them so that they will understand the general arrangement of the garden and be better able to carry out the scheme.

Tools. Tools must be provided in some way before the actual work begins. The number will be determined, of course, by the number of pupils. Since the school garden may be looked upon at first by the

FIG. 9. Gardens of Chico State Normal School after one month's work.

school trustees as a doubtful experiment, the pupils may be asked to bring their own tools. As soon as the success of the garden has been demonstrated the tools actually needed for a full equipment may be purchased.

Time. A regular time for garden work should be provided in the regular program, the amount depending upon the time at the disposal of the grade or school. In taking time for this work it must not be regarded as an addition to the program, but rather as a practical application of several school subjects (p. 41). The best time of day is the first part of the daily session; the next best, the last part of the daily session.

Individual gardens and walks (p. 27). The first work consists in laying out the garden according to plan (figs. 5–6, p. 27), *i. e.* marking off the gardens and walks by means of lines and stakes. (See fig. 8.) There should be no hurry. The chief thing here, as in other garden operations, is to have careful work.

Preparation of garden for planting (p. 23). After the gardens have been staked off, each pupil should put his own garden in good condition for seed-planting. In order that the children may understand just what to do they should be told in simple language the main steps in the process. This should be followed by a demonstration of these steps by the teacher in her own garden. Further instruction can be given to individual children while they are at work.

Seed planting (p. 24). The seeds of a few hardy, quick-growing plants should be chosen for the first planting; others to be added later as desired. If seeds are purchased it is advisable to get them in bulk and then divide them into small packages for the pupils. Many children may prefer to bring their own seeds from home.[1]

As in preparation of ground, the method of planting seeds should be explained and then demonstrated before the children undertake to do

[1]Announcements have been recently sent out by *The School Garden Association* stating that this association is prepared to furnish seeds at a nominal price (a penny per package) to all who may apply. Instructions for planting the seeds are printed on the backs of the seed-packages. The great value of this work is obvious. The following is quoted from one of the association's circulars of information:

COLLECTION No. 1.—VEGETABLE SEEDS. This collection contains five packets. Price of collection, 5c.

1. *Cucumber.*—Early frame. The cucumber is one of the vegetables that grow on a vine, and belongs to the same class as the cantaloupe, watermelon, squash, and pumpkin. It is grown for its white fleshy pulp inside the outer green rind.
2. *Radish.*—Early scarlet globe. The radish is grown for its root. To this class also belong the turnip, parsnip, and carrot.
3. *Parsley.*—Champion moss curled. Parsley is cultivated for its top and is used for garnishing meats and for flavoring. The feathery leaves add greatly to the appearance of a garden, and if covered in the late fall will keep green all winter.
4. *Lettuce.*—Early white summer cabbage. Lettuce has large leaves, which grow more or less compact according to the varieties, some of which form a head like the cabbage. This vegetable is used extensively for salads and table use.
5. *Onion.*—Large red Weathersfield. The onion forms a bulb. It is used as a seasoning and is eaten in many forms. It was cultivated in Egypt four thousand years ago.

COLLECTION No. 2.—FLOWER SEEDS. This collection contains five packets. Price of collection, 5c.

1. *Sweet Peas.*—The vines may hide unsightly fences or be trained against walls, where they will bloom in the greatest profusion and splendor.
2. *Nasturtium, tall.*—This variety grows in long vine-like shoots, thickly covered with leaves of a graceful shape. The flowers come early and form a mass of brilliant color until late in the fall.
3. *Poppies.*—Double mixed and Shirley. These flowers have showy colors, ranging from a rose-flushed white to a deep crimson.
4. *Mignonette.*—The fragrant spikes of flowers have a subdued harmonious green foliage, excellent for borders.
5. *Gaillardia.*—This flower is very interesting to study. The colors are showy, and the season of bloom is from early June until fall.

"The work of gardening is all wholesome and conducive to making better, stronger boys and girls and more industrious, law-abiding citizens."—*Louise Klein Miller.*

All orders from one collection to one hundred or more will be promptly filled. Enclose remittance with order, stating the number of each collection wanted. Do not fail to write your own name and postoffice address in full. Address: "The School Garden Association, Box L (m), Station A, Boston, Massachusetts."

the work for themselves. If furrows are marked out the long way of the garden the first row should be near the boundary line, the next one about ten inches from this one, and so on. A line and rule are to be used to secure accuracy. After the seeds have been planted, covered, and the soil firmed, the end of the row should be marked with a small stake (prepared beforehand) having the name of the plant written upon it with pencil.

Cultivation (p. 25). Methods of cultivation and irrigation have already been given in sufficient fullness. As the plants increase in size it will be necessary to thin them. Each plant should be free to develop without hindrance. It is advisable to remove all the weak plants, leaving plenty of room to the vigorous ones.

Harvesting. Plants should be harvested as soon as they have reached a degree of maturity most desirable for food or ornamental purposes. As soon as all the plants of a certain kind have been removed, the portion of ground on which they were growing should be worked over and other seeds sown (p. 43).

Pupils' records. Pupils above the third grade may keep records of work done and observations made in the garden. The general character of these records will be discussed in another connection (p. 43). A suitable notebook should be devoted entirely to garden records. Rough notes may be made immediately after the work or observations, and later transferred to the notebook. Each book should include diagram of whole garden, diagram of individual gardens, daily records and plant records in form of tables, and personal records of each kind of work undertaken. Diagrams should be drawn to scale, giving exact proportions.

