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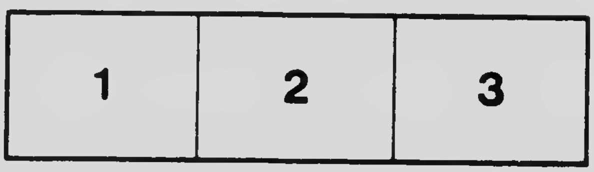

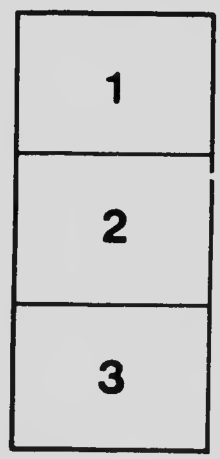

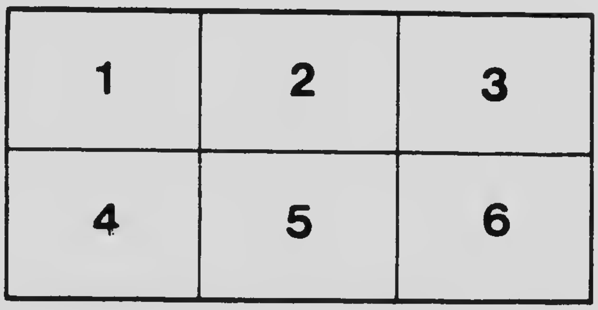

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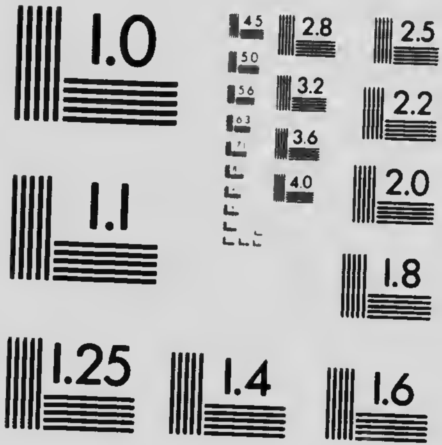

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Compare with a Blackbird's Nest.

The nest should be studied, not in a museum or collection, but where the bird placed it.

THE

NATURE STUDY COURSE

WITH

SUGGESTIONS FOR TEACHING IT

BASED ON

NOTES OF LECTURES

TO TEACHERS-IN-TRAINING

BY

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PREFACE.

When the teachers began to teach the part of the new Course of Study relating to nature work, judging by the questions asked by Normal School students and numerous correspondents, many of them were confronted by difficulties over which the books available did not help them. An engagement to answer such questions, and to offer hints and suggestions on the Nature Study part of the Course has drawn forth the following pages.

Direct the children how and where to *collect the material*, guide their *observations and reasoning* upon what they bring, and teach them the *arts of expressing* the steps and results of their investigation. This general direction seems as simple as it is comprehensive; but in its application almost as many different problems arise as there are different lessons. No one can anticipate all these problems, but solutions of many of them are herein proposed.

The Nature Study teacher well knows the value of comparison. Any one using the course of study prescribed for his own province will derive much benefit from comparing it in detail and in entirety with the course adopted in another province. This little book may, therefore, prove as helpful to teachers outside of the Provinces whose regulations are quoted as to those serving within their boundaries.

"Unfolded is the world only to the observing mind."—*Feuerbach.*

"Original research in hand to hand contact with Nature ought to be made the breath of life in an educational system." *C. F. Hodge.*

Observe accurately, reason logically, judge impartially, express truthfully, enjoy heartily.

"When Nature becomes the subject of study, the love of Nature its stimulus, and the order of Nature its guide, then will results in educational science rival the achievements of science in any other field."

"The true naturalist is the true poet."

"Nay what is Nature's
Self, but an endless
Strife toward music,
  Euphony, rhyme?
Trees in their blooming,
Tides in their flowing,
Stars in their circling,
  Tremble with song."

—*William Watson*

"The way to see a thing is to love it, and love sharpens the eye."—*Burroughs.*

"The teacher must never forget this cardinal fact that observation, accurate and sympathetic, true-eyed and true-hearted, is the mother alike of literature and of science."—*C. Lloyd Morgan in Psychology for Teachers.*

"Nature is the incarnation of thought, and turns to thought again as ice becomes water and gas. The world is mind precipitated, and the volatile essence is forever escaping again into the state of thought."—*Emerson.*

"Happy is he who has learned to search out the secret of things.
. . . The ageless order he sees of nature that cannot die,
And the Cause whence it springs and the How and the Why.
Never have thoughts like these to a deed of dishonor been turned."

—*Euripides.*

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THE

NATURE STUDY COURSE.

Object Lessons.—Nature Study is the direct successor of what for a half-century has passed under the name of Object Lessons. The Object Lesson, except when misunderstood to mean information about objects, exercised the senses, but stopped short of educative observation. Sense training is not very important as an end in itself; it takes on importance as a means to the training of the mind and body. The Object Lesson was usually little more than a merely perceptual exercise. It consisted mainly of looking and naming; it began anywhere and led to no particular place. It failed to train the child to become a self-active, reasoning investigator.

Comenius, in the "Didactica Magna" argued that "people must be taught to get their knowledge, as far as possible, not from books but from earth and sky." A century and-a-half later Rousseau took "Emile" to nature but left him there. His disciple, Pestalozzi, realized and taught that the teacher's art was needed to guide "Emile" to see and understand nature. Then it was that the Object Lesson, as a subject and means of instruction, found its way into school curricula. Froebel followed and taught the child how to act upon nature and through observation, action and re-action, to obtain development, freedom, possession of his powers and enjoyment. The Froebelian spirit breathed into the Object Lesson vitalized it, and started it to grow as though a brush heap had been transformed into a beautiful, living tree. The change was so great that the lesson received a new name. It was called *Nature Study*.

What Nature Study Is.—The new name has the advantage of being easily, as it is frequently, misunderst to be the learning of a mass of facts about natural obje Nature Study is *natural* study, that is, studying by natu methods. It is intellectual, physical and moral developm by and through purpose[illegible] action and re-action upon envir ment, guided, so far as need be, by the teacher. Memoriz facts about seeds and flowers, birds and insects, clouds a rivers, from spoken or printed words, or even from pictur has no claim to be called Nature Study. Information com from Nature Study, and that or enjoyment, usually both, m be what the child seeks; but from the teacher's point of vi the vitally important part of the lesson is the series activities put forth by the child. The verbal or pictori descriptions, sometimes served to children as Nature Stu lessons, are only the expressions of some other person nature studies. In many lessons, even in good lessons, it ma be unavoidable, or for valid reasons advisable, to give som information, but to the extent that second-hand knowledge i used to that extent the lesson falls short of being real Natur Study.

The following is quoted with permission: "I had a dozen o fifteen cardboard boxes, each containing a group of relate objects. One held a ripe stem of wheat and a stem of each of the other cereals; a second had a sample of each of eight kinds of nuts; a third contained a number of pretty corals from the South Pacific; the fourth held a cotton ball, a silk cocoon, a bit of sheepskin and plants of flax and hemp. . . . Each box served for a series of three lessons. I held the articles up or passed them around, gave information about them and had it returned to me in answer to questions. I made drawings which the children copied and worked into their compositions. We all enjoyed these lessons and they won us a reputation for good Nature Study work . . . .

I see now that it was only information and composition. There was no investigation by the pupils. What little investigating was done I did myself. The lessons, however, were good of their kind, and I continue them under the name of object lessons, but I do not now call them Nature Study."

Nature Study *versus* Elementary Science.—The difference between education by nature and information about nature is easily understood; it is more difficult to draw the line between Nature Study and Elementary Science.* Nature Study is simpler, indeed someone has misconceived it as "science in words of one syllable." But the difference is not in simplicity or in the subject matter of study. Science is the ordering and organizing of related facts into a system; it deals with facts that are selected for their fitness in one or another scheme of generalization. When the learner's interest centres on a particular dog or flower or toy, and especially upon the phases of the individual that seem to touch his own life, he has the Nature Study attitude; but when his interest is concerned with the class of object of which his Fido or geranium or pump is a type then his attitude is scientific. Of the teacher's attitude, Prof. Bailey says, in effect, that when the teacher is thinking chiefly of the subject or subject matter of instruction he is probably teaching science, but when he is concerned chiefly with the effects of the lesson upon the development of the child he is probably teaching Nature Study.

In Nature Study the teacher's attention is focused on the learner; in science, upon the subject matter of the lesson. In science the lesson is selected on account of its relation to a body of facts already taught; in Nature Study the child's interest dominates the choice. Appetite is in some respects

*In "Guide to Nature Study" (The Copp, Clark Co., Limited), pp. 10-15, three lessons on The Wasp illustrate the differences in the information, science, and nature study methods of treatment.

analogous to interest. Appetite for a particular food is an indication that the healthy body is prepared to assimilate it. Natural interest is an equally reliable indicator of the appropriateness of a particular kind of mental nourishment. In Dr. Gordy's introduction to Dr. Bigelow's book—"How Nature Study should be Taught"—he says that the author never tires of insisting upon the difference between elementary science and Nature Study, that the concentration of the attention upon the universal aspects (the class relations) of objects is an entirely different thing from the concentration of the attention upon an object as a whole, upon those characteristics which make it an individual. "We have been studying dead things so long, dissecting and analyzing type-forms, that we have well-nigh gone blind to the living side of Nature."—*Hodge.* "Nature Study is the creating and the increasing of a loving acquaintance with nature"—*Bigelow.* "The educational value of Nature Study lies in its power to add to our capacity of appreciation—our love and enjoyment of all open-air objects."—*John Burroughs.* "All other efforts in education are futile till you have taught your people to love fields, birds and flowers."—*John Ruskin.* "To put the pupil in a sympathetic attitude toward nature for the purpose of increasing the joy of living."—*L. H. Bailey.*

The writers quoted emphasize Nature Study as a means of developing the emotional nature, and it would be worth while pursuing it even if that view exhausted the ground. The scientific interest in nature and the esthetic interest are distinctly different, but fortunately they are not incompatible. Nature Study, rightly taught, is as good for the intellect as for the emotions, and it touches the volitional and physical powers at more points than most other school studies do. Interest is the touchstone that determines whether or not a particular topic or subject shall be introduced. But children's interests though real and widely varied are fickle. It is comparatively easy to humor a child's interest in a familiar subject or to excite a flash of interest in a new one; but it is quite another thing, and that the truly educative, to maintain the interest. Prof. James in his "Talks to Teachers" has shown how interest in one portion may be shed over to another part natively uninteresting. Here is the chance for exercising the volitional direction of attention which a high authority declares should be the first object of mental discipline. Interest starts the investigator on the path; Will assists him to complete the journey. "The man," says Dr. Hinsdale, "who cannot do anything but what interests him is only half a man." But remember it is the exercise of the child's own will, not the "you must" of the teacher, that is educative.

Preparation of the Teacher.—In teaching science—botany or chemistry, for example—it is indispensable that the teacher should know the science, botany or chemistry as the case may be. In teaching Nature Study it is helpful to know something of all the sciences, but the essential thing is to know the child, to know how to guide the child into and through the profitable activity of all its powers, in short, to know child-nature and nature's method of training the child. No matter how much knowledge of science the teacher possesses, if he lacks skill in discovering or arousing the child's interests, if he lacks skill and energy to sustain these interests and to guide the activities which they call forth to educative issues, he will not be a successful teacher of Nature Study.

The need to emphasize the last statement is not out of date. A writer in a nature periodical recently stated that in a certain training-school the teachers maintain that knowledge of "other nature" must have precedence over knowledge of child-nature, and that for those whose years at school are limited the knowledge of the menaces to agricultural success is more valuable than the development of the sense-activity through stimuli that appeal to the esthetic side of the child's nature. How does this differ from the conduct of a physician who, instead of studying his patient and choosing the best available treatment and remedies under the circumstances of the case, were to say to the sufferer: "I have brought you a full stock of medicines; I have studied them and know that they are good. Take as many of them as you can; all, if possible"? The physician ought to study his medicines, it is true; but he is useless if he does not know how to study his patients. If he knows how to make a right diagnosis his books can assist him with his materia medica. Even then, he must further study his patient to know whether he is administering the medicines in the most effective way. And so, in Nature Study, the matter of first importance and greater difficulty is learning the nature and needs of the child and the science of suiting the instruction to such nature and needs. There are books in plenty to help him with the "other nature."

Children hunting a lost ball in a meadow adjoining the play-yard discover a ground-bird's nest with four blotched eggs. Their interest is aroused. They describe the nest to the teacher and inquire to what kind of bird it belongs. Unfortunate for them if he is scientist enough and unpedagogical enough to say at once: "It is a bob-o-link's nest." Better were he a good teacher and no ornithologist, for then he would use their interest to lead to some educational activity which would be far more useful to them than the mere information they seek. But best of all if the teacher knows well both children and birds. In that case he can guide them to discover the answer to their question in an educative way, and in doing so excite them to ask and answer by research many other related questions. He engages their interest at the favorable moment to train them to observe, think, investigate and enjoy. This is Nature Study.

Definite Aim in Nature Study.—It is of the highest importance that a teacher should be conscious of a definite aim or purpose in the teaching of any subject, since the aim determines the means to be employed, the choice of materials, and the tests of the success of the teaching. This is especially true of Nature Study, and none the less so because the study may legitimately have several aims. Prof. Hodge's book, "Nature Study and Life," is based on "the things best worth knowing." This view admits lessons on bacteria, scale-insects, the economic value of the food of toads and robins. Dr. Bigelow's book, "How Nature Study should be Taught," is true throughout to its key-note 'love of nature.' He would relegate bacteria and scale-insects to the class in science. Prof. McGovern's "Nature Study and Related Literature" very emphatically, if not professedly, teaches Nature Study that the learner may be trained to appreciate the beautiful literature that nature has inspired.

But in Nature Study neither increment of knowledge, even of economic knowledge, nor enrichment of sympathy, should be given dominance over the training of the child in the means of discovering truth by the proper exercise of his self-activities. "The first work of education," says President Eliot, "and the last is to train men to think . . . . never can thinking come by any compulsion from without, it must always and inevitably be developed from within." Of lessons that pass the test of interest, preference should be given to those that promise the best results for observation and reasoning. Of two lessons deemed nearly equal for training in investigation, give the preference to the one that offers the richer heart-culture or the more useful knowledge. When the aim urged here is judiciously sought the others will be duly realized and that in their proper relations. The education of the head and hand is not here placed higher than that of the heart, but it is recognized that the heart cannot be properly educated without some measure of co-operation of the intellect. If, for example, it is desirable that a boy should feel any compunction in the act of pressing a writhing earth-worm on a fish hook, what better way can that end be reached than by leading him through a proper investigation of the habits and general structure of that animal. The pupil who learned to admire the beauty and grace of a garter-snake, its harmlessness to mankind and its value to the farmer, will neither flee from it in dread nor pursue it with a fell bludgeon. Make the dominant aim to be training in the investigation of those things in which the child feels an interest; the teacher's sympathetic treatment and the truth itself will compass the heart-culture. The teacher who recognizes the unity in the trinity of intellect, feeling and will, in short, who knows the child, will not go far astray in the selection or treatment of the material of his Nature Study lessons.

Observation and Experiment.—Granted that the aim of Nature Study is training the mind through the senses—or observation and reasoning—it may be well to define observation at the outset of a brief consideration of method. Compayre defines it as that prolonged perception which the attention directs toward a determined object. Three inseparable factors stand out prominently in any act of observing: 1st, accurately noting what is presented to the senses; 2nd, attending with some measure of interest and exercise of the will; 3rd, correctly interpreting the perceptual elements. To observe accurately is to put aside prepossession, to restrain the imagination and to direct the mind with singleness of purpose to what is actually presented to the senses. Since perception and attention are factors in observation, it follows that training in observation includes the training of the powers of perception and attention. This kind of training is the antithesis of book-learning. Book-learning as distinguished from thing-learning has probably something to do with the distaste for manual labor. Cultivation of the powers of observation does much to inculcate a love of nature and to give joy to life in the country, and possibly a preference for it. (See Dexter and Garlick's "Psychology in the Schoolroom.") Dr. Bigelow tells of a philanthropist who sent some New York tenement women to the country for a summer holiday. Before a week had elapsed they had all returned to their sweltering city coops. On inquiring the reason he received the answer that they had come back before the time was up because "there was nothin' doin'." Neither book-learning nor no-learning qualifies people to enjoy the delights of country life.

The purpose of observation is not simply to train the senses but to train the individual through the senses. Its value is not determined by the object but by the mental attitude induced. In the first stage it is the development of an image. "Until an image is formed in the mind it is worse than useless to take the next step. To over-emphasize the importance of external presentation and to under-emphasize the importance of the resulting mental product is the mark of much poor teaching."—*Jackman.* The common exercise, writing lists of the names of things observed in a given time, may have value for spelling but it is not much use for Nature Study.

The facts gained from observation are relatively of secondary importance. "It is the power to observe which is the thing; it is the habit of observation which is to be cultivated." It is a common mistake for the teacher to state the result of an observation, or to permit the pupil to read it from a book, and then turn to the object to substantiate the statement. Pictures should not be allowed to usurp the place of objects. A picture appeals to only one sense, and that in a symbolic and more or less imperfect way. Guide the observations of the pupils, but see that they do observe real things and draw their inferences from what they observe.

The term observation is used in a restricted sense, as attention to experience in which we are able to note causes and effects, or in some cases effects only, but are unable to control either. The experiences in which we control causes and study the effects which they produce are called *experiments*. In the former case circumstances are the master of the observer, in the latter they are his servant. A student, for example, observes that cloudiness is associated with absence of dew. In reasoning on the relation he reaches an hypothesis. He may test his hypothesis by continued observation, or more promptly and usually more satisfactorily by an experiment.

From the Nature Study point of view the time to introduce an experiment is when the pupil's conscious need of it arises either with or without the teacher's suggestion; and he should feel at least a partnership in devising the means of carrying it out. The performance of an experiment immediately from the teacher's dictation or the specifications in a text-book, with the pupil's interest centered rather on the mechanics of the experiment than on its outcome, is a mark of poor teaching in either elementary science or nature study. President Eliot, of Harvard, in a recent address as reported in the N. Y. School Journal, said in effect that in spite of his former very different opinion he had come to see "that most laboratory operations are as fruitless in cultivating thinking as learning by heart words from a dictionary." Engagement in experiments for the mere purpose of making them has some value for manual training but very little for thought training, whether it be called science or Nature Study. Experiments are "questions put to nature," but questions are, or should be, prompted by the *desire* to know the answers.

Stages of a Nature Study Lesson. The stages of a completed Nature Study lesson will usually show the following sequence : —

First,—Observation. The attentive exercise of the senses upon the objects or phenomena of study – obtaining the 'raw material' of thought. "It is good to use several senses in the understanding of one thing."—*Comenius.*

Second,—Reasoning. Appereeiving, comparing, relating, seeking causes and effects, experimenting,—working over the 'raw material' gathered through observation and experience. Making judgments, inferences, inductions. Where practicable applying these inductions to new situations, *i.e.*, making deductions.

Third,—Expression. Expressing carefully by the most suitable or the most available mode, or by different modes, the steps in the observing, reasoning and applying processes. "We cannot properly observe unless we can describe what we observe."—*Mill.*

"The education should be of the perceptions first, then of the memory, then of the understanding, then of the judgment. Things and words should be studied together, but things especially."—*Comenius.*

"The first essential is positive, direct, discriminating, accurate observation ; the second is to understand *why* the thing is so or what it means ; the third essential is the desire to know more, this comes of itself ; and the final result is the development of keen personal interest in natural phenomena." —*L. H. Bailey.*

Expression.—Authors' opinions vary as to the value of expression to Nature Study and the nature of the relation of one to the other. Prof. Hodge found that in one school the children's written records of their growing plants were of little value, and were even thought to act as a chill to the spontaneous interests of the children. Dr. Bigelow argues that the drawing and writing may be carried to the extent of annihilation of the Nature Study. But the majority will agree with Prof. Jackman that "appropriate and adequate expression is indispensable" to the best results in Nature Study, and further that "it is of the greatest importance that the expression shall be preserved," if it be of a kind that can be preserved.

Exhaustive expression involves several arts. A learner's enthusiasm may be chilled if he is compelled to express himself by a mode that he uses with difficulty. But the child who has seen or done something in which he is interested naturally desires to give expression to his experience, and just here the competent teacher will see and use his opportunity to teach now one and now another of the arts of reading, writing, spelling, composition, color-work, or modelling in clay, card or wood, according to the suitability of all the circumstances.

For example, the children interested in the ground-bird's nest, referred to on page 6, will take pleasure in describing the nest and the bird by speech, in writing a composition relating the circumstances under which the nest was found and how the bird's name was learned, modelling the nest and eggs in clay, coloring the drawings of the eggs and of the bird, imitating the bird's song, writing a petition to the farmer to spare the nest when reaping-day arrives if the fledglings have not left it, making a diary of the events in the life of the bird-family, reading good prose or poetical literature relating to the bob-o'-link, and finally composing all their observations, drawings, color-work and conclusions into a neat systematic record worthy of preservation in their "Nature Study books." Imagine the zest with which they would then study Bryant's "Robert of Lincoln" in their reading-books! In all these correlations they would take pleasure and make progress if their teacher knows how to teach the subjects. His skill and diligence would be taxed chiefly in sustaining their interest to the last so that the observing would be done cheerfully if not eagerly, and the expressive work with constant aim at truth and beauty.

Correlations.—Not only do the expression and form studies—reading, writing, spelling, composition, modelling, drawing, and color-work—naturally and easily correlate with Nature Study but such subjects as geography, physiology and even arithmetic may be taught in considerable part as Nature Study or by the Nature Study method. Geography of the home and its surroundings cannot be taught well in any other way. In Physiology, what children may learn from the observation of their own bodies, and of articles obtainable at the meat market, and by simple chemical and physical experiments leaves less than half to be taught by the lecture or text-book method. For teaching the teeth and mouth cavity, for example, mirrors are better than charts; for teaching the joints, the pupils' hands, and legs of fowl, are better than the pictures in their books.

In the Nature Study lessons many opportunities occur to introduce number work. The concepts of numbers and of the standard units, *e.g.*, inch, foot, ounce, quart, etc., should be developed from the comparison and quantification of real objects. Something of the Nature Study quality would be given to problems assigned thus:—1. Observe that load of hay passing on the road; estimate its weight. By consulting the newspaper this evening or by inquiry find the current price of hay so that we may estimate the money value of the load to-morrow. 2. Of what kind of wood is this floor made? Note the width of the boards. On Saturday make inquiries of any one who can tell you the prices of such flooring, of the nails needed, of the cost of laying it down. 3. Estimate the distance from the schoolhouse to your home by measuring how far you walk at your usual rate in one minute. 4. Compare the cost per lb. of baker's bread with what it costs per lb. made at home. 5. Find the weight of water which four ounces of beans will soak up. Compare the weight of the water absorbed with that of the dry beans. Beans will absorb what per cent. of their own weight of water? Whenever you make the child an investigator and maintain the investigating spirit or activity to a definite result, then you are putting an important Nature Study quality into his work.

Agriculture. Of the course in Agriculture, little else is suited to teaching in public schools than what can and should be taken as nature studies. The physical composition, water-capacity and classification of soils, the uses of water and air in soil, and the means of circulating them, values and methods of drainage, fertilization and plant-food, development and propagation of plants, can each and all be made practical, interesting and educative nature studies, not only for children who live on the farm, but also for dwellers in the city. In addition to these topics the farmers' children can be guided through a variety of useful studies pertaining to domestic animals, crops, and orchard, to tillage and other farm operations, the observing being done mostly at home and reasoned about and expressed at school. Phenological records of weather, bird-migrations, insect appearances, and farm operations may be systematically tabulated in approved form. These have a practical bearing on agriculture, increase useful knowledge, and afford excellent practice in observation and classification.

Manual Training and Domestic Science.—From the point of view that Nature Study is self-activity exerted upon environment, Manual Training and Domestic Science are specialized subdivisions of that subject. While to the casual observer their purpose seems to be to endow the student with certain kinds of manual dexterity, to the true teacher they culminate in the education of head and heart. When these subjects are properly understood and taught they train the learners to observe, reason and express, and to sympathize with manual labor.

Most of the larger graded schools will probably be equipped in the near future with manual training and domestic science departments. But the rural schools will fare little worse if the teachers make full use of the opportunities offered by the farm, playground, farm-home and village-home, and garden. Where the teacher gives the pupils the guidance and sympathy needed in the construction of play-houses, swings and bars, the replacing of broken panes of glass and worn-out fence-boards, in short, the maintaining of the playground, buildings and enclosures in as neat and complete a state of repair as it is possible for a resourceful teacher and pupils to keep them, the children's delight in these activities is exceeded only by the value to them of the education thereby gained.

Farmers' children usually do, and they all should, participate in the varied operations that make up the indoor and outdoor life on the farm. The school may do much towards making these participations more educative than they usually are. The majority of parents can be got to see the bearing of such lessons from the teacher's point of view, and this will always secure their interest and co-operation.

Seeding, harvesting and threshing take place on every farm. These and other complex operations may be observed if not participated in more actively. Each step has its method and reasons, which, after observation in the field, may be studied, discussed and expressed in the schoolroom. On one farm a tile-drain is in course of making, on another a silo is in construction, on a third a snake fence is giving place to a wire one, etc. These may afford subjects of special studies to be reported at school by children residing on such farms, or, if convenient to the schoolhouse, the objects of visits by the class.

Then there are the indoor operations. How much can be made of a child's participation in a bread-making if it involves observing the qualities, quantities and treatment of the ingredients, questioning as to the whys and wherefores of every step in the process, recording everything in detail, expecting to discuss it in school and to compare it with the experiences and reports of others. If such opportunity cannot come on a Saturday, it is worth any boy's or girl's time, provided that it will be expertly turned to Nature Study account, to stay home a half-day to help with the baking. Further it is practicable to encourage occasional exhibits of buns and tarts, articles made of wood, cardboard and clay, samples of patching, button-holing and hemming, of plaiting, knitting and darning, done partly or wholly at home under parental instruction but with the teacher's knowledge and sympathy,—all accompanied with neat records of the processes and reasons and, in some cases, with illustrative drawings. Where there is a will there is a way; it is certainly not impossible to do a good deal of useful, educative manual training and domestic science in the rural schools.

The School Garden.—Every school, whether rural or urban, may have its garden. The Ontario Regulation of 1904 provides for a special grant for every well-equipped and properly-conducted garden of a minimum area of one acre. But educative studies of great value and variety can be based upon operations conducted in a garden even less than a twentieth of that area. What the laboratory is to the teacher of chemistry the school garden is to the Nature Study teacher. In addition to it, or in its absence, every child may be encouraged to cultivate a little plot at his or her own home, or to

Laying out the Garden.

Opposite Page 16.

participate in the planting and cultivation of the family garden. An autumn exhibit held at the schoolhouse showing the flower, fruit, and vegetable products of the children's home-gardens stimulates general interest in this phase of education. In the City of Chatham, Ont., such an exhibit is one of the most important school events of the year. Group photographs of school children exhibiting their potted and boxed plants are given on pp. 90 and 98 of Hodge's "Nature Study and Life." Showing these and similar pictures to pupils will suggest lines of action. Directions for making school-gardens will be found in "Public School Nature Study" (The Copp, Clark Co., Limited), and H. D. Hemenway's "How to make School Gardens" (Doubleday & Page).

Literature and Art.—The term correlation as technically understood is hardly applicable to the relation that exists between Nature Study and the foregoing subjects from Geography to Domestic Science. They are part of it or it is part of them. But there may be a real correlation between Nature Study and Literature and Art. Much of the finest prose and poetry cannot be fully enjoyed or understood by one who has not first-hand knowledge of the related nature, and many things in nature are not appreciated to the fullest extent by one whose sympathetic vision has not been deepened by the poet and artist.

"The child" says John Burroughs, "does not consciously love nature; it is curious about things, about everything; its instincts lead it forth into the fields and woods; it browses around; it gathers flowers—they are pretty; it stores up impressions. Boys go forth into nature more as savages; they are predaceous, gathering roots, nuts, wild fruits, etc. At least this was my case. I hunted, I fished, I browsed, I wandered with a vague longing in the woods, I made ponds in the little streams, I slept under the trees, etc. . . . . I was not conscious of any love for nature, as such, till my mind was brought into contact with literature. Then I discovered that I, too, loved nature, and had a whole world of impressions stored up in my subconscious self to draw upon . . . Anything like accurate or scientific knowledge of nature which I may possess is of later date; but my boyhood on the farm seems to have given me the feeling and to have put me in right relation with these things. Of course writing about these subjects also deepens one's love for them."

The proper order is nature first and then literature and art. Clearly one of the teacher's duties is to introduce, at the appropriate time, the most beautiful and the most spiritual references that he can find in literature to the nature-lessons studied. A part then of the teacher's equipment should be a well-stocked repertoire of the masterpieces in literature, and of the masterpieces in art, that relate to nature.

Choice of Topics.—Pedagogically Nature Study stands for a method of teaching rather than a quantum of subject matter. A useful course may be made out of the geography, physiology, arithmetic and agriculture taught in the schools. The favorite lessons, however, particularly for the younger classes, will be based on animate nature and these are the lessons that may simultaneously exercise the sympathies and train the observing and reasoning powers. Study of the effects of physical forces, and of experiments upon inanimate matter, will receive increasing attention as the classes become more advanced. But a series of topics cannot be graded on the basis of age or experience. There are some truths about a kitten or a star, for example, that can be discovered with pleasure by the youngest pupils while there are others that will elude the search of the oldest. The choice of subject will be determined chiefly by the interest the pupils have or can be led to take in it, and the availability of the material. Mr. C. B. Scott, teacher of Nature Study in the Oswego Normal School, says that he has always found the interest of the children the best guide in the selection of material at least for the younger classes. The method of treatment, including the suiting of it to the conditions, is under the teacher's control and discretion. Seek here and not in the number of sciences the teacher knows for the highest test of his efficiency.

The whole environment of the child is the field of Nature Study. It may for convenience be divided and subdivided and the subdivisions arranged with regard to the order of the usual development of the children's interest in them.

A. Animate Nature:

Man:
(1) Family and social relations,—food, recreations, etc.
(2) Occupations in home, farm, factory, forest, etc.
(3) Human physiology.

Animals:
(1) Household pets and farm animals.
(2) Birds and local wild animals.
(3) Insects.
(4) Cold-blooded animals: turtles, snakes, frogs, fishes, crustaceans, etc.
(5) Animal physiology.

Plants:
(1) Cultivated and wild flowers.
(2) House plants and garden plants.
(3) Farm crops, seeds, fruits, buds.
(4) Forest, shade and orchard trees and hrubs.
(5) Weeds and innocent wild plants.
(6) Toadstools and other inferior plants.
(7) Plant societies.
(8) Vegetable physiology.

B. INANIMATE NATURE:

(1) Common objects: sugar, flannel, leather, hair, fuel, chairs, houses, etc., etc., etc.

(2) Direction and distance.

(3) Winds, clouds, rain, snow, frost.

(4) Forms of land and water.

(5) Sun, moon, and star constellations.

(6) Atmosphere, water, soil, rocks.

(7) Solution, evaporation, condensation, temperature.

(8) Climate, weather-records.

(9) Gravity, capillarity, cohesion, adhesion, heat, light, electricity.

(10) Mechanical powers, machines.

The Number of Lessons.—How many lessons will it take to exhaust the work outlined? Hundreds? Yes; thousands. And some of them, if taught by the in stigation method, will engage attention now and again throughout a circuit of the seasons. Is there time in the public schools to exhaust the course? No; indeed attempting to do so will defeat the chief purpose of Nature Study.

A groom was hired to train a horse by a certain date to trot a mile in a given time. He did not look with consternation at the quantity of food placed at his disposal and say: "Shall I have to make the horse eat all that hay and grain by the date mentioned?" Not at all; he had a clear idea of the effect to be produced, and his concern was to make such selection of quantity and quality of food and to serve it under the conditions which would produce the desired results. In like manner, the skilful Nature Study teacher, from the subject matter available, selects such topics, and uses them in such manner as will produce the desired effect upon the child. His eye is on the child rather than on the circle of sciences. His aim is not to make the mind fat with knowledge but to make it, and the body too, strong and efficient for usefulness and enjoyment.

Graded Courses of Study.—Graded courses of Nature Study are now adopted in many of the Provinces and States. Framers of the two Courses printed in this book have had the benefit of the experience of several predecessors. Some courses go further than those of Ontario and Manitoba, inasmuch as they indicate not only the work advised in each grade, but also in each month of the year. Teachers who think that such courses would help them will find one in Crawford's "Guide to Nature Study," pp. 164-179. It is constructed in five vertical columns, one for each reading class, and subdivided for autumn, winter and spring study. The topics are arranged in seven series: plants, animals, earth, natural phenomena, celestial bodies, the child himself, and farm and street processes. In C. B. Scott's "Nature Study and the Child" is given a detailed course which has been used in some American cities. It is tabulated horizontally for each of the ten school months, and vertically into columns headed:—plant study, animal study, earth study, physics, sky and weather study,—for each of eight years. E. G. Howe's "Systematic Science Teaching" opens with a chart of twelve pages tabulating nature work and its relations in a series of steps covering the first nine years of school life.

The teacher who tries to follow any of these Courses inflexibly, even the best one, will take the life out of the subject. They are each and all useful for suggestion, but as has been said before, the interest of the pupils, the circumstances of the school, and the availability of material should determine the choice.

Nature Study on the Time-Table. To give Nature Study a place on the time-table happily presents no serious difficulty, although at first it may be confronted with the objection that the time-table is already overcrowded. The alleged overcrowding is probably less real than imaginary, and if real is remediable. Dr. J. M. Rice's thousands of tests show that spelling, for example, is as good in schools devoting only fifteen minutes as in th[illegible] devoting forty minutes a day to it. He holds that his data prove conclusively that satisfactory and, indeed, excellent results in spelling, writing, language, and arithmetic may be obtained though the time devoted to them does not exceed half of the school day. But Nature Study can be given a place without appreciably reducing the time allowed to the other subjects. As has been pointed out, much of the geography and nearly all the physiology and agriculture can be taught as Nature Study. Much of the so-called "busy work," given in the primary classes, may be better described as marking time than as marching on. Here is opportunity for nature work. In arithmetic, and even in history, opportunities will occur to teach lessons by the Nature Study method. Much of the observing and some of the recording will necessarily be done out of school hours. Then the expressive and constructive parts of all the nature lessons afford excellent subjects for composition, drawing, color and form work.

If phenologies and weather phenomena are tabulated on the blackboard or on charts, they may be recorded in the first minute or two after opening. For the other regular nature work begin with the last five minutes before noon. As interest increases and topics multiply resist the tendency to encroach on the dinner hour by beginning earlier and earlier until 11.30 is reached. Lessons in the school-garden, and occasional visits to farms or streams, may justify further modifications of the time-table. A considerable portion of the public, even among farmers, will fail, for some years to come, to understand the educational value of school gardens and excursions; and not every teacher at the start will know how to use them to educational account. But groundless opposition to them will be disarmed by taking time for them wholly or in considerable part outside of the regular school hours. The competent and tactful teacher will deservedly increase his popularity by and through this nature work. The writer knows of an instance where the trustees and teacher at re-engaging time could not agree on the salary to be paid. Some of the ratepayers on hearing of the disagreement petitioned the trustees to retain the teacher's services and offered to make up the difference in salary on the ground that "she is the first teacher we ever had who makes useful lessons on things the children do at home."

Usually there will be several subjects under concurrent observation. In a certain school, on the second Tuesday of September, the half hour's work from 11.30 to 12 noon comprised reports of observations on the differences between the 'prop' roots and the 'stay' roots of Indian corn and on the differences between the two kinds of flowers on the pumpkin vines; third, on the apparent distance and direction the moon had moved from 8 p.m. on Friday until 8 p.m. on Monday, and fourth, the study of the structure and action of a small pump that one of the boys had made. The lesson on the moon, namely, discovering by observation the time and direction of its revolution around the earth, would likely extend over two or three months; the recitations would occupy but a minute or two per day during the time the moon was conveniently observable. Receiving observations made outside of school hours, discussing them and assigning new ones, will usually occupy a considerable part of the Nature Study half hour. The correlated reading, composition, arithmetic, drawing and color work, should be taken at the times regularly allotted to these subjects.

Daily Preparation of Lessons by Teacher. — Dr. Arnold is said to have excused his withdrawing from a pleasant company to prepare the next day's lessons on the plea that he desired his boys to drink from a running stream rather than a stagnant pool. The remark has given form to one of the most familiar pedagogical maxims. Daily preparation by the teacher contributes much to the efficient teaching of any and every subject in any grade, but it is of vital importance to efficiency in Nature Study teaching. It should be impressed, however, that a mere book-preparation is of comparatively little benefit. Referring to the illustration in the preceding paragraph it is obvious that no preparation could be complete without the field study of the roots and flowers referred to, observations of the moon on the evenings named, and examination of the boy's pump. Remember the rule: Do yourself what you intend to guide your pupils in doing. Books in the teacher's hand may play an important and useful part when they guide the teacher's doing but not when they are substituted for the observance of the rule just stated.

Aids to Teaching Nature Study.—If they are kept in their proper place, useful assistance may be derived from books, pictures, models, lenses, opera-glass, microscope, aquarium, terrarium, collections and ready-made apparatus.

Books.—The teacher should have access to, and know how to use, such scientific manuals as Gray's "Botany," Jordan's "Vertebrates," Chapman's "Birds," Comstock's "Insects," and Crosby's "Minerals." He will be benefited by reading and re-reading treatises on Nature Study teaching. The best of these published at date are Crawford's,[1] Silcox & Stevenson's,[2] C. B. Scott's,[3] L. H. Bailey's,[4] Jackman's,[5] Hodge's[6] and Bigelow's.[7]

[1] Guide to Nature Study, Crawford, Illus.,	The Copp, Clark Co., Limited.	$0 90
[2] Modern Nature Study, Silcox & Stevenson, Illus.,	Morang & Co.	0 75
[3] Nature Study and the Child, C. B. Sc[illegible] Illus.,	Heath & Co.	1 50
[4] The Nature Study Idea, L. H. Bailey.	[illegible]bleday, Page & Co.	1 00
[5] Nature Study for the Common Schoo[illegible] W. S. Jackman,	Holt & Co.	1 00
[6] Nature Study and Life, Hodge, Illus.	[illegible] & Co.	1 50
[7] How Nature Study should be Taught, [illegible]	Hinds, Noble & Eldredge.	1 00

A book consulted by the pupils which by statement or picture tells them in advance what the teacher has planned that they shall learn by investigation, defeats the purpose of the lesson. It is worse in some ways than an "interlinear" to language study or a key to a book of problems. The only book published at date which may be safely and beneficially placed in the pupils' hands is "Public School Nature Study."[1] It will assist the teacher in giving directions and asking questions but it tells nothing that the pupil should find out for himself. A pamphlet, briefly treating thirty-six topics on a similar plan was prepared for the Nature Study students at the Ontario Agricultural College.[2]

McGovern's "Nature Study and Related Literature" and Mrs. Wilson's "Nature Readers" give prose and poetical passages of literary merit which may be used in connection with the various Nature Study lessons. F. O. Payne's "One Hundred Lessons in Nature Study," Mrs. Wilson's "Nature Study for Elementary Schools," and Howe's "Systematic Science-Teaching" are books of Nature Study lessons.

Readings from Thoreau and Burroughs, Ruskin and Richard Jefferies, Thompson-Seton and Hamilton Gibson, and a fast-increasing number of other writers of nature literature may afford good examples of literary treatment and sympathetic insight.

Pictures.—After pupils have attempted to express their observations in drawing and color, it will benefit them to be shown how professional artists have treated similar subjects. Several of the books named above are illustrated. Many nature pictures in black and white and color are offered at one or two cents each by the Perry and other dealers in pictures and art goods.

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[1] Public School Nature Study, Illus., The Copp, Clark Co., Limited, 40c.

[2] Outline of Nature Studies, Biological Department, O.A.C., 20 pages.

Models.—Models in clay or other material made by the pupils may be compared with the plaster ones obtained from the dealers in such goods. The pupils' models should always be made from nature, never from the purchased ones.

Magnifying Glasses.—One or more magnifying lenses will be found very useful; they cost from twenty five cents to a dollar, according to quality. An opera-glass aids greatly in the study of birds. A compound microscope, like the unabridged dictionary, would be used more by the teacher than any one else and that chiefly in the preparation of lessons. Occasionally it would be found useful in demonstrating some point to the children or in exciting wonder in their minds. A satisfactory microscope, fitted with one ocular, two objectives, and revolving nosepiece, can now be purchased for from $25 to $30.

Aquarium.—"No one piece of Nature Study apparatus," says Prof. Hodge in "Nature Study and Life," "is capable of serving so many purposes as an aquarium. It may be used wet or dry; filled with water it becomes the means of practical acquaintance with all kinds of aquatic life, both plant and animal; managed as a vivarium or terrarium, it makes a fine insect-breeding case, or fernery, or place for a collection of living mosses, or home for frogs, tree-frogs, turtles, salamanders, snakes, slugs, land-snails." Even this list does not exhaust its uses.

Small aquaria may be improvised by cutting the shoulders off large bottles; 'gem jars' with wide necks and fish-globes serve the same purpose. The usual form of an aquarium is an oblong box with metallic angles and glass sides and bottom. A convenient general purpose size is 8 to 10 inches wide, 14 to 16 inches long, and 10 to 13 inches deep. They may be purchased ready-made from dealers or made to order by any tinsmith. The materials required are strips of heavy angle-tin six eighths of an inch wide, double thick glass for the bottom and good ordinary glass for the sides and ends. In the book last named, which gives specifications for making aquaria of different sizes, the following recipe for making cement for the angles is quoted from the U.S. Fish Commission: "stir together dry, by weight, eight parts putty (dry whiting), one part red lead, and one part litharge. Mix, as wanted for use, with pure raw linseed oil, to consistency of stiff putty. Narrow strips of glass may be used to 'face' the cement along the inside corners; these protect the cement and brace the glass sides.

In stocking the aquarium start with two or three inches of washed sand into which place some water plants such as water-moss or anacharis. Place shells or stones at the roots. Use care in filling up the box with water so as to avoid displacing the plants. Add tadpoles, water-snails, minnows, guarding against overcrowding. With a proper adjustment of animal and green plant life the water will not need to be changed. The green plants exhale oxygen to supply the needs of the animals and the carbon dioxide breathed out by the animals is used up by the plants. There is temptation to put in too many specimens of both classes but particularly too many animals. Each full-sized minnow or shiner, for example, should have a half-gallon of water. Fishes ought not to be given more food than they eat up clean. Once a day is often enough to feed them. Keep the box away from direct sunlight. If slimy growths appear put in more water-snails.

Frogs, small snakes, tree-frogs and salamanders can be kept in 'gem jars' by replacing the glass top with one or two wire discs of suitable size. There should always be some water in the jar where frogs are kept. A saturated sponge or damp moss should be put in the jar containing tree-frogs or salamanders. In nature, cold blooded animals feed irregularly.

All animals need food and wa nd their cages of whatever kind should be kept clean. Those named above feed upon insects, worms, and other kinds of animal food which they usually take alive. When fed artificially with bits of fresh meat the food has usually to be forced into their mouths.

Apparatus.—The time to make an experiment is when the need for it arises. Whether true or not of science, it is true of Nature Study that experiments should not be made for the mere sake of making them. The pupils should participate, if possible, in both the devising and the construction of the apparatus. If there arises the question, for example, whether drained soils warm more quickly than undrained ones, the teacher instead of telling the pupils how to find the answer experimentally will lead them by such a way that they will feel to be discoverers of the means of making nature decide the point. If it be desired to learn whether young plants grow faster in drained than in undrained soils and it is determined to suspend fine stems of grass or thin splinters of wood at an inch from the end attached to the leaves while the free end acts as a swinging pointer, the construction and setting up of the apparatus should be done by the pupils under the teacher's supervision. The total value of the lesson at the Nature Study stage will then be greater than if an expensive auxanometer had been used. Under the stimulus of interest begotten of the desire to find out or prove something the exercise of devising an experiment and constructing the apparatus is often more educative or more valuable than the knowledge gai d. Very little factory-made apparatus is needed in Nature Study work.

Collections.—The children might well nigh convert their schoolroom into a natural history museum without doing much real Nature Study. Mounted skeletons, stuffed skins, embalmed corpses, pinned insects and dried plants may be very useful to pupils at the stage of scientific classification;

the Nature Study class has mainly to do with living plants and living animals. To these pupils the work of collecting is better than the collection made. The objects should not themselves strongly suggest the destruction of life; suitable groups are seeds, dry fruits, leaves, woods, fossils and minerals, weeds and injurious insects. The artistic mounting of these objects, if done by the pupils, is no mean part of the education that can be derived from them. Our pretty wild flowers are not mentioned in the list because it is better to teach the youth lessons on protecting them than on drying them. The killing of injurious insects offers opportunity to teach humaneness in the necessary or permissible taking of life. The writer heard of a lesson on the grasshopper to which the pupils had brought the specimens. Several of them held their hapless captives alive transfixed with pins. Call such a lesson science, if you like, but it lacks an essential quality of Nature Study. The argument is not intended to discourage collecting on the part of the pupils; on the contrary, the practice of having the *pupils do the necessary collecting* cannot be too strongly commended. They should be taught how to collect properly.

Collections made by a class are not supposed to be for the use of its successors. Precious minutes are those spent by the children in the fields or woods in pursuit of a definite educational object. Some of the rewards are sense-training, mental and physical exhilaration, acquisition of tastes that will contribute to life-long enjoyments, and experiences that will live in the mind among its most delightful memories. Every class should enjoy the pleasure and benefits derived from doing its own collecting.

I thought the sparrow's note from heaven,
Singing at dawn on the alder bough;
I brought him home in his nest at even;
He sings the song but it pleases not now,
For I did not bring home the river and sky;—
He sang to my ear,—they sang to my eye. *Emerson.*

Nature Study Record Books. Guarding against the danger that Dr. Bigelow points out (quoted in the paragraph on Expression[1]) original records of investigations and experiments as well as all other expressive work in writing, drawing and color, should be done with critical care and the greatest technical precision of which the pupil is capable. These exercises should be preserved and if they are done on pages of nearly uniform size, such pages may be made into books by punching holes near the back through which cords or ribbons may be passed. Esthetic education is promoted by encouraging appropriate decoration of the covers and of the corners, margins and titles of the pages. In some lessons the objects studied or parts of them are of such nature and dimensions that specimens of them may be attached to the page by sewing or binding, gluing or pocketing. Such objects may be attached to separate bits of paper, and many of the drawings and colorings may be done on separate pieces, and all these sewed or gummed on the written pages at places that have been left blank to receive them.

Students in the writer's classes are advised to record their original observations with scrupulous accuracy as to facts, dates, places, etc., in ordinary note-books and then when the impressional and reasoning parts of the study are completed to make a continuous and artistic summary of the expressional parts in language, drawing, color, and, where practicable, to add constructions and objects. The pages bearing the summary are submitted to the teacher for review and if found worthy are permitted to be put in the "Nature Study Books" for preservation.

To illustrate. Some circumstance occurred to excite the interest of a class in the distinction between the hard and the soft maples. Examples of each of six different species are

[1]Page 19.

growing on or convenient to the school grounds. Observations were made by all concerned in the evenings and recorded. Specimens of leaves, twigs, fruits, etc., were taken from trees whose locations were noted. Notes and specimens were compared and discussed in class. It was decided that certain characters indicated by form, color, texture and margin of leaf, structure of bud, method of branching, color and rupture of bark, afforded means of bringing individual trees into groups which were provisionally named from a prominent character. Wood was obtained from individual examples of the groups and examined in respect to closeness of grain and resistance in cutting. Blocks were weighed in air and compared with the weight of water they caused to overflow when submerged in a filled vessel. The collective inference was that the groups might be re named in terms of the quality of the wood as follows: – Pale hard, dark hard, white soft, serrate soft, milky soft and ash leaved soft. All the specimens of leaves, buds, etc., were re labelled. The interest was maintained or increased. Some had fruit of three or four kinds and desired to see the fruit of all: none had the flowers. So the study was resumed in the spring, and the members of the class were pleasantly surprised to discover such striking emphases of the differences of the groups as were revealed by the flowering pieces. The serrate soft had petals, the white-soft lacked them; some flowers were arranged in clusters, others in long racemes, while the milky-soft alone was noticeably fragrant. The fruits of the earliest reached their characteristic shape and color before the latest shed their blossoms. The systematic literature of the maples was then consulted; the descriptions of the groups were recognized and the Latin binomials bracketed with the common names. The manuals consulted named other kinds of maple than those studied. Inquiry was made where any of the other species could be seen, and some of the students were interested enough to take much trouble to collect leaves and flowers of such species. So much for the inductive part of the work. On the deductive side appropriate uses of the different woods were inferred, and the values of the different kinds for shade or sugar making were considered.