The following is a convenient form of daily record[1]:

Date.	Work	Observations.
Nov. 10	Finished garden by breaking clods and raking.	Found some earthworms.
Nov. 11	Planted radishes and lettuce.	Looked for earthworms, but found none.
Nov. 12	Planted onion sets.	----------
Nov. 13	Planted carrots and beets.	----------
Nov. 14	----------	Radishes coming up.
Nov. 15	----------	Rain.

This form is given more to illustrate what is meant by daily record than one to be strictly followed. It does not matter in what form the record is made so much as to have some sort of systematic account of work and observations.

[1] These record-forms are adapted from Niessen, 1896, pp. 132-136.

What is meant by plant record[1] is shown by the following:

Name of Plant.	Variety.	Time of Planting.	No. of Rows	No. of Plants or Seeds.	Harvest Time.	Harvest No.	Harvest Weight.	Enemies.		Remarks.
								Animals.	Fungi.	
Radish.	French Breakfast	Nov. 10	½	40	Dec. 20	10	.....	None.	None.	Thinned out 10 plants.
Radish.	Scarlet Turnip.	Nov. 10	½	40	Dec. 18	18	.....	None.	None.	Thinned out 8 plants.

The main body of the notebook is to be taken up by personal records. These will be discussed in another connection (p. 43).

Teacher's plan-book. It is important for the teacher to have a plan-book devoted entirely to the school garden. Such a book is valuable not only for systematic direction of the children's work, but also for reference in subsequent years. It should include diagram of garden, with assignments to different pupils; detailed weekly plans, and plant records similar to those made by the children.

The weekly plan is simply an outline of the week's work. The following is an illustration of a condensed form of weekly plan. The subject may be included under three heads: Lessons or special topics, practical work, and observations. These may be arranged as follows[1]:

Nov. 10–15, 1902.

Lessons.	Practical Work.	Observations.
Instruction and demonstration of garden preparation.	Garden preparation.	Look for earthworms.
Instruction and demonstration of seed planting.	Plant radishes.	Look for earthworms.
Instruction in making plant records.	Plant carrots, beets.	.....

All points of special interest or experiences that may be useful for reference in the future should be recorded.

CORRELATIVE SUBJECTS.

It is important to distinguish between the necessary use of these several subjects correlated with gardening and the drawing of illustrative material from the gardening for use in the regular instruction in these several subjects. Except where otherwise indicated, the former use of these subjects is always intended. They are to be brought in, as far as possible, for the solution of definite problems directly connected with the garden work.

What is meant by correlative instruction will be made clear by the discussion of different school subjects individually, and by typical illustrations.

[1] These record-forms are adapted from Niessen, 1896, pp. 132–136.

Nature study. All the processes of gardening are preëminently nature studies of the very best sort. To rear a plant successfully, to be responsible for its life, to protect it and minister to its needs, to become thus vitally connected with it, go a long way toward giving the child the right attitude toward nature. This attitude, or point of view, or means of contact is, indeed, the chief purpose of nature study. This attitude is fundamental for any development of an æsthetic appreciation of nature. To rear a plant with all its beauty of leaf and flower, if not creative art, has at least the elements of it, and leads to more than a passive enjoyment of the beautiful.

Science. "Science" is a term often, if not generally, used to apply to a body of knowledge obtained through scientific study. Much of the so-called nature study is really scientific information. Science is more than a body of information; it is also a method of study or test of human experience. It has to do with exact and impartial analysis of facts. It sets up problems to be solved by careful observation and experiment.

The term "science" as used in connection with our subject will refer to scientific method and not to a body of facts. It is hard to distinguish the boundary between science and nature study. The distinction which has just been made, though somewhat arbitrary, has been given to emphasize the fundamental purpose of each. A great deal that goes by the name of nature study is neither nature study nor science. It is pure nonsense, and has done great injury to the real subject by masquerading under a misnomer. It is with the idea of science as above defined that the following illustrations are given:

Why is it necessary to cultivate the ground soon after a rain or irrigation? A comparison of a cultivated with an uncultivated area will give the answer. This should be followed by observation of well-cultivated and poorly cultivated fields and orchards in the neighborhood.

Why not apply water by sprinkling instead of by irrigation? Try sprinkling a portion of ground alongside of a portion which has been properly irrigated, and compare.

Why is it necessary to firm the soil after planting seeds where the surface layer of the soil is dry? Leave a portion of a row unfirmed, and note the time it takes in both cases for the plants to come up.

Why improve the soil-texture when the soil is adobe or sandy? Try making a garden of a small area of ground that has not thus been treated, and compare with the rest of the garden.

Why not plant peas in very rich soil? Plant some seeds in very rich soil, and compare number of pods per plant with those grown on soil poor in nitrogen. What does the pea plant have that is different from most other plants and that might account for this difference? Examine its roots and note their knotted appearance. Scientists have asked a few more questions and got for their answer the fact that bacteria are

in these knots, and that these bacteria fix the nitrogen of the air and make it available for the plant's use. Look up references on the subject. (ref. II, pp. 33–35, and VII.) This is another way of finding out things when we have gone as far as we can with our own means of inquiry.