By this time there was an accumulation of specimens, drawings, dated observations, notes and inferences to be worked over into an intelligible, systematic and artistic expression worthy to be preserved in the nature study record books. References to the maple in song, story or art were sought to complete the record.

It is worth while to take another illustration of a different kind. Now and again during the term occasion arose, or was made, to manipulate glass. Cutting of pieces had to be done and this was accomplished with a newly-broken file, or scissors under water, or a steel glass-cutter; a hole had to be bored through a bottle near its base to receive an improvised stopcock: tubing had to be bent in the flame: a large bottle had to be cut below the shoulder to make a temporary aquarium: a glass plate had to be ground for a camera: an etched label was required for an acid bottle, etc. After these experiences had established an interest, a study of glass and its manipulation was assigned. Observations and comparisons were made, and the experiments were repeated. At the conclusion of the study the pages in the nature study record books showed: 1st, the qualities of glass as discovered by the five senses; 2nd, its properties, such as fracture, fusibility, gravity: 3rd, the manipulations referred to above—etching, boring, etc. Each of the third class of records stated how the need for the manipulation arose: the method of performing it, the theory, and other applications if any could be supposed. These were not records of what one student saw another or the teacher do or had been heard of, but records in which the first personal pronoun was used for the observer, doer, and reasoner. Attached to the pages in appropriate places were drawings from the objects used or pieces of glass exhibiting the fracture, grinding, "passe-par-touting," silvering, etching, etc., done by the owner of the book. To the so called practical part were appended library gleanings, due credit to the sources being given, of interesting facts connected with the manufacture, chemistry or history of glass.

Investigation studies so difficult as these could not be done by young children, not that maples and glass as subjects of study are too difficult but because the treatment is beyond them. They show, however, the use and place of record-books. Perhaps it is unnecessary to observe here that while the Nature Study method was closely adhered to in these lessons the scientific attitude of the adult student was unavoidable.

Examinations.—If these records are strictly truthful accounts of what the pupil has done himself, they may be used as the basis of a partial examination. Composition, writing, drawing and other arts may be judged from the Nature Study record-books but Nature Study itself very imperfectly. Still less can the efficiency of a class in this subject be tested by oral or written examinations. These may test knowledge but Nature Study's aims are to create and foster interest, to strengthen observing and reasoning powers, and to increase sympathy and happiness. These results cannot be measured by written examinations, and only in a very limited way by the term records. It is easier to show how examinations and prizes may work injury to Nature Study than to show how they may benefit it, a contention that may be granted without denying them the slightest use under any circumstances.

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GENERAL DIRECTIONS OF THE NOVA SCOTIA NATURE STUDY COURSE.

Nova Scotia. —Nova Scotia has the honor of being the pioneer Canadian Province to adopt a systematic Nature Study Course. Superintendent MacKay writes that the idea has been in the provincial course of study ever since 1880. It began with the observation of *forms* chiefly, but has developed into the observation very largely of *action*. For several years records of biological and meteorological facts that can be accurately observed,—such as first flowerings, bird-migrations, thunderstorms, frosts, etc., have been made by the pupils, summarized by the teachers, and forwarded to the Education Department for compilation. He testifies to the value of these phenological exercises to the pupils themselves and incidentally for the use of future students of the biology and meteorology of the Province.

The following general directions are in the hands of every school board and teacher in the Province of Nova Scotia:—

"NATURE STUDY.—The noting, examination and study of the common and more important natural objects and laws of Nature as they are exemplified within the range of the school section or of the pupils' observation. Under this head, pupils should not be required to memorize notes or facts which they have not, at least to some extent, actually observed or verified for themselves. There should be a short 'Nature Lesson' given every day on the daily collections and observations of the pupils themselves—not on the statement of teachers or books—the lesson always being based on the objects or observations. Many books on the list recommended for school libraries are useful guides to the teacher for portions of the work prescribed in some of the grades. These guide books are to be used only to show the teachers how to give such lessons. They are entirely prohibited as text-books for either pupil or teacher, for under no circumstances should 'notes' from the books be given to pupils. All such studies must be from the objects. Observations under this head form some of the best subjects for English composition or drawing exercises in all grades.

"In schools with pupils of several grades under one teacher (as in most rural schools), many of these lessons may profitably engage the whole school. In nearly all, either the whole senior or whole junior divisions of the school can take part. A skilful teacher can thus give profitable object lessons to several grades of scholars at once; at one time giving a Grade V lesson, at another time a Grade VI or Grade VII or Grade VIII lesson, which will also contain enough for the observation and interest of Grade I, Grade II, Grade III and Grade IV pupils. An object lesson given to the highest class can thus, to a certain extent, be made a good object lesson for all the lower classes. The older pupils will see more and think more.

"It must be remembered that the memorizing of notes and facts merely stated to pupils is strictly forbidden under this head. Such memorizing is pure cram, and is injurious instead of being useful. The teacher may not have time to take up in class every object indicated in the Nature lessons of the course. In such cases the pupils should be given two or three objects nearly related to the typical specimen examined in school, with directions to search for and examine them at home, as illustrated in the specimen class lesson. Without much expenditure of time the teacher can note that this work has been honestly attempted to be done by each pupil. The lessons must be direct from Nature itself, but under the guidance of the teacher, who can save time in bringing the pupils to the point desired by his more matured experience. They are intended to train the observing and inductive faculties, to show the true way of discovering something of the nature of the world which immediately surrounds us and which is and will continue to be re-acting upon us in one manner or another. This knowledge is so much power over Nature, from which we have to win our material existence. It is also essential as an element in any true and useful system of philosophy.

"More stress has been laid here on the natural history of each section than on elementary physics and chemistry. Not because physical phenomena are less important; but because the elements of these sciences are the same all the world over, and there is no end to the cheap and well illustrated guides to practical work in them which will well suit a section in Nova Scotia as well as one in England or in the United States. But there are no such simple guides in the biology of each section, nor in many others of its scientific characters. The teacher, then, must become a student and master himself; for such exercises have special power in developing the habit of accurate observation (which is the soundest basis for any career, ranging from that of the poet and professional man to the tiller and lord of the soil, the tradesman, the manufacturer, the inventor) and in developing in connection with history and civics an intelligent attachment to both the material and ideal features of our country."

ONTARIO AND MANITOBA NATURE STUDY COURSES (COMPLETE).

Recently the Province of Ontario adopted a detailed Nature Study course. A few months previous—February, 1904—the Manitoba Programme of Studies underwent revision, or at least re-publication, when but slight change was made in its Nature Study course, in fact, the changes were confined to the subdivision of physiology, hence it may be assumed that the course has given good satisfaction in the Prairie Province. It is supposed that a parallel statement of the two courses, with suggestions for teaching them, will be helpful to Nature Study teachers. The work of the five Forms in the Ontario course is co-extensive with that of the eight grades in the Manitoba one. The term *grade* is used with the same meaning as *year* in several of the American curricula.

GENERAL

Ontario. From the character of the subject the course must be more or less elastic, and the topics detailed in the programme are intended to be suggestive rather than prescriptive. It may be that, owing to local conditions, topics not named are amongst the best that can be used, but all substitutions and changes shall be made a subject of consultation with the Inspector. The treatment of the subject must always be suited to the age and experience of the pupils, and to the seasons of the year, accessibility of materials, etc. Notes shall not be dictated by the teacher. Mere information, whether from book, written note, or even the teacher, is not Nature Study. The acquisition of knowledge must be made secondary to awakening and maintaining the pupil's interest in nature, and to training him to habits of observation and investigation. Books for reference and supplementary reading should, however, be provided in the school library. Some valuable publications on the subject of Nature Study, for the teacher's use, may be obtained free on application to the Department of Agriculture, Toronto.

As means of expression the *art* subjects should be closely related with the nature work. Throughout the courses oral and written *composition* should be correlated with all the other subjects. In the lower forms, the material of Nature Study, in particular, should afford a basis for oral language lessons.

Manitoba.—This work has been arranged by grades, with definite topics for each. It does not follow, however, that all the material suggested shall be covered during the year. The course has been made wide enough to enable every teacher to select such topics as are suitable to the varying conditions met with.

In general, the treatment of a topic should involve the following:

1. Observation by the pupils.
2. Expression:—
   - *(a)* By oral or written language, or both.
   - *(b)* By drawing, painting or modelling.
   - *(c)* Reading of descriptions, and study of selected literature, such as stories, myths and poems.

Special Note for Grades One and Two (1st and 2nd years).

The purposes of the Nature work in Grades One and Two should be the following:—

1. To develop the right moral spirit leading to sympathy, kind treatment and right feeling toward life, particularly toward animal life.

2. To develop the spiritual nature leading to reverence, truth, belief.

3. To cultivate a love for the beautiful, and to train in the expression of it.

4. To help the children to see those things in nature that are best worth seeing and to understand the meaning of the things seen.

5. To maintain an interest in school life and to aid in the work of other studies, especially language and literature.

Additional for Grades Three and Four (3rd and 4th years).

Observation work of this grade should receive the following modification.—The field should be widened and some supplementary reading introduced; home geography should be given a more definite place on the school programme. Topics not directly within the range of the pupil's observation may be studied whenever the relationship is close to actual experience. Drawing, as a means of expression, should be emphasized at every point. The literature bearing on each topic should be read by pupils and teachers.

Additional for Grades Five and Six (5th and 6th years).

The work of Grades Three and Four should receive the following extensions:—There should be greater emphasis placed upon the practical side of the work. Considerable attention may be given to manual-training, experiments, finding the reason of things, and practical application of knowledge. While retaining the spirit of Nature Study, the teacher's aim should be in the direction of a more logical arrangement, a more systematic treatment and a simple classification.

Additional for Grades Seven and Eight (7th and 8th years).

The work should be similar in character to that of Grades Five and Six, but should be still more scientific as to logical arrangement, systematic treatment and classification.

The relation to the practical affairs of every day life should be made more prominent and as much opportunity as possible should be given to manual work by the pupils, *e.g.*, making simple apparatus, performing suitable experiments, etc.

The interests in these grades are directed more toward economic values—toward the controlling of the forces of nature, toward the understanding of observed facts, and toward the making of new applications of physical principles.

Freedom is the key-note of these general directions. The range of the particulars will be found to be so extensive that teachers will seldom find it desirable to go outside of them. The children's interest and environment rather than the prescriptions of the course are to be the determining agents in the selection of topics. There is no danger of the teacher who studies and yields to the children's interests being carried into a groove by his own favorite science. If any teacher feels such favoritism drawing him strongly he cannot do better than to keep his eye on the list of topics. It is a question whether he can make his best nature study lessons on topics coming within a science he knows well. The answer is "Yes" only when he knows the child and pedagogics well.

Ontario. Form I *(1st and 2nd years).* ANIMAL LIFE:—General appearance and habits of pet animals, their care and food; domestic animals on the farm, their care, habits and uses; birds, their nesting, song, food, migrations in the autumn; metamorphosis of a few conspicuous butterflies or moths.

PLANT LIFE:—Work in school garden or in window-boxes; study of a plant, as a geranium or pansy, from slip or seed to flower; caring for plants in pots; buds, their preparation for winter, their development; autumn leaves, collections, forms, tints; economic fruits, collection, forms, how stored for winter, fruit as seed holders, dissemination of seeds; roots and stems, uses, comparison of fleshy forms, how stored for winter.

LIFE ON THE FARM:—Harvesting, primitive and modern methods compared; preparation for winter: the barn and its uses; activities of the farm during winter; winter sports and social life on the farm; the varied operations of spring time; spring time as awakening to new life; effects of sun and moisture on the soil.

In its early stages GEOGRAPHY should be but a phase of the observational work in Nature Study.

Observation of particular forms of land and water, as hills, valleys, ravines, streams, ponds, etc., in the neighborhood of the school; location of objects observed; general notion of position and direction; activities of home and vicinity, the farm, the shops, the factories, things brought to market, food, milk, water supply, shelter and clothing, rail and other roads, waterways; systematic trips to places of geographical interest near the school; observation of the progress of the sun from sunrise to sunset; observation of position and appearance of the moon, the "Great Bear;" clouds, appearance, motions; rain, snow, hail, etc.; stories of child-life in other lands with illustrations.

PHYSIOLOGY AND HYGIENE should, as far as possible, be made a phase of the observational work in Nature Study. General observations of the body. Simple lessons on the hair, teeth, skin and nails, and on the care of the organs of the senses. Very simple lessons on eating, drinking, breathing, sleeping, and cleanliness, for the purpose of forming good habits.

In the prescriptions under Composition, Arithmetic, Art, Constructive Work, and Clay Modelling the correlations of each with Nature Study are emphasized.

Manitoba. Grade One *(1st year).* PLANT LIFE:—1. The anemone, pussy-willow, dandelion, golden-rod, gentian, or other typical plants, with reference to color, odor, beauty, season, home and the enjoyment afforded.

2. The making of bouquets for the school-room and the home. A study of color, harmony, arrangement and placing.

3. A study of a few common trees of the locality, such as the ash-leaved maple, elm, ash, the hawthorn, the willow and the poplar. Ready recognition of these by their general appearance, bark, leaves, etc. Their value as to beauty, shade, protection and wood.

4. The planting, by each pupil, of a few sunflower and bean-seeds for the purpose of becoming acquainted with the beginning of plant life. Reference may be made to soil, moisture, temperature and season. Observation of root-hairs, root-branches, struggle of plantlets to get to the light, etc.

5. The planting, by each pupil, at school or at home, of nasturtiums, sweet peas or other easy and suitable seeds for the purpose of developing the feeling of *ownership* and *personal interest.*

6. The coloring and falling of the leaves in autumn. The protection of the buds in winter. The swelling and opening of the buds in spring.

7. The trees in winter—general appearance, the long winter sleep, the deserted birds' nests, etc.

8. The scattering of the seeds. Reference being made to such plants as the dandelion, thistle, anemone, sweet-pea, wild cucumber, and to such trees as the basswood, poplar, maple, etc.

9. Collection and arrangement of material by individual pupils.

ANIMAL LIFE.

1. Bird life. Reference to movements, habits, food, song, beauty, enemies, nesting, care of the young birds, migration. A general appreciation of the companionship of the birds. Individual experiences of pupils with particular birds.

2. Stories of birds.

3. The poultry-yard. Feeding and caring for the hens, gathering the eggs, observing the mother-hen and her family.

4. Birds in winter.

5. Butterflies and moths. Reference to color, beauty, movements, etc.

6. Study of simple life-history of butterfly or moth.

7. Conversations about domestic pets of pupils.

8. Conversations about some of the wild animals of the district.

9. Stories of animals.

10. Preparation for winter—by pupils, by animals, by insects.

INANIMATE NATURE.—*(This work must be taken.)*

1. Introduction and development of terms describing direction and distance.

2. Observation of the weather The winds, their direction and what they bring. Rain and snow, where they come from, their use.

3. The sun and the moon.

Grade Two (2nd year).

PLANT LIFE.

1. The planting by each pupil of peas and pumpkin-seeds, as in Grade One.

2. The care of a geranium-slip in a pot. Each pupil to be responsible for the planting and care of his and of her own.

3. The study of individual trees continued. The oak and the elm. Comparison of each with the trees already studied as to appearance, time of leafage, flowering, etc.

4. Acquaintance with a few of the more common plants of the roadside and the vacant lot. (From 8 to 13 plants should be studied.)

5. Collecting, arranging, mounting, sketching and comparing of typical leaves.

ANIMAL LIFE.

1. Observation of a few of the common birds of the locality, particularly the pigeon, wild duck, wild goose, and the prairie chicken.

2. Incidental observation of the birds of the district, as in Grade One.

3. Observing the habits of the ant, bee, wasp and grasshopper.

4. The study of the dog. Fidelity, courage, unselfish devotion, strength, endurance, intelligence, ability and willingness to learn. The dog as a companion and playfellow. Games and tricks of the dog. Stories of dogs. Treatment. The wolf and the coyote.

INANIMATE NATURE.—*(This work must be taken.)*

1. Dew. Where found? Where not found? When found?

2. Frost. The crystals. The frost pictures on the school window. The windows of a deserted house. Frost and dew. Frost and snow

3. Clouds. Movements, appearance, beauty, usefulness, etc.

4. Snow. Where snow comes from. Appearance of the flakes. How snow beautifies the earth. The enjoyment snow brings.

Snow in relation to bird, animal and plant life. The children of the Northland.

5. Learning to read the thermometer.

The work in *Drawing* in all the grades is subdiv d into Pictorial, Constructive and Decorative. The Pictorial part is further subdivided into "Thought of Nature" and "Appearance of Form." The first subdivision is based closely on the Nature Study throughout.

All the work in *Geography* up to the Fifth Grade and the work in *Physiology*, *Physics* and *Agriculture* throughout is included in Nature Study which, in the higher grades, is called Elementary Science.

Animal Life.—Comparative Method.—Whenever the comparative method can be employed its use is strongly recommended. Comparison includes contrast, that is, the observation of differences as well as of similarities. In objects that are alike interest is excited by the points of differences and conversely in unlike objects by the points of similarity. The number of resemblances and dissimilarities varies of course with the knowledge and experience of the observer. A biologist said that he could say more on the ways in which a horse and a geranium are similar than on the ways in which they are different, but the child to whom he made the remark could think of only one particular in which they are alike, viz., that they both need water.

The activities of pet and domestic animals appeal very strongly to the interests of the youngest pupils. In one of the lists the dog is suggested as an object of study, but it is easier and more effective to make a Nature Study lesson of the dog in comparison with the cat than of either alone. In the majority of homes both animals may be studied and compared. It is usually little trouble to have a dog brought to the school-room for one or two lessons of direct observation: an adult cat is less obliging, although some teachers have succeeded in having both at the school at the same time. It is not hard to reconcile a kitten to life in the school-room. Although the cat is named in the prescriptions of animal life for Grade Four, an example of the comparative study of the cat and dog is given here.

Cat and Dog.—One or more investigations may be proposed each day to be reported and discussed on the day following. Examples: examine the covering of the dog's body and compare it with that of a cat. Which is softer, smoother, longer, cleaner, warmer? Which has longer whiskers? When this is satisfactorily disposed of the pupils will have discovered that the dog has rough hair and short whiskers, while the cat has smooth soft hair or fur and long whiskers. The roughness of the one may be observed by passing the hair between the thumb and finger, or the difference may be seen wit. a good lens. Lead pupils to infer the relation between the smoothness and cleanness of the cat's fur.

Infer, too, the cat's need of long sensitive whiskers in hunting her prey in dark holes and corners.

Compare the tongues of the dog and cat as to smoothness and moistness. It will be reported that the cat has a rough tongue and the dog a smooth wet one. Continue questions to bring out the uses of the roughness in scraping food off bones and in "combing" the fur. Can a cat gnaw a bone? Compare their food and methods of eating and drinking, and how they use their feet to get or hold food.

Require a comparison of toes and claws ading to a discovery of the number on the fore and hind ..mbs of each, the hardness and roughness of the skin of the dog's toes, the sharpness of the cat's claws, the sheaths of the latter. Follow the observation up with reasoning wherever possible. What is the use of the sheath? Of the thickness of skin under the dog's toe? Why does the cat need sharper claws than the dog? (Food-hunting and escape from pursuit.) Require these differences to be related to the habits of the animals. Discuss methods of preventing cats from preying upon robins and other song-birds; suggest, for example, the experiment of putting a bell on a ribbon to be tied around the cat's neck. Compare dogs with cats as climbers. What are the differences between the ways that boys and cats climb trees?

Question as to the eyes. Direct that a cat be taken into a dark room for a time and that her eyes be observed when she is brought to the light; that the same be done with a dog. The experimenter will note that the large, round pupil of the cat changes to a narrow vertical opening while the dog's changes somewhat in size but not in shape. At this stage you may have to give information as to the relation between the area of the pupil and the amount of light admitted; then the class may proceed to reason out why the cat can see better at night than the dog.

Compare the ways in which dogs and cats show when they are pleased, and when they are angry or frightened, by the sounds that they make, by their hair, by the movements of their tails. Tell how they try to defend themselves when they are attacked.

Compare their methods of play. Does one cat play with another? Do dogs play with each other? Are they similarly fond of the house and its inmates?

Compare kittens with puppies. Are both species blind at first? Does the puppies' mother carry them in her mouth as the kittens' mother does when she wishes to hide them?

Information may be given that can be used as a starting point for observation and reasoning. For example, you may tell the pupils that the wild relations of the dog, such as wolves and jackals, live and hunt in noisy packs while those of the cat, such as the tiger and wild cat, live quiet, secret, solitary lives, and then set them to discover how these traits come out in the domestic dog and cat respectively.*

Comparisons as to form of ears, eyes, nostrils, heads, and limbs may be made; questions may be raised as to which can see, or hear or smell better. Comparison of the organs, senses and structure of both animals may be made with those of children. The comparison of the parts of the cat's or dog's fore leg and foot with the parts of the arm and hand of a child always reveals great surprises to the children. As a rule, studies of structure and of structural differences, except the most obvious and important ones, should be deferred for consideration in higher classes than this one. In ungraded schools all the classes may simultaneously study the same animal; note the excellent suggestion on this point in the general directions for Nature Study in Nova Scotia, page 35. The younger pupils may be studying how the cat

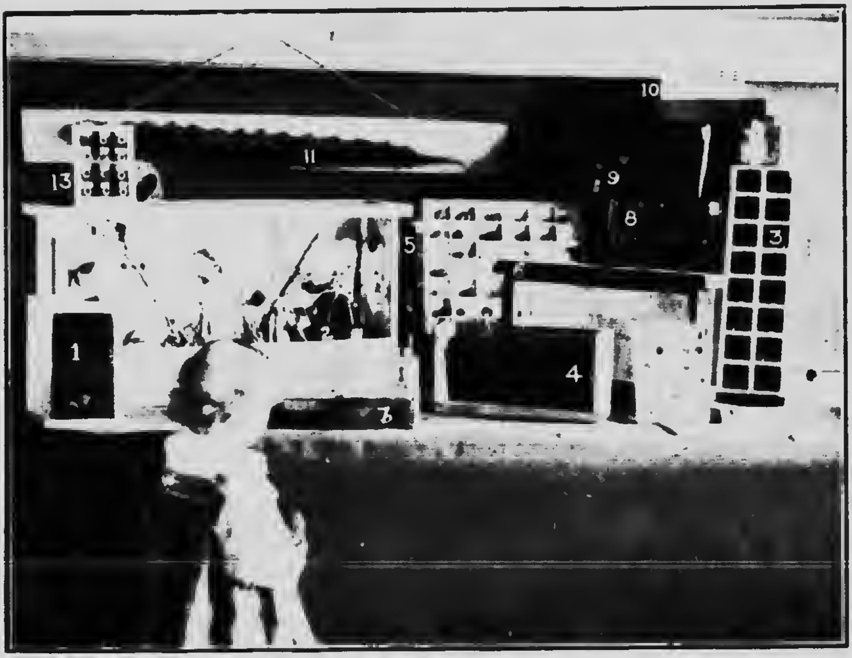
*See "Guide to Nature Study," pp. 83-86, or "Public School Nature Study," pp. 17-22, for a good lesson on the Cat.

climbs a tree, while the oldest ones are trying to discover how she retracts her claws into their sheaths. At or near the end of the observing and comparing bring in stories and literature and pictures relating to dogs and cats. Take first the children's original stories of dogs and cats, then stories from books, stories of Eskimo dog-trains in the Klondike, St. Bernards digging exhausted travellers out of the snow, Newfoundlands rescuing drowning children, Wordsworth's "Fidelity," Holder's "Owney" that travelled round the world alone, Southey's "Llewellyn and His Dog," Scott's "Helvellyn," Dr. John Brown's "Rab and His Friends." Mrs. Browning's "To Flush." Baillie's "The Kitten," etc.

After these observations and comparisons the children who are advanced enough will read these stories to their schoolmates with an interest and expressiveness that seldom marked their ordinary reading-lessons before the introduction of the Nature Studies. The stories, original or second-hand, which they write or relate will afford improving practice in composition. Their taste, if not their skill, will be cultivated by showing them pictures of dogs and cats by Landseer and other good artists.

Rabbit and Guinea-Pig.—In similar manner other domestic animals such as the horse and cow, the sheep and pig, rabbit and guinea-pig may be compared. Lessons on the cow and rabbit are given in "Public School Nature Study," pp 22-33, also in "Guide to Nature Study." An exhaustive study of the rabbit, elementary and advanced, is given in C. B. Scott's "Nature Study and the Child," pp. 38-88. The guinea-pig is easily kept at the schoolhouse. It is sure to be a favorite with the younger pupils who will take great pleasure in supplying it with bread or hay, carrots or grass, or other kinds of vegetable food, and observing its habits. While like the rabbit in many respects it differs conspicuously in the teeth, upper lip, whiskers and ears; further, it has only three

Comparing Living Rabbit and Guinea Pig.



Correlation of Nature Study and Manual Training.

Photograph by S. Pickles. (See Page 197.) *Opposite Page 46.*

toes on each of its hind feet and one more on each of the front ones, and it lacks a tail. A rabbit has five toes on its fore feet; the two hindmost ones, its "thumbs," are apt to be overlooked.

Do rabbits and guinea-pigs eat in the same way? Do they drink alike? What is the favorite food of each? Like the rabbit, has the guinea-pig three eye-lids? Do its eyes stand out so that it can see as far behind it as the rabbit without turning its head? Does it move its nose like the rabbit? Why cannot it jump so far? What sounds does each make and what do they signify? Watch the habits of the animals to observe and compare the uses they make of ears, eyes, whiskers, nose, teeth, feet.

The remark may be made in this connection, although it bears upon the work of a higher grade, that children in examining a rabbit's teeth are liable to suppose that the two upper-grooved incisors are four teeth and to overlook two thin incisors in the immediate rear of the grooved front ones. The rabbit has four incisors in the upper jaw and two in the lower, and six upper molars and five lower ones on each side, making a total of twenty-eight teeth. The guinea pig has two incisors above and two below, and two premolars and six molars on each side, twenty in all. The information may be given that rodent incisors are covered with enamel on the front side only and that the softer dentine at the back wears away more easily than the enamel. The pupils can then infer how these teeth acquire their chisel-shape. Children in the first grade take more interest in the habits and actions of animals, the sounds they make and the affections they show, than in their structure.

Birds.—Bird-life is attractive but difficult to hold under that kind of continuous and connected observation that is most educative. Encourage individual observations of birds along the lines suggested in the curriculum; pay much attention to bird-life, movement and song, when out with children on visits to the woods or on field excursions, cultivate the sympathies of the children on behalf of the birds until every one of them will feel disposed to be a protector of the feathered race. This is not the grade to dwell on the naughtiness of the house sparrow, the cruelty of the shrike, or the predatory habits of the hawk. It is time enough to begin a debit account with the birds when you have laid up a substantial credit of sympathy in their favor. This principle is applicable not only to the study of birds but to that of insects and all other kinds of sentient beings. In addition to the desultory observations of birds in the field and orchard, studies may be made of caged birds borrowed for a day or two. In the case of timid ones guard the pupils against alarming them. I have known a canary to be frightened to death by the exuberant interest of a lot of school children.

Insect Life.—No other insect is easier to rear in the school-room than the common silk-worm. A few eggs can be obtained in the spring, care being taken to have a supply of lettuce, osage orange or mulberry leaves ready for the young larvæ. If the frass is removed and a supply of food renewed daily the silk-worms will require no other care. The box in which they are kept need not even be covered. If the larvæ are started on mulberry leaves they object to a subsequent diet of lettuce; some of them die of starvation rather than change their food-plant. If started on lettuce they can be transferred at any time to mulberry. Their larval habits may be easily observed by the pupils but most of the later transformations take place in the holidays.

If you hear of any teacher who has recently raised silk-worms you need hardly make any apology for enclosing a stamp in a letter and requesting of him or her a score or two of eggs. Every one who raises them in school is pretty sure to have more than will be required for the following spring's supply.

The Corticelli Co., Florence, Mass., advertises helps for the objective teaching of the silk-worm.

Chrysalids collected on milk-weed in September, and cocoons collected on the lilac bushes and orchard trees in the early spring may be pinned up in the school-room. The emergence of the beautiful butterflies and moths will intensely delight the younger pupils. I saw a little girl straighten out the long coiled tongue of a recently-emerged humming-bird moth and rest it in a teaspoon containing some sweetened water. She could scarcely contain her joy, so excited was she with the success of the experiment as she witnessed the liquid disappear through the long sucking tube of the insect.

Plants.—In the study of plants the most important thing at this stage is the creation and fostering of interest in plant-life. Some persons mistake the impulse to pluck pretty flowers for the interest referred to. "The love of a flower in the heart of a child is the highest thing that Nature Study can hope to develop; no amount of knowledge about flowers can take its place nor compare with it in life value."—*Hodge.*

> Hast thou named all the birds without a gun?
> Loved the wood rose and left it on its stalk?
> . . . O, be my friend, and teach me to be thine.
>
> —*Emerson.*

The child who has a real interest in a plant, one might say an affection for it, will hesitate to pluck its flower. Usually the best way to secure this interest is to give the child a sense of proprietorship in a plant, not by presenting him with a full-grown one but with seed or seedling or rooted slip and showing him how to nurse it into vigorous growth. These plants may be kept in pots or planted in the home garden if there be one. If in pots they may be brought to school on stated days and made the subject of discussion and instruction. Is it too much for the teacher to promise to make a tour of visitation to the children's home gardens? Window-gardening in the school-room may be managed so as to give each a proprietary interest in a plant. If there be a school garden the object advocated may be easily reached there. But by some means or other try to have every child in the primary grades cultivate one or more plants of his very own. Note the methods referred to in the paragraph on The School Garden, page 17. Those who are old enough to write may keep a diary of the growth; younger pupils may report important events, such as the showing of buds, the opening of blossoms, etc., to be recorded by the teacher or a monitor.

Recognition of the common trees of the locality by their most conspicuous features is equally interesting and useful to pupils in the junior and intermediate grades. It is enough for the juniors to distinguish maples from oaks and oaks from elms, etc.; the older ones will find suitable problems in recognizing the different kinds of maples, and oaks and elms.

Acquiring a superficial acquaintance with a few common door-yard and road-side plants will also prove interesting and useful observational exercise. A school-inspector said to a Part II class one day: "I will give you ten minutes to go out into the yard to collect and bring in to me one leaf of every different kind of plant you can find." When the time was up each of the nine children had a handful of leaves. They stood between a long bench and the platform, and laid their specimens on the latter. One child was called upon to hold up a leaf while the others sorted over their lots to find one like it. All of that kind were laid on the bench behind the child that held up the specimen. Then another child was called on to hold up a leaf, which action was followed by another assortment. When the exercise was finished the long bench held leaves of twenty-one different kinds of plants which had been collected by these children in a clean, tidy-looking school yard. They knew the name of only one kind

School Garden at Old Barns, Colchester Co., N.S.

(See page 17.)

—that was catnip. Two other names were taught them in the course of the lesson. This exercise, with variations, might be repeated several times with the use of a constantly increasing list of names. The children would, in a few lessons of this kind, acquire an interest in a dozen or more common plants.

Both the Courses of Study properly emphasize the cultivation of plants. Conduct this part of the work with considerable thoroughness and so that interest, skill, and knowledge will keep pace. Make it the central part of the plant study in the junior grades. Devise some method of working in the principle of individual ownership. Keep an eye on the other suggestions of the programme. In the round of the seasons opportunities will likely occur to observe in conspicuous examples most of the phenomena mentioned. Pussy-willows in the spring, dandelions in the summer, and crimson leaves in autumn will attract the children's notice whether the teacher speaks of them or not. Why not be generous with your sympathy, participate with the children in the enjoyment of these beautiful natural objects, and turn every possible occasion to educational account.

Inanimate Nature.—Studies on direction, weather, dew, snow, thermometer, river, valley, sky, should in these grades be almost purely observational. Percepts, images, experiences are in order here. These prepare the way for generalizing and experimenting in the higher grades. The high-school pupil will not exhaust the dew-drop and the cloud, although the youngest scholar may associate both with refreshment of the thirsty plant. Distinct perception of particular facts and phenomena, rather than di cussion of any but the most apparent relations, is the appropriate treatment here. Of course in dealing with causes and effects the teacher need not stop short of the learner's interest and understanding, nor should he go any further.

"This work must be taken." The quoted prescription is probably not intended to imply that this part is more important or educative than the biological work of which it may be assumed that a portion must also be taken. The topics in the inanimate group are few and definite, and they are sure to come within the range of experience of every school, and hence they may be prescribed imperatively.

Ontario. Form II (*3rd and 4th years*). Course of form I. continued. Animal Life: Life history and habits of domestic animals and of familiar wild animals, as the squirrel, chipmunk, robin, crow; earth worm, habits, structure, uses; toad, habits, structure, uses; observation of live insects and their activities, comparison of young and adult stages.

Plant Life: Co-operative and individual work in school-garden; cultivation of plants in pots with observation of the development of leaves and flowers; parts of leaves and flowers; change of flower to fruit and of fruit to seed; functions of the parts of flowers; the forms and uses of trees; activities connected with forestry and lumbering, with study of pioneer life and present conditions on the prairie.

Observation of farm, garden, and household operations.

Geography (*in part*) -Continued observations of local land and water forms. Observations of highest points in the neighborhood, the chief slopes, hills, valleys, divides, etc. Special study of a brook, creek or river, to see origin, direction, size, work of draining, eroding, carrying, plant and animal life along banks, etc. Representation by drawing and modelling of typical surface features actually observed by pupil. Observation of weather; Winds, direction, force; clouds; rainfall; frost; changes of season; characteristic features of each season; systematic weather records; general notions of climate: record of moon's phases, with drawings of their appearance. People of the locality, nationalities, appearance, original homes, etc.; child life in other lands. Location of any places of historical interest in the neighborhood.

Physiology and Hygiene.—Course in Form I continued. Simple lessons on digestion, exercise, cleanliness, and ventilation. Lessons on the organs of the body, that can be taught by the Nature Study Method. General effects of tea, coffee, alcohol and tobacco.

Art. —Free drawing of plants and other common objects. Water-colors of flowers and leaves with autumn tints, butterflies, birds, fish, etc., clay modelling of apple, beet, banana, etc.

Manitoba. Grade Three (*3rd Year*). PLANT LIFE:—1. The germination of corn and scarlet-runner seeds, as in previous grades. Observations should be followed by oral description and drawing.

2. Observation of the marsh marigold, colt's foot, arrow leaf, cat-tail, or other water-loving plants.

3. Observation of such flowering shrubs as the hawthorn, cherry, plum, spiraea, honeysuckle and lilac. A ready recognition of these.

4. The autumn flowers—gentian, pansy, petunia, aster and golden-rod. Reference to season, appearance, etc.

5. Collection by pupils of leaves and dry fruits.

ANIMAL LIFE:—1. The study of such birds as live near the water or frequent the meadows. Special reference to the red-winged blackbird, bobolink and meadow-lark.

2. Incidental observation of the birds of the district.

3. The life history of the toad or the frog.

4. The horse. **Treated** similarly to the "dog" of Grade II.

5. Familiar conversations about the wild animals of the district.

INANIMATE NATURE—(*This work must be taken*).—1. Evaporation. Reference made to the tea-kettle, wash day, sprinkling floors and streets, the drying of roads, ponds and clothes. A good drying day. Practical experiments at home and at school.

2. A hail-storm. Character of the weather preceding the storm. Appearance of clouds, wind. Observation of the hailstones; damage done. The character of the resulting weather.

3. Making weather records during the months of January, April, June and October.

4. A study of the common forms of land and of water as an introduction to a subsequent world study. Such forms should include: Hill, valley, slope, brook, or creek, pond or slough, lake, meadow, upland, plain, cape, bay, isthmus, peninsula, etc.

Grade Four (*4th year*). PLANT LIFE:—1. Germination. Structure of the dry-seed. Need of water. Parts of the embryo. Function of the seed-leaves, behavior of seed-leaves, as shown in the case of seeds studied in previous grades.

2. The planting of a potato or potato section by each pupil. Observation of growth from week to week. Keeping a record of this.

3. Study of cross-sections of twigs, branches and stems. The meaning of the rings and the story they tell.

4. Comparative study of (*a*) marsh marigold, anemone and buttercup, or (*b*) the potentilla, geum and strawberry, for the purpose of showing relationship. Simple technical terms may be introduced when required by the pupils.

5. The wheat-field. Planting, growing, cutting, threshing, marketing, grinding, baking.

6. Making collections of leaves, flowers, weeds, or such other specimens as the pupils are interested in.

ANIMAL LIFE.—1. Special study of the meadow-lark, cow-bird, crow, robin, oriole or other birds.

2. Comparative study to show how wings, bills, feet, color and nests are suited to the lives of the different birds.

3. Incidental observation of the birds of the district.

4. A study of the spider as a house-builder and hunter; his habits, manner of moving, food, perseverance and other qualities. Stories of spiders.

5. The house-moth. The eggs, the larvæ, the cocoon and the pupa, the imago, the egg; or a study of the wasp—a papermaker, making the nest, feeding the young, guarding the young, the wasp in the winter-season.

6. Incidental observation of the gopher and other wild animals of the district.

7. The dairy cow. Food, drink, habits, value to the home, gentleness, love for her young, her home instincts, etc. Treatment of the cow. Stories of the cow.

8. The domestic cat. Eating, drinking, sleeping, movements, senses. Adapted to mode of life. Relation to mice and birds. Stories of cats, tigers, lions, etc.

9. Study of the human body:—(*a*) Comparison with bodies of animals; adaptation. (*b*) Main divisions of head, trunk, limbs, hands and feet. (*c*) Hygiene pertaining to the above. (*This must be taken.*)

INANIMATE NATURE—(*This must be taken*).—1. Continued study of the physical-features of the neighborhood. A special study of any local water-course, reference being made to source, course, slopes, channel, banks, bed, basin, watershed, tributary, current, rapids, shallows, winding, building and wearing banks, delta. Work of streams. Relation of stream to farm, town and district. Life in the stream and on its banks. (*A preparation for the study of a river.*)

2. Drawing plan of school-room, school-house and grounds, home. Making a map of the district and recording the geographical facts discovered.

3. The study of the "earth as a whole"—an immense ball rotating on its axis and exposed to the light and the heat of the sun. Cold, hot and temperate regions. Introduction and use of the terms "equator" and "poles." The land and the water-masses in continents and oceans. The positions and names of these. The earth-plateau. The general character of the climate. Productions and peoples of each continent. The value of each continent to the others (a simple introduction to the meaning of exports and imports). The polar and equatorial winds. (*Free use should be made of the school globe and the sand-map.*)

Life Activities and Adaptations.—The movements of animals, their food and means of obtaining it, their homes, the care of their young, their play, the sounds they make, their expressions of fear, anger and affection, their familiar uses to man—in short, all the activities that suggest interpretation in terms of human experience—appeal much more strongly to children in Forms I and II (1st to 4th years) than do considerations of structure and classification. In Form II, however, observation of apparent adaptations of organ to function, as the teeth of the cat to tearing and those of the squirrel to gnawing, and of general structure to mode of life, for example, the robin to flight and the rabbit to burrowing, should receive considerable attention. One would naturally suppose that lessons based on the life-side of plants and animals would be preferred by teachers, therefore, surprise is sometimes expressed that they seem willing or able to use only dead or dissected organisms. The dead form is observed and the function inferred or remembered or learned as so much information; thus reversing the natural order. Dr. C. F. Hodge accounts for this condition on the theory that the analytical study of things dead and dissected has so long monopolized the higher school and university courses that the teachers know nothing else to teach. If this theory be true it may bring some encouragement to teachers of Nature Study who did not take science in their academic course. I have seen very poor Nature Study lessons taught in elementary classes in the public schools by persons who knew enough science to teach that subject in high schools. It is a good thing to have studied science, but profound scientific knowledge is not indispensable to teaching Nature Study in public schools.

Domestic Farm Animals.—In rural schools, almost without exception, observations on the horse and cow or on the sheep and pig may be directed to be made at the homes. Continue the comparative method wherever practicable. Observing the differences between the ways in which the horse and the cow eat grass in the pasture means more than twice as much training to the child as observing how either one eats without reference to the other. One reason of this is that paying attention to the differences is pretty sure to cause the observer to wonder about their causes.

In the assignment of the observations to be made it is advisable to suggest points to be noted. Observe the differences in the ways in which the cow and the horse eat grass in the pasture; notice the movements of the head, the tongue, the neck. When the child observes that the cow pushes her head forward when she crops the grass and that the horse's movement in the corresponding act is different he will desire to know the cause of the difference, or he will anticipate that when he reports the observation the teacher will inquire whether he found out why it occurs. Continued observation, stimulated by some new suggestion, will reward him with the discovery that the difference is connected with the absence of upper teeth in the front part of the cow's mouth. It will likely prove easier for him to discover why the horse needs a longer neck than the cow.

What differences exist in the ways in which cows and horses defend themselves when they are attacked, as by a dog, or when they fight with other animals of their own kind? The use of the horse's long legs and long neck, and the cow's short, strong neck and her bulging eyes at the corners of her head will be thought of here. In this connection it will be legitimate for the teacher to give some information respecting the habits of the wild relations of the cow and the horse, or of these species in an undomesticated condition. To escape his enemies the horse depended on his fleetness or the force and readiness with which he could use his heels; the cow could not run very fast, neither could she defend herself like the horse by kicking, so she turned her head to her foe and used her horns with all her strength, backed by the weight of her heavy body. The habit, or adaptation, of chewing the cud permitted her to eat a quantity of grass hastily and then retire to a secure place to chew it at her leisure.

Compare their modes of lying down and rising. Why does the cow, in getting up, raise her rear part first? Does the cow always rise in the same manner? Do the cow and horse hold their heads in the same way when they are lying down? Do they fold their legs alike? Do they ever lie with their legs unbent? Do they ever lie on their back or roll over?

What sounds or cries do they make? Try to imitate them. What does each sound signify?

Compare a young foal with a young calf, in respect to size, height, color, actions, including play. Measure, if you can, with a cord or tape-line and record the lengths of corresponding parts. Repeat the measurements and compare with first ones to judge the growth. Make a record of events and note the dates so that, at the end of six or eight months, you can write a history of one of these young animals. How do their mothers show their affection for them?

Observe the uses of the horse and cow to man. If we went to live in a country where there are neither cows nor horses, which should we miss more? What substitutes are there for the services that these animals render mankind?

A teacher, sitting in the school-room, and reading this page or the questions in "Public School Nature Study," on pp. 27-33, will thereby derive help in preparing to conduct a Nature Study lesson on the cow or the horse, or on a comparison of them, but there is a better place to prepare the lesson and a better source of assistance. With note-book and pencil go back to the pasture where these animals are living; observe them at first-hand. The pages referred to will help you more effectively there than in the school-room. You will find which comparisons are easy to make and which are difficult, and hence be enabled to assign the exercises with the appropriate amount of suggestion. Even though you had been brought up on the farm, and had assisted in the care and handling of the live-stock, you will quite probably discover while preparing to teach an observation lesson on horses and cows several interesting things that you had not noticed before.

Mr. J. B. Wallis, Supervisor of Nature Study, Winnipeg, found that a difficulty arose when pupils were assigned what seemed to them common-place lessons, as for example, "The Cat." Some of them fancied that having lived so long with a cat in the house that they must know all about it. The danger, I have found, is not an imaginary one that some teachers will assume that they know enough about certain common-place subjects to teach lessons on them without the preparation that comes from a re-examination of them.

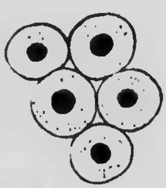
Do not fear to be asked questions that you cannot answer. Expect them; welcome them. Say "I don't know but I am glad that you have asked that question, I shall help you to find the answer if I can."

A Caution.—The following study of the toad and frog is not given for either information or servile imitation, but for suggestion and as a sample expression, save for the reduced number of drawings, of another's Nature Study lesson on the subject. It is quite the right attitude on your part, Teacher, to assume that it may contain mistakes, and hence that you will accept no statement in it as final until you have verified it by your own observation and experiment. Thus viewing it, the chapter may be as useful to you, although it is hardly conceivable that it could be to even the brightest of your pupils, as if it had consisted of a category of questions without answers. In one of the books, justly recommended, on page 24, it is stated in effect that frogs have teeth in their lower jaw. While I hope that there is no statement in the following description so far astray, yet I am conscious that my observation and memory are fallible. So, for the purpose of Nature Study teaching, spare no pains to verify the statements found in this or any other book of its kind before you use them in the class.

Toads and Frogs.—Amphibians or batrachians, including mud-puppies, salamanders, newts, toads, tree-toads, and frogs, after leaving the egg, pass through a metamorphosis almost as well marked and as wonderful as that of the higher insects. The stage of all these classes of animals corresponding to the larval one of insects is called the tadpole, which, like the fish, is adapted to life in the water; the mature form has sacular lungs adapted to life in the air. Salamanders and newts are by many people supposed to be lizards; but true lizards, which in Southern Ontario are occasionally seen and known as swifts, have scales on their body and do not pass through a tadpole stage.

The Frog's Relations.—Mud-puppies are large batrachians, whose red, bushy gills persist throughout life. Salamanders and newts or efts are lizard-like in body and limb; but they have smooth, viscid and usually spotted skin. In the adult state they live chiefly upon snails, slugs, insects and worms, and are quite harmless to man. Tree-toads look like small toads, but they can easily be distinguished by the discs or suckers on their toes. It is by these discs that they cling so well to perpendicular surfaces. They, and to a less extent the common frog, change the color of their skin. The inner skin contains numerous color-cells or spots, which by contraction or expansion change the general color of the body. It is a question whether these color changes can be controlled by the animal; probably they arise automatically under the influence of the color of the environment through the eye upon the sympathetic nerves and those of the skin. All these animals have a tadpole stage, which differs from the higher fishes in no other important way than in the absence of fin rays. This stage is quite as interesting to the younger children as the adult one. Intelligent observation of the segmentation of the egg, the transformational steps, and the details of structure is good exercise for the advanced classes. Choose from the following outline the parts suited to the pupils whose observations you may be directing.

The Eggs:—Search ditches and shallow ponds in early spring for masses or strings of jelly containing small eggs resembling, except for the black spot in each, so many grains of swollen tapioca. Eggs embedded in jelly found in the situations named will probably prove to be either those of the toad or the frog. Should they turn out to be salamander's or tree-toad's, they will be none the less interesting. Frog's eggs are found in jelly masses, toad's eggs in strings of jelly.

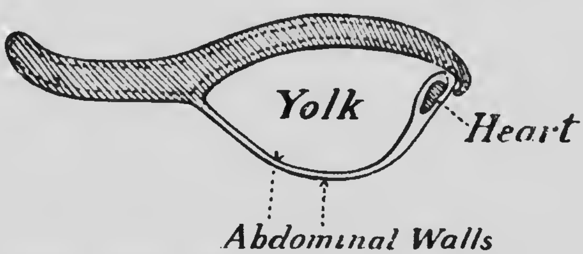

Frog's Spawn.

The Aquarium.—Before collecting the eggs prepare a hatching-pond. In a milk pan or granite-ware or porcelain basin place some sand or scrapings from a pond, mingling therewith stones laid in such manner that at one side of the basin they come to the top of the water and at the opposite side three or four inches below its surface. It is advantageous that some of the stones have green algae growing on them, but whether they have or not plant a few weeds or mosses that [illegible] live under water and keep green in it in the basin. [illegible] the Aquarium, page 26. Do not put in too many eggs; [illegible] three dozens are plenty, indeed that many [illegible] tly overstock a milk-pan pond. The [illegible] it will support depends on the food supply; in any case a [illegible] large tadpoles would be rather too many

The [illegible] Covering of the Eggs.—The eggs when laid vary in size according to the species from a tenth to a fifth of an inch, [illegible] the thin gelatinous covering absorbs water and swells up to the size of large peas or small marbles. The jelly keeps them afloat, while their slipperiness probably protects them from seizure by fish and birds. The embryo is on the dark side; the white part is a store of food. The colder the water the more slowly the embryo develops; water that is too warm would quickly kill them. The tadpoles may begin to appear in two or three days after you stock the basin, or you may have to wait two weeks for them to hatch. *Experiments.*—(1) Try to pick up a frog's egg out of water with a pair of forceps. Infer the difficulty a bird would experience in attempting to feed upon such eggs. (2) Put equal weights of snow or ice on blotting-paper, covering one with a piece of white cloth and the other with black cloth of similar stuff. Expose the preparation to direct sunlight, and observe how much more quickly the substance covered by the black cloth melts than the other. Infer the use of the black layer over the embryo in facilitating hatching.