Plants are injured by certain insects. What are the life histories of these insects? Where do they come from? What habits have they? What are their natural enemies?

An almost endless number of such problems might be given. For further reference, see refs. I, II, IV, and Appendix, p. 75.

Mathematics. Arithmetic will constantly be called into use, from measuring the garden in the beginning, to estimating the amount and value of the crop at the end. Many of the problems included under science will require the aid of mathematics. The value of this lies not only in learning to apply mathematical operations, but also in developing mathematical concepts or sense of quantity as represented by numbers.

Illustrations: Measurements of the garden, its subdivisions, walks, etc. Finding areas of individual gardens.

Numerical record of seed sown, seedlings as they appear, and mature plants. Calculate percentages from these records.

Seed-testing, which involves estimate of germination seeds (ref. II, pp. 77–80). With these data estimate allowance, which must be made in sowing, for bad seed.

From record of mature plants or harvest yielded on a given area in the garden calculate the yield per acre, and value as estimated at rates quoted in current market reports.

If plants are attacked by insects, estimate damage done, first in number of plants (percentage), and second in value. With the rates thus obtained determine the loss per acre. This may be varied by leaving a certain number of plants unprotected. Determine final results in percentage of mature plants or yield on protected and unprotected areas.

Comparison of results of different soil conditions on yield of same kind of plants, *e. g.* pea plants, already cited under "science."

Language. Personal accounts, either written or oral, of work done, form an important part of the training afforded by the school garden. In general, a clear statement should be made of the problem, *i. e.*, what it is desired to find out. This should be followed by an explanation of how the experiment is to be made, work to be undertaken, things concerned, etc.; next, a clear account of the work done; finally, a statement of results obtained.

The best form within the capacity of the pupil must be insisted upon.

The account should be a personal one, not a repetition of words used by the teacher. Dictation has no value in this connection.

In addition to this direct use of language in the regular work of garden instruction, many subjects for exercises in simple description will be suggested to the thoughtful teacher. Correlation with language is obvious without further explanation or illustration.

History. There are two phases of history to which the garden will give added interest and clearness. The first concerns the whole subject of history, for the human race since civilization began has been largely dependent upon the products of the soil. Many historians regard this relation of man to the products of nature as the most important one in history. According to one of them, Dr. Brinton, the fundamental thing in the progress of civilization "has been the acquisition and preservation of his property. This has been the immediate aim of all arts and institutions of man and the chief incentive to individual exertion."

Property means ability for man to live and maintain himself in the world. For the majority of mankind, property refers directly to the soil and its products. What sustains life has always been the vital question in history, however remote it may seem to have been when we read the accounts of wars and political strifes.

The child who, by his own care and labor, is able to rear a few plants has learned his first and most valuable lesson as to the meaning of property and the property rights of others. If he has to struggle to protect his own property, so much the better. The lesson will be the more valuable. At the same time he will recognize that he can not do everything himself and that better results can be obtained by various kinds of division of labor with others. He will thus unconsciously learn what is meant by community spirit.

The second phase referred to concerns the history of plants themselves: Where they were first grown. How they came to be introduced into this country. The effect of dominant economic plants of the neighborhood on local history. Local history usually centers around inducements offered by the natural resources of a region for men to come and settle there. A fruit-growing region will therefore have a history different from that of a wheat-growing region. The very nature of the plants in the former instance requires more constant and careful attention, and smaller farms—hence more thickly settled communities. The opposite is true of the latter.

Geography. Much of the study just indicated is closely related to geography. Concrete experience with soil conditions in the school garden forms a basis for understanding the soil conditions in the environment of the school. The clearness of this picture determines the

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clearness of conception of other localities as to industries, natural production, etc.

In most places in California it is possible to grow many plants that are of commercial importance in other places. Such plants may be obtained at small cost from the *Southern California Acclimatizing Association*, Santa Barbara, Dr. F. Franceschi manager.

The action of plants in modifying the earth's surface can be studied first in the garden and then around the school.

Drawing. There is much use for drawing connected directly or indirectly with school-garden instruction. Plans drawn to scale develop an accurate sense of proportion. Call these plans maps, and we have the best introduction to map-drawing that can be afforded. Children should make maps before they consult them or copy them.

Many results of inquiry can be expressed better by drawing than in any other way. As in language, accuracy of expression to the full limit of the child's ability should be required. Nothing offers a better opportunity for expression in color than leaves and garden vegetables. For example, a comparison of different varieties of radishes is not complete without use of color. The whole history of a leaf fading away and dying through lack of water or on account of disease can be beautifully and clearly shown in color.

The value of such a correlation with drawing lies in making use of it as a means of expression and not as an end in itself. It then becomes an additional resource or tool to be used for definite purposes.

Manual training. All the processes of garden-making develop manual dexterity and control over the larger muscles. If instead of the regular sloyd models, articles which are needed in connection with garden-making and experimentation are substituted, a large part of manual training becomes a part of school-garden instruction. Some such adaptation as this is the best kind of manual training for rural schools.

The possibilities of the correlative phase of garden work are well shown in the correlation chart prepared by the Hyannis (Mass.) Normal School, and published in Report of Philadelphia School Gardens (Bennett et al., 1904), from which this is reprinted.