Development of the Embryo. If newly laid eggs be obtained, removed from the jelly, and placed in water in small saucers or watch-glasses, the initial changes may be observed with a pocket-lens. The older pupils will find these observations extremely interesting. Two meridional grooves and a circumpolar one mark off the little globe into eight areas. These divide again and again; the globe flattens and lengthens. By and by the neck appears and movement is exhibited. In about two weeks the tadpole, if of a frog, struggles out of the envelope and although still mouthless it has a pair of suckers under where the mouth will be by which it attaches itself to a leaf of the water-weed. Watch it closely in this attitude to observe its external gills develop. These are three pairs of thread-like extensions at whose bases are openings that lead into the throat. Water entering by the mouth passes out through these clefts as it does between the gills of a fish. The external gills of the young toad or frog soon disappear and their use is served by internal gills. As this change is taking place, eyes, nostrils and ear patches come into view. It finds the use of its swimming tail; its mouth opens as a small tough or horny aperture with which it sucks off its food from weeds and stones.

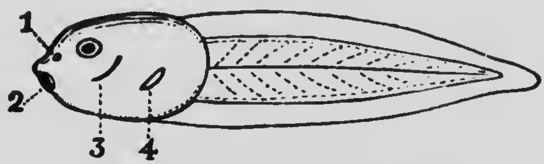
Egg in 1st stage of division.



Section through the half-hatched embryo (diagrammatic).

Up to the time it detached itself from the water-weed, where it has been hanging since it was hatched, the food for its growth and all its changes has been supplied by the yolk of the egg which it carried in its body. Subsequently its principal diet is the vegetable matter that grows on the stones or weeds in its pond. Tadpoles are not above cannibalism if driven to it by hunger. In ponds with meagre food supply the ragged and frayed tails show where they had begun to eat each other, and some individuals may entirely disappear.

'The Balance of Nature.'—The vegetable growth in the water not only supplies the tadpoles with food but, if it be green, with oxygen also. The living green plants in daylight are constantly giving off oxygen, which is absorbed by the water and taken up by the gills of the young tads to purify their blood.

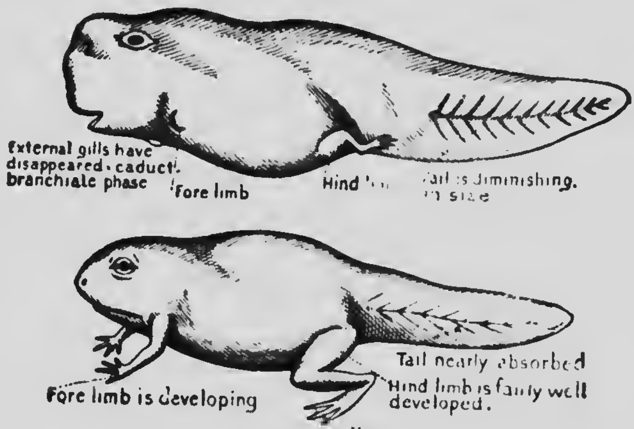


1, Nostril. 2, Mouth. 3, Ear. 4, Gill-cleft.

The waste given off by their bodies is taken up as nourishment by the plants; each uses the other's waste, so between them the house is kept quite clean. A tadpole seems to be little else than head and tail, but it really has, as befits a vegetable feeder, a long intestine coiled up like a watch spring.

Legs and Tail.—The next change that the pupils will be able to observe will be a pair of little stumps near the junction of the tail with the body. These will elongate and reveal their character as hind legs. In the case of the frog, at the age of two months, the toes can be made out. The smaller front legs are growing at the same time, but they are hidden under the fold of skin that covers the gills and are not seen until they burst through it. Children are apt to think that the front legs have grown suddenly. As the legs lengthen the tail shortens; it is gradually being absorbed. Other changes are in progress, the mouth is flattening and lengthening; in some kinds teeth are developing in the roof of the mouth and in the upper jaw.

The Transformation.—When the well developed tadpole rushes to the surface of the water and discharges little air bubbles you will know that its lungs are developing and that it is beginning to use them. A quick inspiration succeeds the little bubble and the tad rapidly descends as if frightened. Its preference for vegetable food is yielding to one for a diet of insects, especially flies: a concomitant change



From "Guide to Nature Study"

is taking place in the length of the intestine—carnivorous animals having as a rule much shorter intestinal canals than vegetable feeders. The young frog, or toad as the case may be, is transforming from a 'four-legged fish' to a land quadruped—from an herbivorous aquatic to a carnivorous terrestrial creature. Possibly as wonderful changes take place in the life-history of many other animals, but in no other group than this can they be so easily observed. There is much for the oldest as well as the youngest to think about. For example, the frog will not need that swimming tail but yet it is not wasted; it assists in nourishing the animal while it is adapting itself to the change from water-life to land life. How is the substance of the tail carried into the body? Internal changes present many other questions equally difficult.

A Critical Period.—The transformational period is the critical one for batrachian life. Your pupils may well be proud of the achievement of carrying some of the specimens safely through it. The following way is worth trying: Transfer one (or a few) to a gem-jar kept on its side and having a wire netting disc in its screw-cap. Put water and some small stones with vegetable growth on them in the jar; introduce a few house-flies: in short, maintain the conditions suited to both tadpole and frog until you see it capture a fly. From that time supply it with insect diet.

The Sacredness of Life.—After taking out the few individuals that you will try to carry through the metamorphosis send the rest of the stock to the nearest pond or ditch to teach the children a lesson on regard for life. It may be probable that none of the tadpoles thus returned will attain to froghood. Then why, it may be asked, take the trouble to carry them to the ditch? A fundamental principle of Nature Study teaching is violated by using an animal so long as it serves one's purpose and then leaving it to perish with apparent unconcern.

A Mixed Collection.—It will frequently happen that instead of the gelatinous spawn the children will bring in the hatched tadpoles. For the younger pupils the omission of the initial stages is unimportant. You are liable in the case supposed to get a mixed collection but that rather adds to the interest and value of the study. Most kinds of tadpoles are brownish; those that are as black as ink are young toads. The development of the latter is very rapid as compared with that of the frog: they will be ready to leave the water in two or three months while one kind of frog—the American bulfrog—is said to remain in the tadpole stage about two years.

The Adult Toad.—Of all the batrachians the toad is or should be the farmer's and gardener's special friend and favorite. It has been advised by some writers that every gardener should make an artificial pond where a good supply of toads can be raised. If a toad be confined in a box containing two or three inches of soil, kept moist but not wet, and covered with a wire-screen, its value to the gardener can be approximately estimated. Cut-worms, cabbage-worms, and other kinds of destructive insects may be collected and put in the box. The species and numbers of these that the toad will devour may be observed. Almost everything that crawls or flies, if not too large, will be filliped into its mouth almost too quickly for the eye to follow. It has been estimated by an observer, who kept count of the number of insects that a toad ate during a few days, that it requires about 10,000 grubs and insects to support a toad during a season.

Feeding and Hiding.—The toad can be studied in the home-garden and in confinement at the school-house. Its method of catching a fly by everting its tongue, which is attached at the front and is free behind, never fails to interest young or old. Its concealment by partially burying itself in the soil in the day-time gives the opportunity of studying its method of digging. It buries itself to a considerable depth to hibernate during the winter. It digs with its hind legs and pushes its body backwards into the hole. All these operations may be observed in the toad-box at the school-house.

Casting its Skin.—There is another interesting operation that may take place in the box where the well-fed toad is confined, but which may be missed even by the most assiduous observer, that is 'the casting of the skin.' Human skin is continually coming off in little flakes; snakes shed their skin all in a piece, and insect larvæ similarly shed their skin when it gets too small for them. What about the toad? When its outside skin gets too tight and dry, a new skin grows underneath it. When the new growth is complete the old skin cracks along the back while the toad keeps twisting and wriggling to loosen it all the way round, and thus it gets it off its sides. It pulls its head out like a boy taking off a shirt. But the skin is still hanging to its legs. By the help of its front legs it pulls its hind legs out and then it holds the skin with its mouth while it pulls its front legs out. Have you ever found a toad-skin on the path? Probably not. because the next thing the toad does after getting its front feet out is to use them in bundling up the old skin into a bunch that it can swallow. Now, if there is any mistake in this account be sure to correct it the first time you observe a toad through this process of donning a new suit. You may miss seeing the act but you will not fail to observe the result in the brightness and cleanness of the new dress.

How the Toad Defends Itself.—One day when carrying a toad in my hand I overtook a couple of boys, one of whom addressed this remark to me: "Say, Mister, will a toad give a fellow warts?" Turning to the other I asked him what he thought of the subject. He replied at once: "If you haven't warts they'll give you them, but if you have warts they'll cure them." "What makes you think so?" "Because that's what all the boys say." Probably the warty appearance of its own back suggested the common but declining prejudice against the toad as a wart-producer. The dog that has teased one and then takes it in his mouth knows the disagreeable taste of the secretions of these warts. Save for that exudation it would be entirely defenceless and even that is no protection against birds of prey and large snakes so it is not very effective. Its defencelessness may explain why the toad, though possessing such beautiful eyes, seldom ventures out in broad daylight. Seek for other reasons that may account for its crepuscular and nocturnal habits.

The Toads' Annual Concert.—Every spring all toaddom makes a pilgrimage to the ponds and ditches. Who can tell how they know the way or whether they try to go to the pond where they began life as tadpoles or to the nearest suitable situation? Perhaps depending on their hearing they move in the direction of the noisy saengerfest. It is only the males that join the chorus. Their loud and long continued trill distinguishes them from the other musicians of the swamp band. Than that they find their way to the pond it is still more astonishing that they return, as it is claimed, to their respective homes. If you bring a toad from a neighbor's garden to your own will it stay with you or return to your neighbor? This question ought to be easily answered by experiment Toads can be tamed and petted. Pennant tells of one that lived as a pet in a British garden for forty years.

The Adult Frog.—The adult frog is a more attractive and lively animal than the toad. It does not slough and swallow its skin like the toad, but sheds it in flakes and patches, which come off in the water. Its skin, when wet, takes part in respiration, hence a frog's health soon suffers if it cannot get a bath. Like the toad it is carnivorous, feeding upon worms and insects, flies and mosquitoes being its favorite delicacy, and always refusing to capture its prey until movement indicates the presence of life. Either of these animals would starve beside a basin of dead flies. The frog is easily kept in captivity, and its habits observed. I have kept one in apparent comfort and good-health for over four years, confining it in a two quart gem jar, with wire disc in the screw-cap. The jar usually lay on its side and contained about a teacupful of water which was changed every day or two, or frequently enough to keep it sweet and clean. Most of the time there was placed in the jar a bit of brick or wood or stone for the frog to rest on. Occasionally it was allowed a hop around the floor for exercise. It was fed on flies, insects, and earth-worms, and when these were not easily obtained, it was given a bit of fresh meat, which of course had to be put in its mouth. When a person handled its jar or objects nearby, it showed that it expected food by the way it leaped against the end and sides of the jar. To show its method of seizing a fly a student would place a tumbler over a house-fly on the window pane, slip in a bit of stiff paper large enough to cover the mouth of the tumbler, and, carrying the covered fly to the gem jar, whose base was placed towards the light, hold the mouth of the tumbler against the mouth of the jar and pull out the paper, thus permitting the fly to enter the jar, as it immediately does to go towards the light.


How the frog captures a fly.

A glass jar, such as has been just described, is a suitable and convenient means of holding many kinds of small animals for observation. The external movements of respiration in the frog as thus exhibited is interesting to even a young child. Lacking the diaphragm and ribs to make a cavity for the air to rush in the frog fills its mouth with air drawn through its nostrils, and then closing its oesophagus swallows the air into its lungs. This fact explains the incessant slight movement of its nostrils and the conspicuous up and down movement of its chin and throat.

Questions about the Frog.—In what situations are frogs found? Why are they seldom seen far from water? What is their food? How do they obtain it? How do they move from place to place on dry land? Do they ever walk or run? How far can they jump? Notice how the shortness of the body and the length and strength of the hind legs are adapted to jumping or hopping. Put a frog in water and observe how it swims.

Its Structure.—Notice the color, dampness and smoothness of the skin. Obtain two similar frogs, one of which keep in a jar laid in the shade over, or wrapped in, a black cloth, and lay the other in a bright place over a white cloth or paper. After a time observe the difference in the color of their skin. What advantage may a change of color be to a frog?

Measure the lengths of its body and those of its front and hind legs. Compare them. Observe its position when resting. Notice its four separate fingers and its five webbed toes. What use is the web?

How wide can it open its mouth? What is the use of the wide gape? Can it breathe when its mouth is open? What is the shape of its tongue? What advantage is it that the tongue is free behind?

Has it a bright eye? Describe the eye. Touch the eye. Study the eye-lids. Infer whether the eye is surrounded by a bony orbit. Touch the eye when the mouth is open. Notice its ear-drum below and back of the eye. Observe the nostrils.

Feel whether it has ribs. Name the bones that you can locate by feeling without hurting the animal. Compare the bones of its hind leg with those of a human leg or a cat's leg. Where is its knee? Where its ankle?

Circulation of Blood.—If a compound microscope is available it is easy to show the pupils one of the most beautiful and instructive microscopic objects, namely, the circulation of blood in the web of a frog's hind foot or in the nearly transparent margin of a tadpole's tail. One who has seen this wonderful sight a hundred times will turn to it again with interest. The simplest way to exhibit the phenomenon is to have one child take a position at the observer's left to hold or keep the frog's body still on the frog board. Another child standing on the right uses both hands in keeping the web expanded under the objective of the microscope by holding the toes against the board. The frog's body, leaving out the left hind leg, should be wrapped in cheese cloth which should be kept wet. The frog-board may be a piece of thin, smooth board three to four inches by nine inches pierced with a five-eighths-inch auger about two inches from the middle of one end. The hole should be covered with a thin plate of good mica cemented to the board. The web is extended on the mica over the hole. The left hand end of the board has to be supported on a box or book the thickness of the height of the table of the microscope.

Uses of the Frog.—Infer from feeding experiments that frogs reduce the number of troublesome flies and mosquitoes. Some people make soup of the fleshy part of frogs' hind legs. Criticize the cruelty of frogs'-legs collectors, who cut off the legs without first killing the poor animals.

Comparison of the Frog and Toad.—In guiding children through a comparative study of the frog and toad ask questions that will lead them to discover that the frog's skin lacks warts, and that it has longer hind legs than the toad. The toad is quite toothless while the frog has teeth in its upper jaw and in patches in the roof of the mouth. It is needless to say that no harm can happen to the softest finger from feeling the frog's teeth. Their tongues are similar in front but the toad's is not forked at the free end. Their food and method of feeding are similar. Compare their bodies, hind legs and toes to see why the frog is the better swimmer. Compare their locomotion on dry ground.

Tree-toads, newts, efts and salamanders may easily be kept in the school-room at least long enough for a general study, if put in such a cage as was described for the frog, with damp moss or a saturated sponge to keep the atmosphere in the jar moist. There is no exception to the necessity of keeping all animal cages sweet and clean. The interest in living animals is so well nigh universal among children that when a teacher speaks of its lack it is nearly certain that the subjects have been approached from the structural instead of the functional side. The animal that the child has helped to feed and care for will call forth his interest and sympathy. To serve is more educative intellectually and spiritually than to receive service. Preaching and telling and reading avail little for the ethical training of children if not followed up by doing with definite ethical purpose.

Ontario. Form III *(5th and part of 6th years).*—Course of Form II continued.

Animal Life:—Adaptation of different kinds of animals to their respective habits and surroundings; birds, life-history of types, habits of wild fowl in different seasons; fish, forms and uses of different parts of the body, food and how obtained; life-histories of moths, butterflies, beetles and grasshoppers; useful insects, as ladybird and dragon fly; harmful insects; Nature's insecticides.

Plant Life:—Germination of seeds under controllable conditions and in the school garden and window boxes; opening of buds; study of the forms and functions of the parts of plants, and comparison of these forms and functions in different plants; observation of the culture of farm and garden crops and of orchard and shade trees; the observing and the distinguishing of the common forest trees.

Different kinds of soil, as sand, gravel, loam, leaf-mould and clay; experiments to ascertain how soils are composed, whether of mineral or of decayed organic material, and which best retains water. Additional phenomena of spring in the vicinity of the school, cause of snow melting, ice floating, etc.; how nature prepares the soil for growth of plants. Distinction between hard and soft, pure and impure water; tests and methods of purification of water.

Sources of heat:—Experiments to show the effects of heat in the expansion of solids, liquids, and gases; practical applications. Temperature; thermometer, construction and graduation. Methods of transmission of heat, conduction, convection, and radiation; causes of winds and ocean currents; ventilation.

GEOGRAPHY (*observational part only*): *The earth as a whole*.—The earth in space: Observation of phases of the moon; relation of the earth and moon to each other; rotation of the earth, direction, time and rate, effects; revolution of the earth, path, direction, time and effects; general observation of stars, difference between fixed stars and planets; observation of position of North Star. Observation and description of the occupations of men and of local industries, emphasizing those that are typical. Collection of pictures, sketches, materials, and products. Dependence of local industries and commerce on soil, climate and other local physical conditions; and consequent localization of settlement, routes of travel, mills, villages, towns and cities.

PHYSIOLOGY.—Continuation of Form II. Growth, waste and renewal of the body. Effects of narcotics and stimulants.

ART in relation to Nature Study is a continuation of Form II and the drawing of simple landscapes.

Manitoba. Grade Five (*5th year*). *See general notes.* The work from this on to the end of the course is called Elementary Science.

PLANT LIFE:—1. Trees. Care of individual trees, value of wind breaks, shade trees, bluffs, forests.

2. What becomes of the dead leaves, grass and trees?

3. Experimental work for the purpose of determining:—

(*a*) How many seeds will germinate out of a hundred seeds of each of the following: Stink-weed, Canada thistle, wheat, etc.? Recording results.

(*b*) What plants and how many are produced during one season on any small area?

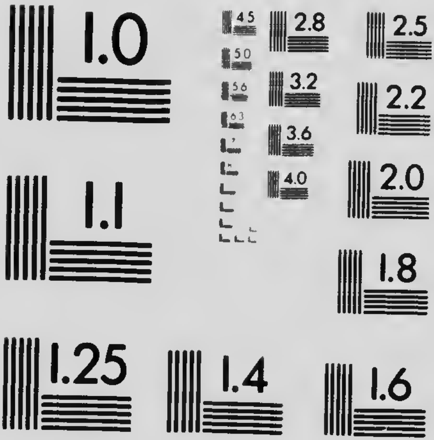
(*c*) Observation of the vegetation that will occupy a burned prairie, a burned woodland or a clearing.

4. Distinction between the root and the stem. Making a collection of roots and stems.

5. The study of leaves in relation to light. This work to be based on observation and experiment. The dandelion, bedstraw, horse-mint and shepherd's purse are suggested.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



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6. Comparative study of typical plants continued. Note resemblances and differences. At least eight plants to be considered.

7. Making a flower calendar for April and May, September and October.

ANIMAL LIFE:—1. The value of birds. Their protection.

2. How birds conceal and disguise their nests.

3. Study of some birds of prey: habits, structure, flight, sense-discrimination, cunning, etc.

4. The study of some of our winter birds.

5. Incidental observations of birds and conversations based on them.

6. Insect life in relation to shade trees—aphis-fly, caterpillar, and leaf-gall of the maple suggested.

7. Rearing mosquitoes and butterflies from eggs in order to obtain life-histories.

8. Recognition of the ladybird-beetle with a view to protecting it. Finding the larvæ on trees infested by aphides.

9. Observation of insect life in an old log, a rotten stump, a sand hill, etc.

10. Incidental observation of insect life.

11. A study of some of our mammals, as the deer, bear, wolf, rabbit, badger, gopher, etc.

12. A study of the common toad continued. Rearing the toad from the egg, the life of the young toad, the change from water to land, the life on the land. Domestication of the toad.

HUMAN PHYSIOLOGY—(*This must be taken*).—1. Our food and drink. Necessity of food and drink. The best kind of food. Cooking of foods. When and how we should eat and drink. Iced water, tea, coffee, candy, pickles, gum, tobacco and alcohol.

2. Digestion. Chewing the food, swallowing, the stomach. Hygiene pertaining to the above.

3. Breathing. Measuring the chest when the lungs are compressed and when the lungs are inflated. Number of breathing acts per minute. The importance of breathing good air.

4. The blood. (*a*) The pulse; number of beats of pulse per minute, when seated, when standing, when rested, when playing. (*b*) The veins and the arteries. (*c*) The heart.

5. The bones and the muscles.

PHYSICS: 1. The study of solids, liquids and gases as to characteristic properties.

2. Heat—sources, effects on solids, liquids and gases.

Grade Six (*6th year*). *See general notes.* PLANT STUDY:— 1. Experiments and observations to show the relations of water to plants, reference being made to the following:—

(*a*) The greater portion of the weight of plants is water.

(*b*) Vegetation is more luxuriant in damp grounds and in rainy seasons.

(*c*) The plants must have water.

(*d*) This water is taken in by the roots.

(*e*) The leaves and branches of plants are arranged to form a system of water-troughs.

(*f*) The water passes through the stem and the leaves in definite channels.

(*g*) The surplus water is evaporated.

2. An examination of the plant-societies found in some of the following situations:—

(*a*) By the roadside.

(*b*) Along a water-course.

(*c*) On alkaline grounds.

(*d*) On marshy grounds.

(*e*) In vacant lots.

(*f*) On the city boulevards.

(*g*) Along a portion of a railway track, etc.

In this study note should be made of the plants comprising each society; the plants predominating and thus giving character to the group. What conditions of sun, shade and soil seem to be most favorable to the well-being of each society?

3. Seed dispersal. By winds, by animals, by water, by special contrivances.

4. Comparing and drawing:—

(*a*) Cross-section of a young maple and a corn-stalk.

(*b*) The veining of the leaves of the above plants.

(*c*) The seed-leaves of a maple or an oak, and the seed-leaves of a grain of corn.

5. An acquaintance with the appearance of a mushroom, a bracket-fungus, a puff-ball, a horse-tail, and a fern, for the purpose of extending the meaning of "plant life."

6. The comparative study of the stink-weed and the shepherd's purse; the clover and the pea; noting resemblances and deepening the meaning of *relationship* among plants.

ANIMAL STUDY:—1. Special study of the nighthawk, wren, bluejay, and rose-breasted grosbeak.

2 Comparison of typical scratchers, climbers, waders, swimmers and perchers, noting common and distinctive characteristics.

3. Observation of the interdependence of insects and flowers.

4. Special study of the grasshopper. Finding the eggs, observing the young hoppers and the growth of their wings, the adult, the most favorable weather, food and how eaten, behavior in wet or in windy weather, etc.

5. Special study of the rabbit. Home and home life, habits, structure, enemies. A type of the "gnawers." Stories of rabbits.

6. What are our native wild animals? In what way are these animals adapted to the country?

7. What are the wild animals that formerly inhabited this province? Are their remains to be found? What led to their extinction?

PHYSICS:—1. Water, its use. Hard and soft water. The character of the wells and springs of the district.

2. Water as a solvent. The boiling of water.

3. Convection of heat. Reference to water and to air.

4. The heating and the ventilation of the school-room.

5 The lever in its three simple forms.

PHYSIOLOGY:—(*This must be taken*).—1. Foods and food materials.

2. Digestion.

3. Food habits and cooking.

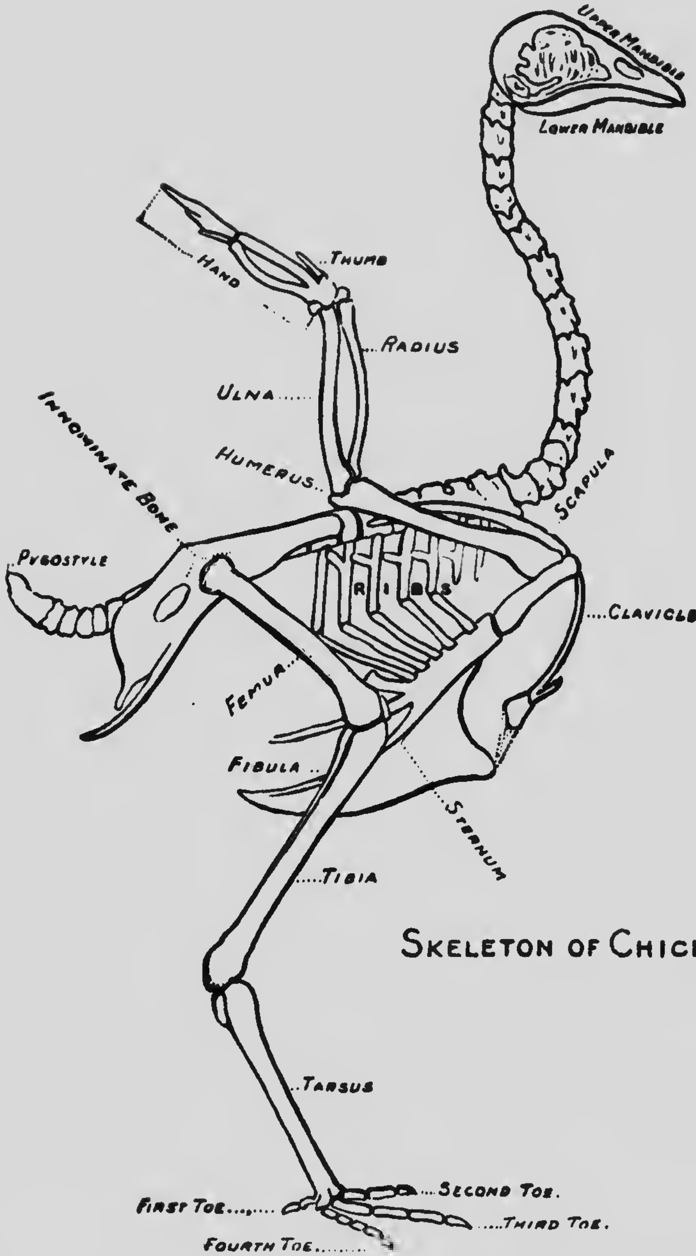
4. Circulation.

5. Respiration.

6. The framework and motion of the body.

Familiar Wild Mammals.—The observational study of the wild mammals and birds must be largely incidental. Trips a-field and excursions to the woods will seldom fail to afford observations that can be utilized as subjects for reflection and occasions to extend or deepen the sympathies. Some of these mammals can be tamed quite easily; frequently living specimens are kept for a short time caged or on a chain. But a squirrel, for example, on a revolving wheel, except for the opportunity of seeing it at close range, is a poor substitute, from the Nature Study point of view, for a squirrel in a beech tree. However, if opportunity offers to have a raccoon or fox, squirrel or gopher, brought to the school-house for a half day it can be turned to good use. Some kinds of squirrels overcome their fear of mankind if they are gently treated. A teacher in Ancaster Township told me an interesting story of a squirrel which her pupils studied. It made its home in the woodshed, and evinced no fear of entering the school-house at any time when the door was open. Silcox and Stevenson's "Nature Study," pp. 4-27, gives a brief systematic account of the common species of Canadian wild mammals.

Birds.—The robin and crow, particularly the former, may be made the subject of special study by nearly every school. Sometimes the opportunity for the continued study of some other species may be afforded by a bird-family's taking up its residence in the school ground. Individual pupils may be encouraged to make special studies of birds that nest near their own homes in places easily accessible for observation. In the educational exhibit at the Pan-American, Buffalo, the most interesting of a series of lessons reproduced by cinematograph and phonograph was a Nature Study one on the hen. She was brought into the school-room in a crate, through whose latticed sides she could be easily studied. In the parts of the lesson where it was necessary to handle her, her remonstrances were heard high above the children's voices, but they did not interrupt or disconcert the lesson. The outlines for a study of the hen in Forms I to IV will be found in "Public School Nature Study," pp. 34-38.

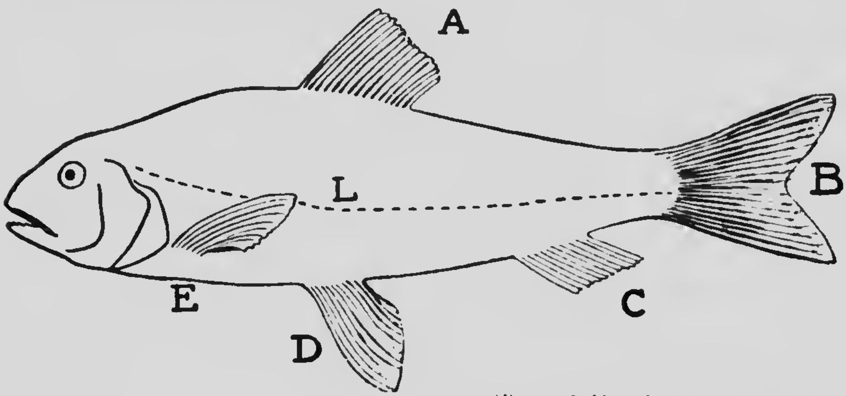


SKELETON OF CHICKEN.

(From "Public School Nature-Study.")

Fish.—Fish eggs can be hatched in the school-room if kept in a gem jar in clear cold water changed frequently. The writer has used eggs of trout which were packed in moss and received by mail. When the egg yolk is absorbed the young fish may be fed daily on boiled liver grated fine. After each feeding the water must be changed to keep it clear and cool.

Minnows may be put in the same aquarium with tadpoles and snails, but it is usually better to keep fish for study in aquaria or jars by themselves as cleanliness is absolutely necessary. Gold-fish and prepared fish-food can be bought cheaply from the dealers.



(From "Public School Nature Study.")

DIAGRAM OF A FISH.

A—Back Fin (dorsal).
B—Caudal Fin (tail).
C—Anal Fin.
D—Leg Fin (pelvic).
E—Arm Fin (pectoral).
L—Lateral Line.

Locomotion.—Buy or borrow a gold-fish, or have the boys bring in a fish from the stream. Study its movements in the largest glass vessel that you can get. Observe that it propels itself with its tail and balances itself with the other fins. By putting a rubber band over its paired fins in turn and so holding them flat against the body learn the particular use of each pair.

Breathing.—Oxygen is dissolved in the water where fishes live. Note the rhythmical movement of mouth and gills by means of which the fish bathes its gills with currents of water. This is its breathing. Explain that the red fringes of the gills do the same work for the fish that our lungs do for us. Infer the necessity for the frequent change of water in the fish jar. When a fish is left too long in unchanged water it pants for breath by moving its gills very fast.

The fish's sense of smell is located in its nostrils. With a bristle try to reach the mouth cavity of a dead fish through the nostril. Infer that this organ takes no part in breathing.

In studying the fish it is well to have a dead one for comparison. Has the fish eye-lids? Can it wink or shut its eyes? Can it roll its eyes around and look downward or upward or back? Can it turn its head? Account for the zigzag manner in which a fish swims.

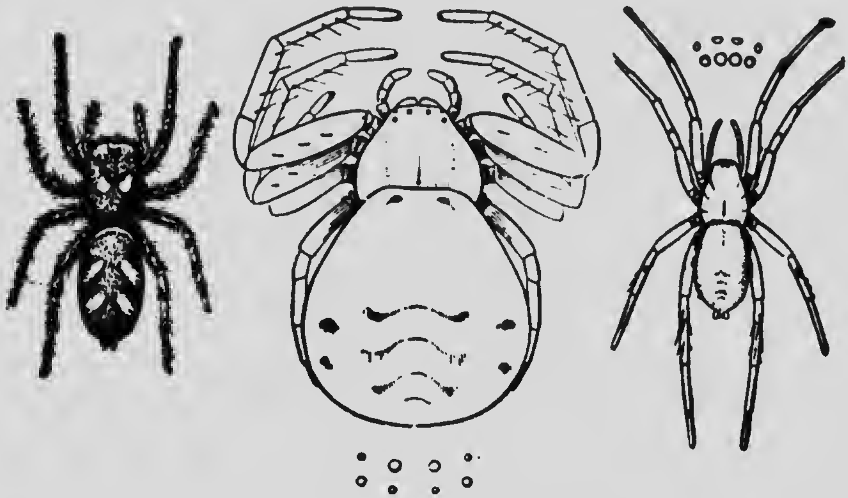
Feed the fish and watch it take the food. Examine the teeth in the dead fish's mouth.

Notice the scales, their arrangement, their edges, their shapes. Do they give the color to the fish's body? Where is the color darker? Being darker above they are less easily seen. Some fishes, as the catfish, like the frog, can change their color to suit their surroundings.

What advantage to the fish is its pointed wedge-shaped body? Observe the forking of the tail and the muscular part of the fish that controls it.

Spiders.—The study of the spider is prescribed in the Manitoba course. Foolish, although not inexplicable, prejudice exists against spiders, toads, garter-snakes and bats. It is worth while conducting studies on these interesting and useful animals if for no other reason than to remove the hatred and fear with which so many people regard them.

Some spiders are attractive on account of the remarkable beauty of their bodies, others for the wonderful webs which they spin. Some of them show much solicitude for their eggs and young; some of them brush their faces with their hairy palps, thus reminding one of the similar action of a cat. Gloves and stockings as curiosities have been woven out of the



(From "Guide to Nature Study.")

silk of their webs. In observing the adaptation to circumstances of their snaring operations one will hardly dispute them the credit of being the most cunning of all the articulates. After snaring their prey they pierce it with a pair of pincers (mandibles or jaws) each of which terminates in a minute hollow tube that conveys an atom of poison into the wound to paralyze the victim. A large spider might be able to puncture the skin of a soft finger and inject enough poison to cause some inflammation, hence children should be cautioned against handling large spiders carelessly. Any one may lift them and hold them in a fold of cloth or they may be dropped into a glass bottle for examination.

Why do they spin webs? What different kinds of webs have you observed and in what situations? How do they spin webs?

Some spin circular webs, others sheet webs, others funnel-shaped webs, and some do not make webs of any kind. Some kinds spin their snares, then lie in wait for luckless insects to be trapped; others watch for passing insects and then jump upon them. The spinners have usually three pairs of spinnerets on the abdomen covered with numerous hollow hairs. When they spin they exude through these hairs minute streams of a fluid which hardens and compacts into a very fine thread. Some kinds of spiders rise high in the air and float or are blown along with the wind as far as they wish to go. How can they perform this feat? To find out, fix a long broom-straw by a cork into a small bottle filled with water. Immerse the bottle up to or above the cork in a cup of water. Set the cup in an open window, release a captured spider, preferably of the smaller species, on the straw, and observe it, after making repeated unsuccessful efforts to escape from the base, ascend to the top and throw out a floater to carry it off through the air. Infer how the spider can stretch his web from tree-top to tree-top. If a spider is held by a hind leg with a pair of forceps it will commence to spin a thread which can be caught on a twig or straw and drawn out under observation.

Spiders' eggs are found in little silken sacs, a quarter to a half inch in diameter, hidden under loose bark or among stones, or hanging up in dark corners. These may be collected in the fall and kept in a dry place in a shed or cool garret until the spring. Then the capsule may be broken up and the hatching process observed. Not so many spiders will leave the box as there were eggs put in it because the survivors make their start in life by eating the late comers.

Compare the spider with the fly or bee as to means of locomotion, and as to food and how each obtains it. The spider has two main divisions of its body—cephalothorax and abdomen; the fly has three—head, thorax and abdomen.

The spider has eight legs of usually seven segments, the fly has six of four divisions. The spider's eyes are small, bright, separate, simple specks, two, four, six or eight in number; the fly's eyes are two large compound masses made up of scores of simple eyes. Emerton's "Common Spiders" (Ginn & Co.) is a scientific and attractive treatise.

Plant Life.—Individual and co-operative cultivation of plants along the lines suggested for the lower class should continue to lead efforts in this subdivision. Both Courses of Study emphasize observation of development. Use the comparative method. For the advanced classes strong and instructive contrasts are shown in the side by side development of oats and peas, or corn and beans, but for the younger pupils and especially rural school juniors, less common and less dissimilar plants are preferable. For the individual garden-plots plants should be selected with a view to easiness of culture, economic value and beauty of flower. Radishes, carrots and tomatoes—asters, salpiglossis and calliopsis—pansy, verbena and mignonette—are a few of the species that can be recommended for the gardens of pupils in this grade. Select a sufficient variety for comparison and maintain interest by the expectation of future reward of flowers or fruit.

Window Gardening.—In addition to the gardens, or in their absence plants may be cultivated in the school-room, either on the co-operative or individual plan. A rural school teacher reports success and satisfaction with the following experiment:

"On the next Monday after I had given an object-[illegible] the whole school on the way to fill a flower-pot in order [illegible] proper drainage and good soil, each one of the seven pupils in my [illegible] Class and six in the Junior Third, at my direction, brought a flower-pot or tin-can and the materials to fill it. I had a packet of garden balsam seeds and another of dwarf nasturtium ready to be sh[illegible] [illegible] among them. We took a few minutes and all went outside, [illegible] other pupils to act as witnesses, advisers and critics of the pla[illegible]. We had an old table upon which the thirteen pots and some boxes were set. This we could move from place to place or even carry outdoors. Several seeds of each kind germinated in every pot; they were finally thinned out to one of each kind, most of the removed ones being taken away to plant somewhere else. Each child watered and looked after his own pair of plants, and kept a record of the chief events in their development. There was a race to have the first to blossom. Some of them would like to have taken their plants home on Friday night, but I thought it better not to start that. Of course they were all taken away for the summer holidays. The whole school observed the differences in the leaves and the method of growth of the two kinds of plants. Several of the other pupils planted balsam and nasturtium at home, so after holidays we had an unlimited supply of flowers and stems for comparisons. Both kinds have spurred flowers and watery stems. The spur is above in one and below in the other, indeed the differences in petals, sepals, stamens, stigmas and ovaries made ideal lessons for the Fourth Class. Some of them watched the way insects entered and came out of the flowers, and proposed good reasons for the markings and shapes of the parts."

An empty fruit can with the top neatly cut and a hole broken into the bottom for drainage serves the purposes of window gardening in a school-room better than a small flower pot. The latter, unless varnished, is so porous as to permit excessive drying from Friday until Monday. It is a good plan to set school room plants on a movable table. They do better on a shelf placed four or five inches below the window sill than on the window sill itself because the pots are not so directly exposed to drying influences; then, too, they interfere less with the light and with the movements of the window-sash and blinds.

Continue observation of common native plants at flowering time and of flowering shrubs and trees. It is worth while to learn the names of these if for nothing else than that in future references the name will call up a more or less distinct image of the plant. The attention of pupils in this grade may very well be drawn to so much of the ecology of plants which they observe as to mark the dampness or dryness and the exposure to sun and wind of the situations which such plants prefer.

Assign studies based on the observation of pruning orchard-trees, seeding and planting, tillage, harvesting, threshing. Topics: the need of the process; the methods of performing it; the theory.

Seeds. *Germination of Seeds.*—The phenomena of germination afford a variety of observations and easy experiments.

Can seeds germinate without moisture? Try them in moist and in dry soil, or sawdust.

Do the seeds of dry land plants germinate in water? Why not? Infer that germinating seeds require moisture and air.

Experiment with seeds planted at different depths to call attention to the relation of heat to germination.

Shrunken, unripe, old seeds germinate slowly or not at all. Convenient seed-testers may be made as follows:—In a deep plate spread a thoroughly wet piece of flannel and on it place seeds of one or several kinds; lay another piece of wet flannel over them and cover with another plate or board. Carefully add water from time to time to keep the flannel moist. Compare the time the different kinds of seeds take to germinate. By actual count determine the percentage of good seeds.

A good germinator can be made of a fruit-can and a strip of flannel narrow enough to go easily into it. Fold the flannel length-wise six to eight or more times into lengths of four or five inches. Sew the folds across, $1\frac{1}{2}$ inches from one end, leaving the longer end to hang in water in the can. Put different kinds of seeds in each of the upper open folds; water will be constantly supplied to them by capillarity. A pair of hat pins passed through the folds may be used to suspend them in the can.

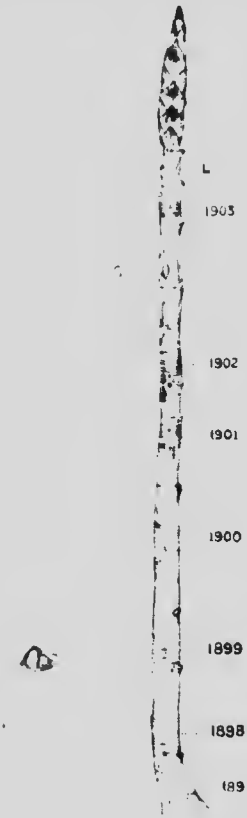
A method of observing the development of roots is to plant seeds against a slanting pane of glass. Cut away three-fourths or more of the side of a box. Substitute for the removed side a pane of glass moved inward at the bottom to give it a decided slant. Nearly fill the box with a dark loamy soil that retains water well. The roots in their downward growth spread themselves over the slanting glass and may be easily observed.

Storage of Seed Food.—Prove experimentally that shrunken seeds do not make such vigorous plants as plump seeds. Cut out the upper rounded end of a dozen grains of corn and plant them. Plant an equal number of unmutilated grains. Compare the seedling plants produced. Infer the use of the stored starch or oil or albumen in the seeds.

The Parts of Seeds.—Swell seeds to soften them. Observe the coats, the one or more seed lobes (cotyledons) and the embryo. Use peas, beans, morning glory, pumpkin, castor-oil beans, oats, etc. There is an interesting study of the morning-glory seed in McMurry's "Special Methods in Science," pp. 174-180. Consult any book on botany for the functions and names of the parts of the seed. For further help see "Public School Nature Study," pages 122-129.

Buds.—Buds of trees and shrubs in winter and early spring show conspicuous differences. Except two, all the species of maple can be more easily distinguished by their buds than in any other way, except by their fruits. Twigs may be cut off in February or March, put in bottles of water and set in sunny windows. Their development there is more closely observed and better understood than it would be out of doors. Buds of the tulip tree and buttonwood are peculiar; show these, if they can be had, and seek others to illustrate curious features of buds.

Twigs.—Leaves, flowers and fruit, when they fall off, leave distinguishable scars on the twigs. The bud-scales or bracts

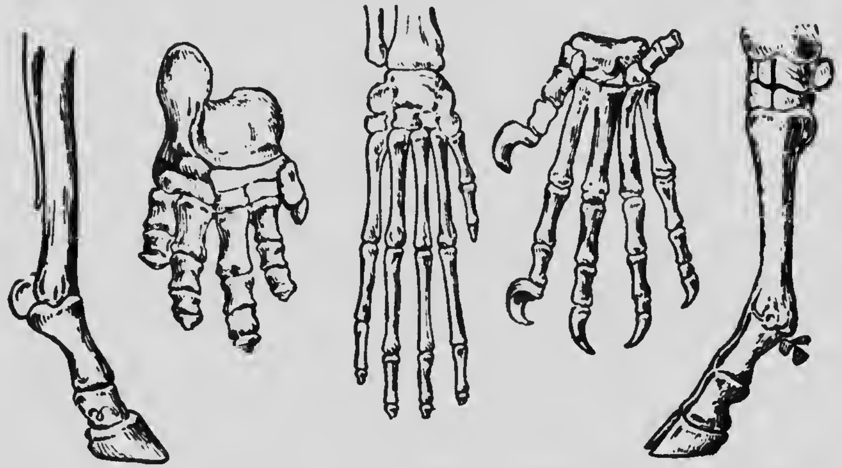


A beech twig 3 inches long, showing the annual extensions from 1897 to 1904-5. Scars of the bud scales opposite the dates. L, lenticels. S, a scale insect. 20 bud-scales shown on the 1904-5 bud. 2, 3 or 4 leaf-petiole scars on each annual extension.

also leave distinct markings by which the annual extensions of the branchlet can be read with certainty. Twigs afford interesting and instructive observations along these lines.

Selecting large buds of different kinds, as of beech and elm, study comparatively their shape, the scars left by fallen buds, the arrangement whether alternate, spiral or opposite, the outer and inner scales, whether hard or soft, thick or thin, smooth or hairy, etc., etc. In the book last named there are lessons on buds and twigs, pages 97-106.

Physiology. It has proved a good method of introducing physiology and hygiene to have the children compare their own bodies with those of well-known animals as suggested in the Manitoba Course. The comparison may profitably be begun



From Knight's "Introductory Physiology and Hygiene."

Hand, or front foot of various mammals. The first to the left is that of the horse, which walks on one toe (the middle) only; the next that of the elephant; the next, the ourangoutang; the next, the sloth; and last, the ox.

even earlier than there indicated. It not only teaches human morphology and organic function but also heightens interest in the animal studies. The child's arms correspond to the fore legs of quadrupeds and the wings of birds. The child easily infers that fact, but it does not surprise or please him nearly so much as when he discovers the joint that may be called the dog's or the cow's elbow or ankle as the case may be.

In this connection, either here or in the next class, the teacher may give some information if he proceeds to comparison of the human hand with the animal foot. Even in the highest public school class it will not likely be learned by the Nature Study method that the horse or cow has no collar-bone, that the horse's foot is the middle finger and his hoof is the finger nail of that digit. Such facts as these may be told in their right time. I say "will not likely be learned," because there is no saying how far some teachers and pupils may pursue an investigation. I have sometimes been astonished at the clearness and definiteness of the knowledge of a horse's skeleton possessed by a farmer's boy. His interest in the horse had led him to ask his father the names and uses of the parts when the skeleton had offered the opportunity or had caused him to pay close attention when it was described and discussed by others in his presence. Desired parts of the skeleton of the horse, the sheep or other domestic animal can usually be got in most of the rural school sections by inquiring among the boys. Some one among them usually knows where a skeleton is lying in the woods.

The practical study and hygiene of the sense organs as prescribed in the Manitoba course may be taken to mean the morphology of the parts visible without dissection and their proper care, testing and exercise. Most people get little more sense-training than nature gives them not because art is helpless to increase the acuteness of the senses but because it is not known how to use it or not thought worth while to take the trouble. The trained blind distinguish objects by touch, trained musicians, sounds,—trained artists, colors,—among which most people discern no difference. Training to increase the acuteness and usefulness of the senses must be done in youth if at all. Little if anything can be gained in this line after adolescence. Appereeiving may continue improving with experience, but it is doubtful that the power of perceiving does so after youth is passed. It is generally held, although the ground is debatable, that what sense-training can be done in the public schools is not very important and not worth the time it would take. If it be done at all it should be done in this grade. But whether or not sense-tests and exercises be taken for the purpose of sense-training excellent Nature Study lessons for the training of the mind through the senses and teaching how to take care of the sense organs may be taken up in this and the higher classes. Pages 4 to 13 of "Public School Nature Study" (The Copp, Clark Co., Limited) give an excellent series of Nature Study lessons on the senses and sense organs. There are good lessons on the hygiene of the sense organs in Knight's "Introductory Physiology and Hygiene."

Inanimate Nature and Geography.—The prescriptions under these headings are quite specific, and require the teaching of standard lessons in physical geography by the observational and comparative method. Concepts so far as possible are to be originated from out-door observations and experiences, and to be reviewed and expressed in the school-room. "Topics not directly within the range of the pupil's observation may be studied whenever the relationship is close to actual experience." As a mode of expression the Manitoba Course emphasizes modelling on the sand-board. Substitutes for sand are clay, putty and paper-pulp. A material called "plasticene" can be bought from dealers in school supplies. This substance remains plastic, and hence can be used over and over again; it is easy to mould, clean to work with, and can be spread on slate, wood, or cardboard. A little of it goes a long way, so that in the end it is not expensive. Objection is made to the repeated use of the same plastic material on the ground that diseased hands may render it liable to inoculate the hands of subsequent users. Manufacturers should incorporate some germicide capable of preventing that result. Clay may be got at the nearest tile or brickyard.

Systematic Weather Records.—For the making of these records some school boards supply printed forms. Pupils may rule such forms, each for himself, from a copy on the blackboard. In some schools a form is ruled on the blackboard, and pupils in turn under the criticism of the class fill the blanks. The chief objection to the last plan is the monopoly it involves of considerable blackboard space. Pupils in this grade are very well able to make and fill out forms ruled for a week as follows:

DATE.	CLOUDINESS.	WIND.		TEMPERATURE.	REMARKS.
		Direction.	Velocity.		