ADAPTATION TO SCHOOL CONDITIONS.

An attempt has been made in the preceding chapter to give definite plans and suggestions, and at the same time to have them general enough to be modified and adapted to any school conditions.

The same general plan of procedure will need to be followed whether the garden is large or small. The work undertaken, however, will have to be adapted to the time at the disposal of the teacher and the grade of the pupils.

Division into groups according to grade. It is practicable to divide the grades into three groups: Group I including grades 1–3; Group II including grades 4–6; and Group III including grades 7–8.

Work adapted to each group. The work adapted to the first group is simple garden-making, *i. e.*, rearing some of the common hardy kitchen vegetables, such as radishes, lettuce, beets, carrots, etc., and one or two quick-growing flowers, such as dwarf nasturtiums or sweet alyssum. It is not advisable to attempt any problems outside of a few observational ones immediately connected with the work; *e. g.*, Why not sprinkle the soil? The need of cultivation after rains or irrigation, etc. It is better not to attempt to have the children of these grades keep records; it will be sufficient to have oral accounts given. Garden work for this group will have its greatest value in the sense already indicated under the subject of nature study (p. 42).

An entirely different line of work is possible for children of Group II. Instead of the common vegetables, typical California economic plants such as the cereals, sugar-beets, beans, hops, flax, etc., may be substituted. These will require much less work of cultivation, leaving plenty of time for special studies correlated specifically with science and geography. Simple experiments such as the effect of variation in soil texture and content upon plants, seed tests, planting from selected and unselected seed, map-making to scale of garden and parts of neighboring farms, etc., are examples of work adapted to children of this group.

Children of Group III are prepared to use their gardens wholly for experimental purposes. Such experiments have already been indicated (pp. 42–43). Refs. I, II, III, and exercises given in full in Appendix will be found especially useful in giving directions for experimentation.

Except in small country schools it will be advisable for the teacher to select one or two grades for the first year's work. After experience has been gained it will be found practicable to include as many pupils as the garden facilities will accommodate.

SCHOOL GARDENS OF THE LOS ANGELES AND CHICO STATE NORMAL SCHOOLS.

Since the foregoing discussion has grown out of the writer's experience and experimentation in school gardening at the Los Angeles and Chico State Normal Schools, a short account of the development of these school gardens may be of interest.

Los Angeles. During the school year of 1898–99 an area of ground 64 by 122 feet was laid out for a school garden. The original intention was to have the garden furnish illustrative material for botany and nature study. With this purpose in view about twenty irregular plats were prepared. These were separated by gravel walks and arranged to give a miniature landscape effect (fig. 10). Several plats were given over to the children of the training school to plant and take care of. Other portions were devoted to plants of especial commercial or botanical interest.

At one end of the garden area a cement basin 12 feet in diameter was prepared for a "pond." It had a sloping bottom, giving a range in depth for water from 3 inches to 2 feet. The overflow was conducted to an adjacent plat of ground somewhat larger than the other plats. In this way conditions were provided for different kinds of pond life, gradually merging into wet soil and finally into arid soil conditions. These features of the garden have been retained.

The rest of the garden space was found to be too small to carry out successfully the scheme for a botanical garden, and its use for this purpose was therefore abandoned after the first year. During the second and subsequent years the gardens were devoted entirely to nature study for the children of the first six grades of the training school.

The experience with the children's gardens during the first year was not entirely satisfactory, owing to the difficulty of managing groups of children having only a community interest in the gardens. It was evident that some of the children were gaining a great deal, while others were wasting their time. The group method was tried the second year, with the hope of being able to eliminate the difficulties encountered the first year. The work met with better success by having smaller groups of children work together, but was still unsatisfactory. During the next two years (1901–02) most of the plats were divided into individual gardens. This was so great an improvement over the group method that in the following year the whole garden, except the portion adjacent to the "pond," was replatted so as to give

FIG 10. Gardens of Los Angeles State Normal School as first planned.

FIG. 11. Gardens of Los Angeles State Normal School as they now are.

the children individual gardens. The essential features of this arrangement are shown in fig. 6, p. 27, and fig. 11, p. 48.

All kinds of tools were tried at various times, but experience showed that the weeding fork and small rake were the most satisfactory. So far, tools have been kept in a small toolhouse near the entrance of the garden. Much time is always lost in getting the tools out and putting them back again. There is also more or less confusion, especially among the children whose turn comes last, while the teacher's attention is directed to the tool-house. To avoid these difficulties lockers have been recommended, to be arranged along one of the garden walls, from which tools may be taken with minimum confusion and loss of time. The interest of the children in garden work has been great from the very start. Many children who would never have thought of having gardens at home have taken up home gardening of their own accord.

Chico. School gardens had been in successful operation for three years previous to the writer's connection with the school in 1905. Conditions as to soil and moisture are more favorable here for gardening, and the results of the spring-term's work are, therefore, already highly satisfactory.

Starting seven years ago with the idea of using the garden as part of nature study, the writer has become convinced that instead of being a part it should be the center and practical working basis for almost all the nature study in the grades. Experience has justified this conclusion, although many details of the plan have not yet been worked out. Plans are now under way for enlarging the garden at Chico so as to carry out this idea more completely. These plans include considerable attention to practical horticulture. It is the intention to grow seedlings and by budding and grafting make a fruit orchard which will ultimately include all kinds of fruit adapted to this region.

USEFUL REFERENCE BOOKS AND BULLETINS FOR SCHOOL LIBRARY.[1]

REFERENCES ON GARDEN-MAKING, AGRICULTURE, NATURE STUDY, ETC.

I. **Bailey, L. H.**

Principles of agriculture. Price, $1.25.
Practical garden book. Price, $1.00.
New York: The Macmillan Co.

Both of these books deal with general principles. The former contains many suggestions and problems that may be worked out in any school garden. The latter, as its name indicates, is devoted to the application of the principles of plant-rearing to garden-making.

II. **Burkett, Stevens, and Hill.**

1903. Agriculture for beginners. Ginn & Co. 267 pages. Price, 80 cents.

A very useful reference book for school gardening. It contains chapters on soil; the plant; how to raise fruit trees; diseases of plants; orchard, garden, and field insects; farm crops; domestic animals; farm dairying; an appendix with references and tables; a glossary.

III. **Hemenway, H. D.**

1903. How to make a school garden. New York: Doubleday, Page & Co. Price, $1.00.

"This little manual has grown out of the experience of the author in children's garden work, and it is in answer to many inquiries which are received from various points all over the country from persons who are enthusiastic and realize the purpose and advantage of the school garden movement, but who have not had the agricultural advantages and training to understand the best methods of making and conducting a garden so as to get good results from an agricultural and horticultural standpoint."

It contains the following chapters: How to make a school garden; how to prepare and fertilize the land; lessons in garden work; lessons in greenhouse work; root-grafting; budding; school-garden bibliography.

[1] This list has been carefully prepared with the view of putting the teacher in possession of the best sources of information pertaining to a great variety of questions which may arise in connection with school gardening.

IV. **Hodge, C. F.**

1902. Nature study and life. Ginn & Co. 15+514 pages. Price, $1.50.

There is no book on nature study which combines so many good qualities as this one. It contains a rich and varied subject-matter in which the great facts of each subject are made to stand out. Two important principles are made use of: first, the natural interest of children in living things; second, the practical or economic phase of nature study. The author recognizes that the former may be directed toward the things of life that have practical human values.

More than half of the book centers more or less directly around the growth of plants. Some of the chapters relating to school gardens are: garden studies; home and school gardens; nature study and property of children (two chapters); propagation of plants; insects of the garden (two chapters); beneficial insects; the common toad; our common birds; elementary forestry (two chapters).

V. **Miller, Louise Klein.**

1904. Children's gardens. New York, Boston, and Chicago: D. Appleton & Co. 230 pages. Price, $1.20.

"This book discusses school gardens as a factor in education and shows the sociological and economical significance of the training they afford. It gives detailed directions for planting and caring for school gardens in both city and country, with concrete examples in actual practice, including tree-planting, hedge-growing, and herbaceous borders, with chapters on wild flowers, vegetables, window gardens, roof gardens, propagation, grafting and budding, soil, fertilizers, insects, pests, birds, and implements."

VI. **Wickson, Edward J.**

1897. The California vegetables in garden and field. A manual of practice, with or without irrigation, for semi-tropical countries. San Francisco: Pacific Rural Press. Price, $2.00.

This is the only reference book on garden vegetables which takes into consideration California conditions. The first part is devoted to soils, irrigation, drainage, cultivation, fertilization, propagation, etc. Each garden vegetable is then taken up and discussed in detail, giving best varieties, soil, special directions for culture, etc.

VII. **U. S. Department of Agriculture.**

A list of publications of this department will be sent on application and a monthly circular containing list of publications will be sent regularly to all who apply for it. Applications should be addressed to: Secretary of Agriculture, Washington, D. C.

Many of these publications should be in every school library.

1905. Soil inoculation for legumes: with reports upon the successful use of artificial cultures by practical farmers. By George T. Moore, Physiologist in Charge of Laboratory of Plant Physiology, Vegetable Pathological and Physiological Investigations, pp. 72, pls. 10 (Bulletin No. 71, Bureau of Plant Industry). Price, 15 cents.

VIII. University of California.

Bulletins and circulars from the Agricultural Experiment Station of the College of Agriculture.

These publications are sent free on application to the Department of Agriculture of the University of California, Berkeley, Cal. A list of publications available for free distribution will also be sent on application. From this list selections may be made and ordered by number. Among the most useful for school library are the following:

BULLETINS.

No. 115. Remedies for insects and fungi.
121. The conservation of soil moisture and economy in the use of irrigation water.
128. Nature, value, and utilization of alkali lands.
131. The phylloxera of the vine.
135. The potato-worm in California.
138. Citrus fruit culture.
139. Orange and lemon rot.
142. Grasshoppers in California.
143. California peach-tree borer.
144. The peach-worm.
145. The red spider of citrus trees.
146. New methods of grafting and budding vines.
149. California sugar industry.
150. The value of oak leaves for forage. (Gives description of live oaks of California.)
151. Arsenical insecticides.
152. Fumigation dosage.
153. Spraying with distillates.
154. Sulfur sprays for red spider.
155. Directions for spraying for the codling-moth.
157. Commercial fertilizers.
160. The hop aphis.
162. Commercial fertilizers.