As a sample method of procedure, suppose that the record is to be made in a form similar to the above ruled on the blackboard. The observations may be made during the noon hour and immediately before entering school in the afternoon. The teacher, or pupils in their turn, may enter the report which is agreed upon by the class.

Cloudiness.—If the sky be clear the word "none" is appropriate. If it be cloudy, the nature and degree of cloudiness will be described in phrases or sentences by the pupils; the teacher will accept a correct brief phrase and gradually introduce the suitable technical term. In this way the pupils will learn the appropriate words to apply to the different kinds of clouds.

Thin, whitish, high, half-transparent clouds usually drifting easterly at an altitude of four or five miles are *cirrus* clouds. When banded and layered they are known as *cirro-stratus*. The whole sky may be thinly overcast or veiled with this kind of cloud. In such conditions, halos and coronas around sun or moon may occur. Sometimes the cirrus is broken up into little fleeces or bunches, *cirro-cumulus*, or flecked and speckled, and then it gives the effect called 'a mackerel sky.' Cirrus clouds consist chiefly of ice spicules.

Great rounded cloud-heaps, like immense fleeces, with flat bases are called *cumulus* clouds. To extensive cloud areas, seeming to be made up of masses of banded cumuli, the name *stratus* is applied. *Nimbus* is the cloud stratum from which rain or snow is falling.

It is not much trouble to collect a set of good pictures showing typical cloud-effects. The continued, intelligent observation of clouds, not to speak of its practical value, affords a constantly increasing source of pleasure.

Wind.—Only the suggestion is needed to get some boy in the class to make a wind-vane. It may be nailed to a suitable part of the school fence or set up on the wood-shed. It should be distant enough from the school-house, if not on it, to avoid the eddies caused by the wind's sweeping around corners. To determine the direction of the wind, besides observing the vane, pupils should be encouraged to notice the smoke as it issues from house or factory chimneys. The angle of ascent as well as direction of the smoke is important.

In the absence of an anemometer, the velocity of the wind may be approximated and described as calm, faint, gentle, moderate, strong, violent. The terms—air, breeze, gale and storm—with degrees indicated by adjectives, are used by seamen to describe twelve grades of wind-velocity ranging from calm to hurricane.

Temperature.—A thermometer should be hung outside on a shaded side of the building where the pupils who expect to be asked to report the temperature may easily consult it. If the school is possessed of only one thermometer, a monitor may be appointed whose duty it is to hang the thermometer out during the noon hour and bring it in when school is called.

The column headed *Remarks* should receive the record of observations of halos, sudden changes of wind or temperature, thunder-storms, rain or snow falls, and other noteworthy or unusual phenomena.

Excellent practice in comparing, relating and judging will frequently be afforded by noting those conditions which are usually followed in a day or two by rain, cold weather, or clearing skies.

In a rural school all the pupils in the Second Class may be observers during one week; those in the Third Class the following week, and so on.

Soil.—Have a hole, with vertical sides, dug in the ground to the depth of a foot or two. This may usually be done in some corner in the school-yard or at a convenient place outside of it. The digging of the hole will be fun to the boys of this grade while the other pupils are observing. Changes in the color and texture of the soil will usually be evident. Probably the surface layer is quite dark in color, below it a layer, somewhat paler will appear, and below that a yellowish or pale-grey or dark-red soil known as the subsoil. In some places gravel or hard-pan, or shale or even rock will be reached within a foot or two of the surface.[1] The pupils will note the color, feel the texture, and measure the depth of each layer. The series will probably be leaf-mould, loam, subsoil. Something of the origin of soil may be learned by observation, much more in some localities than in others, but in all more or less information will have to be given if the origin is studied in this grade.[2] Pupils ought to learn in some way that the subsoil and a large part of the surface soil are derived from the disintegration of rocks effected by such agencies as carbon dioxide, rain and water currents, wind and climatic changes, frost and ice. Three important soil-forming rocks are quartz, feldspar and limestone. Samples of these and other soil-

[1] See soil boxes, Nos. 1 and 3, opposite page 16. [2] See Field Excursion, page 165.

formers may be picked up in many school sections. Nearly every granitoid boulder, examples of which are scattered all over the country except in the sedimentary soil (*e.g.*, around Lake St Clair) will show quartz, feldspar (usually reddish in color) and mica (small glistening flaky particles). Try to obtain in some way, samples of these rocks for use in a lesson on the origin of soils.

Frost as a soil former is sometimes shown experimentally as follows: Take two or three pieces of porous stone and a piece of brick; wash them clean and then soak them for several hours in water. They imbibe better if not entirely covered with the water. Put each piece in a clean saucer and set them outside overnight or for two or three nights. In accounting for the particles of the rock that may be found in the saucers the pupils will discover how Jack Frost works as a soil maker. This experiment has to be done in the winter, the weather should be so cold at the time that the water will freeze before it has time to dry out.

Classes of Soils.—Returning to the hole, obtain samples of each of the kinds of soil observed; a quart tin-can or a gem jar full of each will suffice for co-operative study. To a small cupful of the subsoil add an equal volume of water. Stir it very thoroughly and pour off all but the heaviest layer into another vessel, add some more water, stir and pour off and repeat until you have only the *course gravel* left. What has been poured off should be saved, and after the sediment has settled and the nearly clear surplus water is poured off and thrown away a process of separation is gone through similar to the first until only the *sand* is left. The residue is *silt* and *clay*, which may be obtained by settling and siphoning off the nearly clear water. The three samples may then be dried and weighed or measured. This operation gives a mechanical analysis of the soil by sedimentation. Which ever constituent predominates gives its name to the soil, hence the classes gravelly, sandy, and clay soils. The operation is performed more quickly and with more certainty by using a set of three sieves. One with holes, 2 millimetres in diameter, keeps back the coarse gravel while it permits the fine gravel, sand and clay to wash through; the second, of 1 mm. diameter, separates the fine gravel, the third of $\frac{1}{2}$ mm. permits only the clay, silt and finest sand to pass, and the last may be separated by sedimentation. If the samples of gravel and sand be dried and weighed, and their weight subtracted from the total it gives the quantity of clay.

Humus. There is a fourth class of soils called vegetable or peaty soils, which, when mixed with gravel, sand or clay, make respectively gravelly, sandy or clay loams. Children do not find it difficult to discover the cause of the dark color of the surface soil. In talking about it with the teacher they learn to use the terms *humus, leaf mould, vegetable mould* and *loam*. If comparison is employed and children are asked to bring samples dug in various situations, one taken from the surface in the woods will be found to be almost wholly vegetable in its origin, and even less mineral matter will be found in one taken from the surface of a bog. The proportion of humus is determined by comparing the weight of the sample of dry soil with the weight of ash left when it is burned on a fire shovel over a bed of coals. It is easy to set up experiments to demonstrate that humus aids sandy soils in retaining moisture, and that it contributes to water drainage and air circulation through clay soils. It renders all soils more fertile than they would be without it. This fact opens the way to introduce fertilization. Why is it better for the gardener to bury the stems and prunings of plants in it than to burn them and scatter the ashes? What kind of soil—light or loose sandy soil or close grained clay—receives greater benefit from having straw or chaff worked into it? Humus, rough straw manure, leaves, etc., make the close clay mellower and more pervious to circulation of air.

A different way of teaching a classification of soils is to have the pupils bring samples one or more, or as many different kinds as they can find—from their homes. These may be brought in tin cans or strawberry boxes, or even paper bags. Collectors should be charged to note carefully or remember where each specimen was taken from and its depth from the surface. Each one may be emptied out on a board or slate and examined by the class as to texture, composition, color, and other qualities, and broadly referred to its class. By the time that a dozen or more unlike samples have been studied the pupils will have acquired considerable knowledge of soils and skill in classifying them. Typical specimens may be set aside in gem jars or boxes and labelled.

Water Capacity of Soils.—It may have been observed that a certain flower-pot dries out much more quickly than another of the same size. Why is this the case? The pupils may offer two reasons—(1) the plant in the first uses more water, (2) the soil in the second retains water longer. Let us experiment to find out whether some soils have more power to retain moisture than others. To-morrow bring samples of different kinds of soil in tin fruit-cans. Inquire who can bring clay loam: who, gravelly soil; who, leaf mould, etc. Before you fill the can make four nail holes in the bottom of it. We shall need to weigh the samples. Who will bring a spring balance? (Trustees will become willing to procure weighing appliances for the school when they hear how much you need them.)

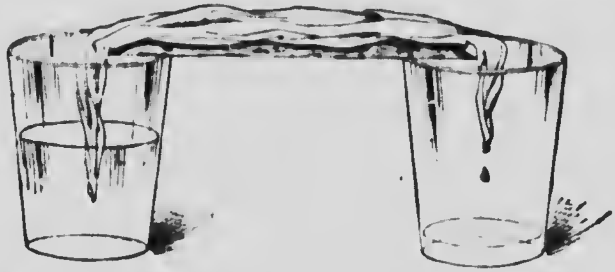
The samples are brought, saturated with water and weighed after the water ceases dropping from them. They are weighed on each of several subsequent days and the percentage of loss of weight calculated. These experiments will partly account for the high value of soils composed of humus, sand and clay in right proportion.

The experiment may be varied by using two samples of the same clay soil of equal weight and with equal quantities of water added, one being mellow the other pressed. This will show the greater retaining power of mellow over packed or sun-baked clay.

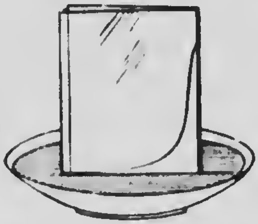
Field observations should be assigned when studying the important phenomena of water capacity of soils.

Other ways of determining the soil's capacity for retaining moisture may be proposed. Encourage pupils to suggest experiments; indeed it may sometimes be advisable to adopt an inferior method devised by the pupils than a superior one that you had thought of yourself. Propose yours and have both compared; try both methods. Here are a half-dozen samples of soil. After they are dried and crumbled weigh out a half-pound of each to be put in similar funnels, or lamp chimneys, or inverted ink bottles or tumblers or gem jars. Add to each a pint or smaller definite quantity of water and catch and measure the drainage. The less the drainage the greater the retaining power of the soil. If lamp chimneys or tumblers are used the ends or mouths must have cheese cloth tied over them; if ink bottles, the bottoms may be cracked off with a red-hot iron. All should have a fine wire screen or cheese cloth below the soil to hold it from coming out.

Capillarity of Soil. In some situations the subsoil serves like a floor to hold water, and the tilled soil draws it up to feed the roots of plants. This power of drawing up water is called capillarity. Illustrate it by hanging a damp cloth over



the edges of two tumblers, into one of which a quantity of



water is put, or by setting up in a saucer of inky water two small squares of glass touching at one edge and separated slightly at the other. The black water will rise nearly to the top at the edges in contact. An oven-dried brick may be set on end in a saucer of water to exhibit the same phenomenon.

Take one of those tin cans with the holes in the bottom used in the last experiment. Fill it with quite dry soil and set it in a saucer of water, adding water from time to time if necessary. Lay a pane of glass over the top of the can and observe when moisture appears. The can of soil may be weighed before and after to determine the weight of water absorbed by capillarity.

If lamp chimneys are used and different kinds of soil put in them the pupils may observe the different degrees of rapidity with which the water ascends in each. They can infer that the faster the water comes to the top the more rapidly it will evaporate at the surface, and hence why sandy soils dry so much more quickly than clay ones. The pupils have already seen how much faster water drains downward through it.

Why can sandy soils be tilled earlier in the spring than clay ones? Why do the former suffer more in seasons of prolonged drought?

Soils as Conductors of Heat.—The construction of a hot-bed, or the setting of a lamp under a pan of germinating seeds, may have attracted attention to the relation between warmth and the growth of plants. To study the part the soil plays in conducting heat, set on a hot stove three similar fruit-cans filled to the same height with dry sand, wet sand, and water respectively. Why does the sand in both cases heat more quickly than the water, and why does the dry sand heat more quickly than the wet?

Set on a hot stove cans containing similar quantities of different kinds of soil, all equally dried, to determine the conducting power of each kind. As a test, tablets of lard or soft wax may be laid on the surface of each sample, or thermometers if you have them, or can borrow them, be covered near the surface. Another way is to heat the different samples to the same temperature, then remove them from the fire to learn, with the aid of thermometers plunged in them, which kinds cool the more rapidly. Make further inferences as to the respective advantages and disadvantages of sandy and clay soils, and the value of drainage.

Acidity and Alkalinity of Soils.—Vinegar is *acid.* Dip blue litmus paper in it and observe how quickly the paper reddens. Lye is *alkaline.* Nearly fill a fruit-can, having holes in the bottom, with hardwood ashes. Pour water on the ashes and allow it to leach through into a tumbler; pour the water back and let it leach through again. Notice how this lye, in the proportions of about a teaspoonful to a quart, softens hard water as shown when soap is used in it. Dip red litmus in the lye and observe how quickly the paper turns blue. Mix some of the lye and vinegar and test the mixture with the litmus paper. You may succeed in making a *neutral* liquid.

Peaty soil in which water has been standing does not yield a vigorous growth of cultivated plants. Sometimes it seems to smell sour. Lay a bit of blue litmus paper between two moist lumps of it. If the paper reddens acidity is proved. Such soil should be sweetened, in other words, rendered neutral or slightly alkaline. Infer from the experiment the effect of scattering ashes or lime over sour soils. Soils that in some parts of the country have borne many crops of vegetable matter, and that have had little rain to leach off the ash equivalents, have become very alkaline. The best soils are either neutral or slightly alkaline.

Heavy and Light Soils.—The farmers call sandy soils *light* and clay soils *heavy*. Weigh a fruit-can full of dry sand, empty and refill it with dried clay. Which weighs heavier? This experiment shows us that it is not the weight of the soils that gives them these names. Roll some wet sand into a marble; roll a bit of wet clay into a marble. When the marbles are dry or nearly so which breaks up more easily? Which is easier to dig or hoe in—sand or clay? These experiences show us why the farmers call sandy soils light and clay soils heavy. Studying the marble of clay may teach us that we should not work clay soils when they are wet.

Rub some clay into a gem jar of water; shake it well, then add some lime and observe the result. Recover the clay by sedimentation and after it has dried to the proper consistency make another marble. Infer the effect that lime has upon the stickiness of wet clay soils.

Drainage.—Review experiments, or make new ones to supplement observations, to determine the value of drainage. When the cold early-spring waters are drawn off warm rains and warm air fill into the soil and impart their heat to it.

Packing is prevented; mellow soil retains moisture better than packed soil. The circulation of air in the soil returns ammonia to it, stimulates chemical changes that contribute to plant growth and nourishes nitro-bacteria, but these important facts cannot be taught experimentally at this stage.

Encourage observation of drain-making. Have pupils learn how the digger determines the slant in the bottom of the drain to make a proper fall for the water. The channels may be made of tiles or stones or wood. If convenient, visit a drain-maker at work. A teacher, assisted by his pupils, in Lambton County tile-drained the school yard into a road-side ditch.

Correlate Observation with Experiment.—As has been already stated experiments should not be made merely for the sake of making them. The need for an experiment on soil should arise naturally in some study or discussion of plant life. It should seek to answer a question and, when successful, should be applied in as many ways as can be conceived. The need for an experiment may create the need for, and may maintain interest in, a series of which it may be near the beginning, middle or end. A need does not usually arise by accident; the skilful teacher anticipating it, selects a path that leads his pupils, unwittingly it may be, to the issue he desires. Experiment and observation should mutually reinforce each other. While the experiments with soils in fruit-cans are in progress their correlatives, taking place on a large scale on the adjoining farms, should be observed and discussed.

Water.—*The Volume of Equal Weights of Water and Ice.* A glass bottle filled with water has been burst by the frost, hence the opportunity to introduce the lesson.

What follows when a water-soaked porous rock is subjected to hard frost? In another lesson it was seen that soil may be produced by such action.

Try to borrow a stone-chisel and hammer to drill a hole, widening downward into a lump of limestone or other kind of rock. Fill the hole with water and set it out to freeze solid. Observe the result.

What kinds of water containers are sometimes burst by frost? Lead-pipes, pails and iron pots may be mentioned.

Float a cube or other easily measured block of ice in cold water. Obtain the ratio of the height of the emerged part to the height of the whole block.

Measure the cubic contents of the block of ice and weigh it. Melt it and weigh the resulting liquid. One cubic foot of water weighs 1,000 ounces; calculate from this fact the volume of water obtained from the ice.

The experiments, if carefully made, should show that there is no loss of weight due to melting, but the volume is reduced one-eleventh. Compare this ratio with that of the height measurements.

Now have pupils infer why ice floats in water, how it can make soil out of rocks and burst vessels of glass, wood, lead and iron.

The Weight of Equal Volumes of Water and Ice.- Apply your experiments to determine the weight of eleven cubic feet of ice.

What volume of ice will ten cubic feet of water make?

What weight of water will be obtained from melting a block of ice 3 feet long, 22 inches wide, and a foot thick?

If you have the means of weighing a piece of ice, both in air and in water, determine its *specific gravity* by dividing its weight in air by its loss of weight when weighed in water. The ice has to be loaded to cause it to sink. Or, float the ice in a vessel brimful of water; prepare to collect the overflow that will occur when the ice is pushed under the water. Add the weight of the overflow to the weight of the ice to get the weight of water displaced.

A lump of ice weighed $34\frac{1}{2}$ ounces; the overflow of water weighed 3 ounces. The specific gravity of the ice was $34\frac{1}{2}$ divided by $34\frac{1}{2} + 3$, which gives 69 seventy-fifths or ·92. Using the specific gravity, find the weight in ounces of a cubic foot of ice.

What if Water Shrunk in Freezing?—Water expands in volume as it freezes, hence ice floats.

If water continued contracting so that its bulk in ice were less than in the liquid form would it float?

If the ice in the ponds and rivers and lakes kept sinking as s formed what would happen to the fish? If the pond or lake were frozen from the bottom to the top how would its thaw g be affected.

Convection.—Water at or above 39° F. is expanded by the application of heat. Expansion makes it lighter, and hence the water touching the bottom of a pot on a hot stove ascends as it warms and thus allows colder water to take its place. Apply this to warming an upstairs room with water heated in the basement and to boiling the water in a tank by means of a pipe passing through the stove.

Heat Expands Solids and Liquids.—Insert a small-bore glass tube through a perforated cork. Push the cork into a bottle filled with water colored with dye or potassium permanganate. The water will rise in the tube as the cork enters the bottle. Warm the bottle and observe the consequent rising of the liquid in the tube; cool it and observe it descend. Compare with the movement of mercury or spirit in a thermometer.

Make a ring on the end of a wire that will *almost* let a marble drop through. Hold the marble supported in the ring over a flame, and show it fall through by the heat caused enlargement of the ring. Lead pupils to the induction that heat causes expansion of bodies whether solid or liquid. Deduce practical applications, such as loosening the metallic top of gem jars, setting buggy-tires, starting ground-glass stoppers, etc.

In Winter the Coldest Water is not at the Bottom of the Lake.—Choosing a day when the thermometer stands about 32° F., set the bottle of colored water, referred to on the preceding page, with the liquid standing high in the tube, on the outside window-sill. The pupils may observe the liquid descend until the thermometer falls to 39° F.; then, if the adjustments are all good, the water will begin to rise.

Lead the pupils to see that water contracts as it cools to 39° F. When it gets colder than that it expands and, like ice, will come to or stay at the surface. The surface layer is converted into ice but the layer at the bottom does not get any colder than 39° F. How does this affect the life of the fish? Why can no ice form on the lake until all the water in it has cooled down to 39° F.? Lead the class to see that the Great Lakes give off enormous quantities of heat and thus temper the winter climate of adjoining regions of country.

Freezing and Boiling Points.—Immerse the thermometer bulb in a mixture of snow or broken ice and cold water. Note its reading.

Put the bulb in boiling water and note its reading.

What is the temperature of water when it is passing from the *liquid* to the *solid* form? When passing from the boiling liquid to *vapor*?

A study of the thermometer may be made here, and if Fahrenheit and Centigrade scales are both to be had they may be compared.

Evaporation. Boiling water passes off into transparent *vapor.* Frequently this vapor condenses and becomes visible; then we call it steam.

Use a wet cloth on the blackboard, or pour some water on a slate. In a short time the water dries off or evaporates. Can water evaporate without being heated?

The more quickly it evaporates the drier the air is. When water evaporates very slowly outdoors rain is probable.

As a rain-indicator, experiment with a wet slate set outdoors in a calm place, noting how long it takes to dry off.

Snow and ice may evaporate without passing into the liquid form. Let a layer of frost form on a wet slate, and leave it outside during a winter night in a dry place, or let a sprinkling of snow fall on it, and then set it aside in the wood-shed for a day. The ice or snow will evaporate without liquefying.

Condensation.—Breathe on a cold slate. Explain the observed result.

Can you see your expired breath in the warm school room? Can you see it if you go outdoors on a frosty morning? The vapor of the breath condenses into steam in the cold air.

When a pitcher of cold water is set on the table it becomes coated with dew. Whence comes the dew?

What part does condensation play in the working of a steam engine?

Connect studies of evaporation and condensation with studies of clouds, rain, dew, fog, etc.

Water takes up and gives out Heat.—Sprinkle water of the same temperature as your hand on the back of it and hold it still until the water evaporates. Does the water feel cold as it is evaporating? Water always takes up heat when it is passing into the state of vapor.

Put some lumps of ice in water and set the dish on the stove. Test the heat with a thermometer. Test it again when half the ice is melted. Why does the thermometer show the same reading as before? Because all the heat that the water received has been used to convert the ice into water.

Water in going from ice to liquid and from liquid to vapor takes up heat, and when it is coming back from vapor to liquid and from liquid to ice it gives out just as much heat as it took up.

Connect this with the fact that when clouds are forming for rain, temperature rises: when water is passing off into vapor, temperature falls.

Why does it cool the school-room to sprinkle the floor with water? Would sprinkling it with hot water cool the air in the room? Is a feverish brow cooled by bathing it with warm water and allowing the water to evaporate?

Get the advanced classes to see that the water in the atmosphere is the great equalizer of heat. When the air gets cold its intensity is arrested by condensation; when it gets hot the intensity of the heat is checked by evaporation. Were it not for this equalization the extremes of temperature would render the globe uninhabitable.

Sources of Fresh Water.—How does the atmosphere become the great distributer of water?

What are the sources of wells, springs, rivers and lakes?

Hard and Soft Water.—Where do we get soft water? Where, hard water?

But we saw that rain was the original source of well-water. What has made it hard?

Here is a basin of water. How can you tell whether it is soft or hard? By testing it with soap. If it will not make a frothy sud or lather with a small quantity of soap, the lime or magnesia which has made the water hard has used up—*i.e.*, has wasted—the soap or part of it.

How may soft water be made hard? By adding an extremely small percentage of lime to it.

How can hard water be made soft? By boiling it. This can be proved by the soap test. The reason is too difficult to be taught experimentally in this grade. The lime in hard water is held in solution by free carbonic dioxide; the heat drives this gas off and the lime settles to the bottom of the kettle. Water can be softened chemically and strangely enough one method is to add more lime, enough to use up the free CO_2 and then all the lime is precipitated.

Why is water in the lakes and rivers softer than what is in the wells? (Well-water where there is no limestone is not usually hard.)

How comes the well-water to be so clear? Try to construct a filter of sand and earth and crushed charcoal. Put in turbid or chalk-whitened water and catch the clear filtrate.

Uses of Water.—What are the uses of water in the household, on the farm, and in the factory?

How is mankind served by water in the ocean, in the lake, in the river; by falling water, running water, still water?

For what purposes is the solid form particularly useful? The gaseous form?

Why cannot plants and animals live without water?

What is meant by the old saying that water and fire are man's good friends but bad enemies.

Potable Waters.—Why should drinking water be pure and clean?

Waters that are "riley," discolored or possessed of taste or smell, are not always or necessarily unwholesome. Waters that look clear and transparent may contain disease germs. Many people have an erroneous notion that a powerful microscope will reveal living forms in any and every drop of water. In most samples of ordinary drinking water, when taken from the well or river or lake, the best equipped examiner might search a long time without finding a single living organism. Some open springs and forest rivulets abound in microscopic life, and yet people derive no harm by drinking water from them. Generally, however, waters that contain life that can be seen with the microscope are not safe to drink.