CIRCULARS.

No. 7. Remedies for insects.
9. Asparagus rust.
10. Reading course in economic entomology.
11. Fumigation practice.
12. Silk culture.

IX. Seed Catalogues.

A great deal of useful information may be obtained from a good seed catalogue. These are sent free on application to the seed companies publishing them. The following are recommended:

Germain Seed and Plant Co., 326–330 South Main street, Los Angeles, Cal.

Cox Seed and Plant Co., 411–415 Sansome street, San Francisco, Cal.

Trumbull & Beebe, 419–421 Sansome st., San Francisco, Cal.

Southern California Acclimatizing Association, Santa Barbara, Cal. Dr. F. Franceschi, manager.

X. Periodicals.

The Pacific Rural Press, San Francisco. Price, $2.00 per year.

This journal is devoted to the horticultural and agricultural interests of the State. Professor Wickson gives credit to this journal for much of the special information on garden methods which he has published in his "California Vegetables." The current numbers as well as the files of back numbers would be an important source of information on a variety of subjects connected with school gardening.

XI. Nature Study Review. 525 W. 120th street, New York. Price, $1.00 per year.

"A bi-monthly journal dealing with all phases of nature study, agriculture and science, for elementary schools. A journal for all persons interested in nature study and science for general education."

"Publishes *original articles* by the best writers on nature study and science in education, and *notes* and *reviews* on books and important articles published elsewhere."

Edited by Prof. L. H. Bailey, Cornell University (*Agriculture*); Dr. H. W. Fairbanks, Berkeley, Cal. (*Geography*); Prof. C. F. Hodge, Clark University (*Biology*); Prof. J. F. Woodhull, Teachers' College, Columbia University (*Physical Science*); and Prof. M. A. Bigelow, Teachers' College, Columbia University (*Biology, Managing Editor*). More than sixty collaborators from schools and colleges in the United States, Canada, and Great Britain.

This little magazine is the first of its kind in this country. Its editorial staff is a sufficient guarantee of its high character.

REFERENCES ON INSECTS REFERRED TO BY NUMBER IN LIST OF CALIFORNIA INSECTS (pp. 17-22).

GENERAL REFERENCES.

INSECTS IN GENERAL—CLASSIFICATION AND DESCRIPTION.

1. **Comstock, J. H.**
1895. A manual for the study of insects. Ithaca, N. Y.: Comstock Pub. Co. Price, $3.50.

METHODS OF STUDY, POINT OF VIEW, ETC.

2. **Hodge, C. F.**
1902. Nature study and life. Boston: Ginn & Co. Price, $1.50.

SPECIAL REFERENCES.

(Sent free on application, unless otherwise specified.)

3. **Banks, Nathan.**
1902. Principal insects liable to be distributed on nursery stock. U. S. Dept. of Agriculture, Division of Entomology, Bulletin No. 34.

4. **Benton, Frank.**
1896. The honey bee. U. S. Dept. of Agriculture, Division of Entomology, Bulletin No.1. Price 15 cents. (Apply to Superintendent of Documents, Washington, D. C.)

5. **California State Board of Horticulture.**
1889. Annual report.

6. 1900. Insect pests and remedies. Bulletin No. 71.

7. 1902. Eighth biennial report. Contains directions for collecting and preserving insects.

8. **Chittenden, F. H.**
1901. The fall armyworm and variegated cutworm. U. S. Dept. of Agriculture, Division of Entomology, Bulletin No. 29.

9. 1902. Some insects injurious to vegetable crops. U. S. Dept. of Agriculture, Division of Entomology, Bulletin No. 33.

10. 1903. Principal insect enemies of the sugar beet. U. S. Dept. of Agriculture, Division of Entomology, Bulletin No. 43.

11. **Clarke, Warren T.**
1902. The peach-worm. University of California, College of Agriculture, Bulletin No. 144.

12. **Howard, L. O.**

1894. The armyworm. U. S. Dept. of Agriculture, Division of Entomology, Circular No. 4.

13. 1898. The San José scale, in 1896–1897. U. S. Dept. of Agriculture, Division of Entomology, Bulletin No. 12.

14. 1898. House flies. U. S. Dept. of Agriculture, Division of Entomology, Circular No. 35.

15. 1900. How to distinguish the different mosquitoes of North America. U. S. Dept. of Agriculture, Division of Entomology, Circular No. 40.

16. 1902. How insects affect health in rural districts. U. S. Dept. of Agriculture, Farmers' Bulletin No. 155.

17. **Howard, L. O.,** and **Marlatt, C. L.**

1902. The principal household insects of the United States, with chapter on insects affecting dry vegetable foods. U. S. Dept. of Agriculture, Division of Entomology, Bulletin No. 4.

18. **Kelly, Henrietta Aiken.**

1903. Silkworm culture. U. S. Dept. of Agriculture, Farmers' Bulletin No. 165.

19. **Kirkland, A. H.**

1904. Usefulness of the American toad. U. S. Dept. of Agriculture, Farmers' Bulletin No. 196.

20. **Marlatt, C. L.**

1896. Insect control in California. U. S. Dept. of Agriculture. Reprint from Yearbook.

21. 1898. Principal insect enemies of the grape. U. S. Dept. of Agriculture, Farmers' Bulletin No. 70.

22. 1898. The true clothes moth. U. S. Dept. of Agriculture, Division of Entomology, Circular No. 36.

23. 1902. The silver fish. U. S. Dept. of Agriculture, Division of Entomology, Circular No. 45.

24. 1902. The bedbug. U. S. Dept. of Agriculture, Division of Entomology, Circular No. 47.

25. 1902. Cockroaches. U. S. Dept. of Agriculture, Division of Entomology, Circular No. 51.

26. 1903. Scale insects and mites on citrus trees. U. S. Dept. of Agriculture, Farmers' Bulletin No. 172.

27. **Simpson, C. B.**

1902. Report on codling-moth investigations in the Northwest during 1901. U. S. Dept. of Agriculture, Division of Entomology, Bulletin No. 35.

28. 1903. Control of the codling-moth. U. S. Dept. of Agriculture, Farmers' Bulletin No. 171.

29. 1903. The codling-moth. U. S. Dept. of Agriculture, Division of Entomology, Bulletin No. 41.

30. **Woodworth, C. W.**

1897. The California vine hopper. University of California, College of Agriculture, Bulletin No. 116.

31. 1902. Grasshoppers in California. University of California, College of Agriculture, Bulletin No. 142.

32. 1902. The California peach-tree borer. University of California, College of Agriculture, Bulletin No. 143.

33. 1904. Insects of California. Berkeley, Cal.: C. W. Woodworth. Advanced sheets are published in pamphlet form. Each number contains one group of insects. Orthoptera and Coccidæ have already appeared. Subscription price for whole set, $3.00. Pamphlets: Coccidæ, 15 cents; Orthoptera, 25 cents.

34. 1904. Reading course in economic entomology.[1] University of California, College of Agriculture, Circular No. 10.

The following extract from the introductory portion of this circular will indicate its importance: "The desire has been very widely expressed for individual or class instruction along agricultural lines by those unable to attend the University. One of the topics upon which inquiry has been particularly made is that of Economic Entomology. We have decided, therefore, to offer a reading course in this subject calculated to give the student a broad general knowledge of the facts of the science, and an acquaintance with the most recent publications of the working economic entomologists of the country."

35. 1904. Silk culture. University of California, College of Agriculture, Circular No. 12.

36. **Woodworth and Osterhout.**

1900. Butterflies and the living plant. University of California, College of Agriculture. Nature Study Bulletin.

This bulletin is prepared especially for the use of teachers in the California elementary schools.

[1] In a circular now (July, 1905) being prepared, Professor Woodworth proposes to give more definite instructions as to study and collection of insects. This circular will be particularly useful to teachers.

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American Park and Outdoor Art Association.[1] Charles Mulford Robinson, secretary, 65 So. Washington St., Rochester, N. Y.

1902. Report of the special school-garden session of the 6th annual meeting, Vol. 6, Part 3, pp. 1–44.

It contains a valuable collection of papers and reports on school gardens.

1903. Report of special school-garden session of the 7th annual meeting, Vol. 7, Part 3, pp. 1–54.

It contains report of standing committee on school grounds, which gives a summary of the school-garden movement in the United States. In this report the following is recommended:

"1. That the American Park and Outdoor Art Association, acting through its committees, individual members, and affiliated organizations, lend its active support and encouragement to the beautifaction of school grounds and to the establishment and maintenance of school gardens and playgrounds for children.

"2. That, in pursuance of this end, the association coöperate with city and school officials, local associations, and other organizations; and

"3. That the association encourage the establishment and maintenance of courses of study in normal schools, agricultural colleges, and other like institutions of learning, such as will prepare teachers for work of this kind."

This report of special school garden session also contains reports on school gardens from twenty different states, and from Porto Rico and Hawaii.

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[1] The American Park and Outdoor Art Association no longer exists under this title. At St. Louis, Mo., June 10, 1904, the American Civic Association was formed by the merger of the American Park and Outdoor Art Association and the American League for Civic Improvement. (See Crosby, 1904.) All communications should now be addressed to American Civic Association, North American Building, Philadelphia, Pa.

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One chapter is devoted to school gardens, and another to the agricultural phase of nature study.

The book is divided into three parts: Part I—What nature study is; Part II—The interpretation of nature; Part III—Some practical inquiries and some ways of answering them.

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This is a brief account of the work in industrial-social education which is being done in the Hyannis (Mass.) Normal School, "supplemented by a discussion of the pedagogical reasons for the work and a few chapters showing exactly how some things have been done." Four chapters are devoted to school gardens, giving detailed account of plans and work done.

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"The school laws of Nebraska require teachers to pass a satisfactory examination in the elements of agriculture, including a fair knowledge of the structure and habits of the common plants, insects, birds, and quadrupeds, for second grade county certificates and all grades above the second. This book has been prepared and published in answer to the direct demand resultant from the law quoted above."

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APPENDIX.

SOME EXERCISES FOR EXPERIMENTAL STUDY OF SOILS AND OTHER FACTORS OF PLANT GROWTH.

Equipment: Plenty of empty tin cans (quart fruit-cans); one or more balances, with weights (spring balances may be used, provided a hole is made near upper edge of can for attachment); a few small flower-pots for experiments requiring heat; various kinds of seed (peas, wheat, radish, etc.).

I. Kinds of soil and character of each.

Object: To learn to know different kinds of soils and something of their local distribution.

Plan of work: Prepare two sets of soil samples: (1) Including typical soils: (*a*) Adobe; (*b*) Clay; (*c*) Leaf-mold from woods; (*d*) Sand. Examine each kind carefully, using lens. Describe. Wet a portion of each and mold into a ball. Allow ball to dry. Note which retains its shape after drying; which is most easily crushed; and other characters. Make a rough classification based on these experiments.

(2) Samples of as many kinds of soils as may be found in the vicinity of the school. Each sample should be marked, giving locality and name of collector. Compare these soil samples with (1). Which kind of soil predominates in each sample? What is the local name given to each kind? Indicate on map of your school district the location and distribution of each.

Note: In general, a soil is a combination of clay, leaf-mold, and sand. The name is given according to the one predominating.

II. Origin of soils.

From what is known of the geographical position of your school district, relation of streams of this district to their sources, and from a consideration of other factors which seem to have a bearing on the question, determine the probable origin of the local soils.

III. Soil elements in rock.

Object: To find and recognize the soil constituents in rock.

Granite: Do you find anything like sand in it? If so, test its hardness by seeing if it will scratch glass. Sand consists of mineral quartz.

Feldspar: The flesh-colored or whitish portion of granite is feldspar. Pulverize some and compare with clay.

Mica: Identified by its metallic scales. Test hardness and elasticity. Do you find mica in any of the soil samples?

Reference: Look up this subject, soils and soil formation, in any good physical geography; also, Chap. I, Burkett, Stevens & Hill (ref. 11).

IV. **Organic matter in soils.**

Object: To determine presence and amount of organic matter in soils. (*Note:* Dark rich soil should be used.)

Plan of work: (*a*) Examine soil with lens. Do you detect any small bits of decaying plants?

(*b*) 1. Dry a portion of soil sample and weigh. 2. Place on shovel, or in a small flower-pot, the soil of (1) and heat in stove on bed of coals. (This may be done over a Bunsen burner flame.) After the soil is thoroughly burned, weigh again. Most of the loss of weight (all of it, if drying is complete) is due to burning of organic matter or humus. Calculate the per cent of organic matter in soil tested.

V. **Water-holding power of soils.**

Object: To determine relative capacity of different soils for holding water.

Plan of work: Weigh dried samples of each kind of soil. Saturate with water, and weigh again. What per cent of its weight will each kind of soil hold? Which soil holds the most water?

VI. **Water-retaining power of soils.**

Object: To determine relative capacity of different soils to retain water.

Plan of work: Set samples of soil of Experiment V away after weight has been taken. Arrange so that the soils may drain. Weigh from day to day. Which soil loses water through drainage most rapidly?

Is there any relation between the water-holding and water-retaining capacity of different soils?

VII. **Conservation of water in soils.**

Object: To determine the best practical method of keeping water in the soil and prevent its evaporation from surface.

Plan of work: Nearly fill two cans with thoroughly moistened soil. Label them (*a*) and (*b*). In (*a*) press soil down firmly, leaving it compact and smooth on top. In (*b*) loosen upper portion so that it will become dry. Weigh both cans after two or three days. Which loses water most rapidly?

Practical application: What does this suggest as to method of keep-

ing water in soil by means of cultivation? Vary experiment by using two small plats of ground (*a* and *b*). Prepare (*a*) by leaving compact and smooth on top. Prepare (*b*) by having loose layer on top as above with can (*b*). Stir upper layers of (*b*) frequently. Compare two plats at end of a week's time. Which plat seems to be in the best condition for plant growth as to moisture and texture?

VIII. **Irrigation.**

Object: To determine best and most economical method of applying water to soil.

Plan of work: (*a*) Saturate the soil in a can, taking note of the amount of water used. As soon as top is dry loosen the top layer and keep it in that condition, as in (*b*) Ex. VII.

(*b*) Take same amount (by weight) of same kind of soil and apply the same amount of water, but add a little each day without stirring top layer.

After about a week weigh both samples. Which has retained the most water? Note, also, condition of surface in both cases. What do you conclude as to best method of applying water? Repeat experiment, but use plats of ground as in Ex. VII.

IX. **Relation of moisture in soils to plant growth.**

Object: To determine importance of water in soils.

Plan of work: Plant various kinds of seeds in:

(*a*) Dry soil;
(*b*) Slightly moist soil;
(*c*) Quite wet soil;
(*d*) Saturated soil. (Keep in this condition.)

After allowing time for seed to sprout, draw conclusions as to the importance and necessary amount of water.

X. **Relation of air in soil to plant growth.**

Object: To determine importance of air in soils and how it may be made available for plant growth.

Plan of work: Fill two cans (*a* and *b*) nearly full of good soil.

1. Imitate in (*a*) the conditions giving the best results in Experiment IX. Plant several seeds of wheat or peas about one half inch below surface of soil.

2. Saturate the soil of (*b*). Plant the same number of seeds as in (*a*), but two or three times as deep. Press the soil particles together and keep the soil in the can saturated so as to deprive the soil of most of its air spaces.

Note the number of plants and times of sprouting in each. Compare rate of growth and general appearance of both sets of plants. What