Reservoirs of drinking water are lakes, streams, springs, dug wells, artesian wells, rain cisterns, surface-water cisterns, cisterns for hauled-water. (To many people, clear sparkling, hard water is more palatable than clean rain water, but it is not more wholesome.)

What causes may make water taken from each of these sources of supply unwholesome or of suspected purity?

Tests of Purity.—Water may contain mi eral impurities, vegetable impurities, animal impurities.

Dissolved minerals remain and may be seen when water is evaporated in a clean glass vessel.

Organic impurities—vegetable or animal—are probably present if any odor develops in a sample of water kept in a warm place for a day or two in a clean, tightly-corked bottle Such impurities are present if a two or three hours' exposure to light bleaches out the purplish-pink color imparted to the sample by a few drops of solution of potassium permanganate. In a teaspoonful f the water dissolve a few crystals of the salt just named. Have a sample of the water to be tested in a clean bottle or clean cup. Add the solution, drop by drop, until the sample becomes pink. Set it in the light, protected from dust. Organic matter will bleach out the pink color and usually settle to the bottom. Nessler's test for ammonia in water is described in nearly every text-book on chemistry.

A certain farmer of the writer's acquaintance had always watered his horses and large herds of dairy cows at a pond not very distant from his stables. In an unusually dry season the pond failed, and he had to drive his stock a mile or more to a river. Shortly after his cows began to drink the purer water he observed a marked improvement in the milk and butter. This fact convinced him of the value of good water for the farm animals. He drained off the pond, dug an expensive well, and had a windmill erected to pump the water for his stock.

Pages 171 to 182 of "Public School Nature Study" give a series of good lessons on Convection, Evaporation, Condensation, Clouds, Dew, etc.

Water is taken in the preceding paragraphs as a sample of a series of lessons on *common objects* by the *Nature Study method.*

Observation and experiment, investigation and experience, now one and then another, are to be exercised so far as possible at every step. Information outside of the pupils' means of acquiring it by investigation may be given to prepare the way for steps that they can investigate. Looked at from the science side these are studies in physics and chemistry, geography and hygiene, agriculture and domestic science; from the Nature Study side, water is simply an interesting and important object in the child's environment.[1] The teacher seizes upon and uses the points of interest to the child and those capable of practical applications in the home life. Not all these lessons

[1] Nature, as she thrusts herself upon the attention of children, is neither classified nor bookish. Nature shows herself as an interesting collection of physical realities, and it is only little by little that children discover and recognize the threads of system running through these.—McMurry's "Special Methods on Science," p. 12.

are suited to the same grade of pupils, nor equally to the same season of the year. Indeed they should not be called lessons for they are only broken outlines and suggestions of lessons. Even as a list it lacks completeness. The same teacher, owing to varying circumstances, would make a different selection from those given here and introduce different additions in one school from what he would do in another. Nothing has been said about *expression.* A Fourth Class or a Senior Third, after going through ten or a dozen of these studies, should be able to compose an illustrated and very readable essay on "Water."

Study of Glass. —As an example of treatment of another common object see pages 32 and 33 for an outline study of *glass.* The references there relate solely to the arrangement and composition of the expressive parts; they do not show the chronological order of the studies.

We may assume that the occasion to study glass arises out of the accident of a broken window-pane. The alert teacher will see that the replacing of the pane is made the opportunity of a Nature Study lesson. The old pane has to be removed; the sash may have to be t. .en out. Fortune favors if the new pane is too large and has to be reduced in size. The broken glass will do to practise on. It will be unsafe to risk operation on the new pane before success in manipulating the broken pieces gives confidence in the method. "The scholars," writes a teacher, "are proud of their achievment. We used hot water to loosen the old putty, collected it and hammered it into powder and put some oil in it; we cut an eighth of an inch off the end of the new pane to get it to slip in, and temporarily secured it with the new-old putty. They are even prouder of their puttying than of their glass-cutting."

This is a start. The teacher may resolve to make further educative use of glass and, therefore, keep on the outlook for opportunities or go out of the way to make them. An oldfashioned object lesson may be based on the fragments of the window-pane at the time they are obtained, or they may be kept until further experience has increased interest and practical knowledge of glass.

We can see objects through it, therefore we say it is *transparent*, hence it is useful for windows, lanterns, spectacles, etc.

We feel it and say that it is smooth and hard; we taste it and smell it and say that it is tasteless and odorless; hence it is useful for drinking vessels and the tops of certain kinds of tables.

Submitting it to comparative tests along with iron, tin and wood it is seen to resist better than they the corroding action of acids, hence its value for bottles and preserve jars.

If heat be carefully applied, it stands a great deal of it before yielding, but when white hot it can be bent, and when molten it can be moulded, hence its value for test-tubes and hollow rods, and many kinds of scientific apparatus.

Why is glass difficult to cut and bore? Why is it used to cap the supports for the wires on telegraph poles? Why does it sink when dropped in water?

To bore glass—use the corner of a newly-broken triangular file, keeping the point of contact wet with water or turpentine, or turpentine and camphor.

To grind the surface or edge of glass—rub one piece of glass on another, keeping emery and water between them.

To etch glass—coat it with wax or paraffin, write or draw with a needle or awl, and etch by floating diluted hydrofluoric acid over the engraving. Rinse the acid off with water and then remove the wax.

To silver glass, lay tin foil smoothly over it, pour some mercury on the foil and leave it a few hours preferably under pressure. Drain off the surplus mercury.

Other Object Lessons.—Lessons similar to those on water and glass may be based on a great variety of objects, natural and artificial, such as coal, salt, paper, iron, stoves, wire, wood, chairs, pails, wool, hats, umbrellas, rubber, sulphur, soap, sugar, &c.

Method.—Seize occasion of interest as opportunity for introducing the topic. Appeal to observation. Leave pupils to make inferences or hypotheses. Use experiments for illustration or for proof or refutation of inferences. Search for practical applications of the truth inferred. Express in suitable modes.

Heating and Ventilation of Living Rooms.—Refer to known examples of different methods of heating—open fireplaces, stoves, furnaces, steam, hot water. Heat from the fireplace like that from the sun comes in rays, radiates, or is *radiant.* Such heat passes through the air without much decrease and is absorbed or reflected by denser bodies. It is a healthful mode of heating because the objects, including the people in the room, are heated more than the surrounding air. It is [illegible] to feel comfortably warm in a cool atmosphere.

Air heated in a furnace in the basement *conveys* the heat to the living room. It feels comfortable but it is not stimulating.

Heat is mostly radiant but partly conveyed where stoves, steam pipes and hot water radiators are in the room.

Ventilation.—In school-rooms it is very important that fresh air be supplied in large quantities. Count how many times you breathe in a minute. Fill a bottle with water, invert it into a basin of water. Expire a breath through a rubber tube into the bottle. Measure the displacement of water to find how many cubic inches you expire with each breath. Four per cent. of that is vitiated product, mostly carbon dioxide, in place of the oxygen you used in your lungs. Find how much impurity each pupil breathes into the room per minute and multiply that by the number of pupils in the room to find the total vitiation. Air ceases to be fit to breathe before the impurities increase to ten cubic feet in ten thousand. From these investigations the Fourth Class can calculate how much fresh air should come into the room every minute, and of course the same amount should pass out to make space for the pure air to get in.

Measure the incoming or outgoing current by the deflection of a candle flame. If you carry a candle through the room at the rate of 100 feet in 15 seconds will it blow out? Compare the result with observed effect, setting the lighted candle in the ventilator and thus estimate the rate of current. The area of the ventilator and the rate of current enable you to tell the quantity of air passing. The Ontario school law prescribes that it shall be at least one-twentieth of the capacity of the school-room per minute.

Bring a ten-ounce bottle filled with water into the room. Empty it there so as to fill it with the air you wish to test. Put in a half ounce of limewater and shake thoroughly. If there is enough carbon dioxide in the bottle of air to make the limewater milky the air in the room is too foul for the health of the pupils. Observe the effect on limewater of passing the breath into it through a straw or tube.

Close the ventilators, and charge the air in the room with smoke. Open the ventilators; if the room takes longer than twenty minutes to become perfectly cleared of the smoke the ventilation is below requirements.

The best test is one that compares the quantity of air circulated with the quantity of impurity put into it. This admits suiting the amount of ventilation to the number of pupils in the room. Children grow better, have better appetite, and are better nourished in a well-ventilated school-room than in an unventilated one. The author of a treatise on ventilation[1] says children can learn six times as much in pure air as in a crowded unventilated room.

Ontario. Form IV. *(Part of 6th Year and 7th Year.)* NATURE STUDY. Course of Form III continued. ANIMAL LIFE.—Relation of fish, birds, and wild animals to man; life histories of conspicuous and economic insects; organs and functions.

PLANT LIFE.—Study of organs of plants and their functions; study of economic and wild plants from seed to fruit in the school-garden, home-garden, farm and forest; weeds injurious to crops and methods of destroying them; buds and twigs; wood, rings, grain and bark, uses, etc.

INANIMATE NATURE.—Observing local minerals and rocks, their properties and uses; experiments to show composition of soils and their relation to drainage, temperature, etc; varieties of soils adapted to different crops; fertilizers, etc. Implements and tools used on the farm and in the household, mechanical principles applied in their construction.

The atmosphere; its composition; combustion, simple experiments, study of candle flame products; changes produced in the air by respiration; reciprocal relation of plants and animals as regards the atmosphere; impurities in air.

PHYSICS.—Gravity; air and liquid pressure, the barometer. Cohesion and adhesion, the nature of these forces; phenomenon of solution and diffusion; amorphous and crystalline forms of matter. Practical use of heat, steam and electricity in connection with the study of industries.

In GEOGRAPHY the observational work of Form III is continued. Observations of the more prominent star constellations and the evening planets. Weather observations.

In PHYSIOLOGY.—Bones and muscles; circulation and respiration, ventilation; exercise; hygiene of the vocal organs and nervous system. Narcotics and stimulants.

In ART.—Course in Form III continued.

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[1] "Ventilation of School Buildings," Morrison, p. 23.

Manitoba. Grade Seven. *(7th year.) See general note.*

PLANT STUDY.—

1. How plants obtain food from the soil.—
   - (*a*) some substances are soluble and others are insoluble in water.
   - (*b*) The former substances pass readily through the roots.
   - (*c*) The food is left in the plants when the water has evaporated.

2. Uses of roots.—
   - (*a*) They fix the plants in the soil.
   - (*b*) They obtain nourishment from the soil.
   - (*c*) They act in some cases as storehouses.

3. Leaves.—
   - (*a*) Classified as persistent and deciduous.
   - (*b*) Classified as foliage-leaves, scale-leaves, bract-leaves, and floral-leaves.
   - (*c*) Parts—blade, petiole, stipules.
   - (*d*) Study of form and venation.

4. The arrangement of leaves as represented by the bedstraw, anemone, shepherd's purse and the mint.

5. The meaning of spines, tendrils, prickles and hairs.

6. The distribution of plant-life as follows :—
   - (*a*) Where is plant-life most vigorous? Why?
   - (*b*) Where is plant-life least vigorous? Why?
   - (*c*) What locations have the greatest variety of plant forms?
   - (*d*) What locations have the least variety of plant forms?
   - (*e*) What plants are found in the woods?
   - (*f*) What plants are found in the alkaline grounds?
   - (*g*) What plants are found in the cultivated fields?
   - (*h*) What plants delight in a northern exposure? Why?
   - (*i*) What plants delight in a southern exposure? Why?

7. The simple classification of fruits, the pupils to determine the basis of classification.

8. Observation of the order in which flowers open, reference being made to the shepherd's purse, the three-flowered avens, the buttercup and the dandelion.

9. Flower arrangements, reference being made to the mustard, the yarrow, the sunflower and either the carraway or the meadow parsnip.

Animal Study.

1. The food supply of some of our wild birds. A commencement to be made in this grade and continued in the next.

2. A special study of the cat-bird, the downy woodpecker, the flicker and the tame or the wild pigeon.

3. What birds tenant the nearest groves?

4. The relation of the English sparrow to our native song birds.

5. Study of the cockroach and the field cricket.

6. Simple classification of insects according to the character of the wings. The following is suggestive: Dragon fly, locust or grasshopper, aphis, potato-beetle, moth, house-fly and ant.

7. The insect pests of the ash-leaved maple and other shade trees.

8. The appearance, habits, food, home, etc., of the earthworm. The value of the earthworm to man. Difference between an earthworm and a caterpillar; between a spider and a grasshopper.

9. The gopher and the grain fields. The badger and the grain fields.

10. A comparison of the gopher and the red squirrel.

Inanimate Nature.—

1. Study of the soil (see pages 93 to 101). Testing the productiveness of the following by planting the same kind of seed in each:—

(*a*) Clay.

(*b*) Sand.

(*c*) Clay and sand.

(*d*) Humus.

(*e*) Clay and humus mixed.

(*f*) Sand and humus mixed.

(*g*) Clay, sand and humus mixed. Applications.

2. Sun-drying a pound of each of the above. Finding by weighing the dry remnants the amount of water lost in each case. Experimental work for the purpose of ascertaining which of the above will retain the moisture the longest when subjected to the continued heat of the sun. Applications.

3. Have the natural features of the district determined to any extent the locations of the dwellings of the people, the proximity of timber, of springs, of streams?

PHYSICS.—

1. Distillation. Meaning of term. A method of distilling. The story of a rain-drop.

2. Evaporation, reviewed, enlarged and applied.

3. Capillarity as shown by a lamp-wick. A piece of blotting paper. A lump of sugar. A cotton cloth. The soil. Applications.

4. The meaning and the value of the forces of adhesion and cohesion.

5. The pulley and the wheel and axle.

Grade Eight *(8th year).* AGRICULTURE Outlined as follows:—

1. The plant, including the seed, the young plant, the plant and the water, the plant and the soil, the plant and the air, the structure and growth of plants, naming and classifying plants.

2. The soil. Nature and origin of soil, tilling and draining the soil, improving the soil.

3. Wee

4. Insects of the fields.

5. The rotation of crops.

6. The garden.

7. Bees and birds. The food supply of our wild birds, continued from Grade Seven.

8. Forestry.

9. Roads.

10. The country-home.

11. The science of every-day-life, including the atmosphere, water, heat, and a simple analysis of the air.

PHYSICS.—

A practical study of the inclined plane, as follows:—A type of machine. A machine cannot create work. What is gained in power is lost in speed. Wasted work. The law of the inclined plane. Applications.

PHYSIOLOGY. *(This must be taken.)*

1. The kidneys and the skin and their duties.
2. The care of the skin.
3. Stimulants and narcotics.
4. The nervous system.
5. The senses.
6. Health and disease.

Nature Study should be both Intensive and Extensive.—Education through Nature Study takes place along two quite different lines,—the close, almost exhaustive study of one topic or a few topics carried on concurrently with open eyed attention to much or everything in the child's surroundings that is capable of exciting his interest. Only mentioning these two lines will suggest to teachers the special and complementary values of each. M. C. Dickerson, the teacher of Nature Study in the Rhode Island Normal School, writes that:—"Nature Study will never accomplish what it is capable of accomplishing . . . until the number of topics studied is sacrificed somewhat to thoroughness and inductive method. Observation and interpretation to be effective must concentrate attention for a considerable length of time." In the matter of making field excursions, even with Normal School students, the writer found it extremely advisable to propose the trip for a definite purpose. Scores of things were sure to claim subordinate notice but the special purpose of the trip was kept in the forefront of attention. If this government or subordination of interests is important for a class of teachers, it is nothing short of necessary for a class of public school pupils This maintaining of prominent interest and attention through a series of studies upon a single topic at a time avoids in large part the desultoriness to which inexpert teaching of Nature Study is liable. (Page 165).

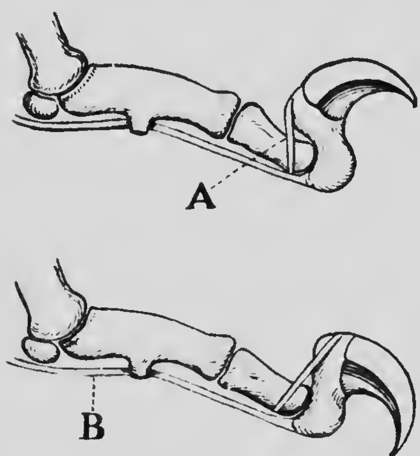
In the lower grades, the cat and dog, the balsam and geranium, and a limited number of topics have been studied for weeks or even months, off and on, but observation has been exercised and sympathies excited in a great many directions By this time, however, the pupils are beginning to recognize threads of order and system running here and there through the multitude of physical units that environ them. They begin to feel pleasure in the scientific attitude which, in high school and college, will lead to generalization of structures and systems of classification.

Although generalizing and classifying may become pleasurable and profitable there will never come a time when the student is too advanced for intensive study of a single type or ecological studies of plant and animal societies. In the literature of science there is no other class of books which teachers more greatly desire to see increased than such delightful and helpful monographs as Sargent's "Corn Plants" and Marshall Ward's "The Oak."

Elementary Science and Nature Study.--Read the general directions under Grades Five to Eight of the Manitoba Course (page 38). Grade Eight corresponds to the Fifth Form of the Ontario system. Studies of subjects such as the Covering of Animals, Bills and Feet of Birds, the Distribution of Seeds, Morphology of Floral Organs, Regions in Cross-sections of Plant Stems, Formation of Different Soils, Methods of Controlling Weeds, if properly treated, show the transition from Nature Study to Elementary Science.

Structure, Function, and Classification.—When the cat and dog were compared (page 13), the difference in their hair was noticed. The difference may now be reverted to again, but this time in connection with a comparative study of the natural coverings of animals. Flowers have been observed time and again as wholes in connection with the plants that bore them: their colors, forms, size, and perhaps their insect visitors, have been noticed and commented upon. Forms, arrangement, and names of the organs that compose flowers may now be studied and compared. Beginners are interested in flowers, not in carpels and filaments and stigmas. They are not repelled by the technical terms: on the contrary, most children are rather partial to big words. When they are mature enough to understand structure and function of these organs, they will easily learn the names in the same way that they learn the harder names of their playmates, by associating name with object. From this stage it is but a short step, if the teacher chooses that they take it, to elementary classification.

Discovering and generalizing the characteristics of hair, fur, wool, feathers, and scales is as suitable exercise for pupils in the Fourth and Fifth Forms as discovering the appropriateness of fur to the cat and hair to the dog was to those in the First Form. The child in the First Form is interested in the retractile claw of the cat from the points of view of the child's relation to the cat or the advantage of the structure to the cat itself. In this class the pupil is probably more interested in how the cat retracts her claws and why the dog is unable to do so. Hence the skeleton of a familiar animal that has been observed in life may now be more interesting and educative than the living animal.



KITTY'S CLAW. A, the retracting tendon. B, the extending tendon.

Animal Life.—The Courses of Study reported here emphasize the study of bird and insect life in these grades. Children who live on the farm may profitably continue the study of the domestic animals,—a line of investigation that they cannot exhaust. Helpful assistance will be found in Part V of James' "Agriculture." The "Farmer's Advocate," a weekly illustrated journal, will also be found valuable. The respective Agricultural Departments of the Provinces publish reports that may be obtained on request.

Birds.—There is something very fascinating about the study of bird-life. This fascination probably explains the fact that there is a greater wealth of good nature literature devoted to birds than to any other group of natural objects. Chapman's "Bird-Life" (1904) is a helpful book; it has an appendix of 80 pages for teachers. McMurry's "Special Methods in Natural Science" devotes 38 pages to lessons on the chicken, robin, red-headed woodpecker, crow and owl. Consult Crawford's "Guide to Nature Study," pp. 180-207, for methods of bird-study and notes on ten species. Silcox and Stevenson's "Modern Nature Study" gives descriptions of the bird families, pp. 47-67, and a study of the kingbird. Hodge's "Nature Study and Life" treats domestication of wild birds and taming and feeding birds, pp. 327-363. If possible, visit fields and woods with some enthusiastic bird-lover.

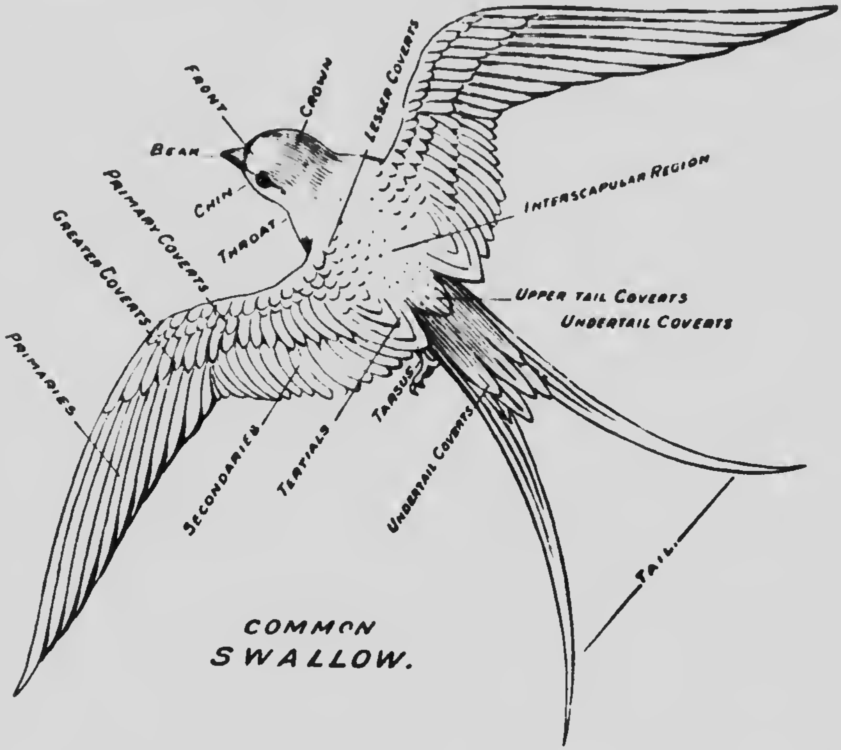
Encourage the children to make phenochrons of the arrival and departure of the migrants. In Nova Scotia, since 1903, a list of eighteen birds is printed in the annual register, and every school in the Province is expected to report annually to the inspector a table of the dates of the first observed arrival of each kind of bird in the spring and the date of the last observed departure in the fall. This exercise is definite, simple and valuable. Teachers' associations in other parts of Canada might adopt and carry out the Nova Scotian plan. The advantages of co-operative observation over a county or a group of inspectorates are obvious. Interest is heightened and maintained, and means of testing the accuracy of the observations can be devised. Of course the phenologies need not be confined to birds. In the Nova Scotia registers one hundred items are listed, only eighteen of which relate to birds.

A Bird-Phenology of Wellington County.—The Ontario Natural Science Bulletin, Guelph, 1905, pp. 21-24, gives a migration table for 1904 of the birds of Wellington County by the Field Naturalists' Club. It lists 138 birds under the following headings:—

NAME.	FIRST SEEN.	LAST SEEN.	ABUNDANCE.	REMARKS.
Killdeer, etc.	Mar. 17	Oct. 20	Common.	

The same number of the Bulletin gives Mr. Klugh's list of 197 birds of Wellington County. Reports like these are useful to teachers for comparison with their own records.

It may be assumed that birds have been observed incidentally and sympathetically (pp. 12, 77), and that later there have been systematic studies of the hen, duck, pigeon, or other fowl that can be brought to the schoolroom in an observation crate, as well as of the robin, sparrow, or other half-tame birds, and possibly pet cage-birds. Pupils are now prepared for comparative studies of structure, based on the forms and adaptations of bills, feet, nests, colors and wings. A bird's skin or a stuffed bird is needed for reference and to learn the names of the chief regions of the bird's body. Birds are *not* to be killed to furnish Nature Study subjects. "If thou hast named all the birds without a gun . . . then be my friend." But whenever opportunity supplies the material, observations should be made and recorded. Children frequently find recently killed birds; these they may be requested to bring to the teacher. It is far better in every way to train children to be house builders for the birds than nest destroyers. Abandoned nests, of course, may be brought to the school for study.



Topics for Study of Birds. 1. Migrations: Migrative records; summer and winter residents.

2. Nests and Eggs: —Location, material, form, method of constructing; size, color, shape and number of eggs; appearance, care, feeding of the nestlings; the regard children should have for eggs and nests.

3. Song: —Character; time and manner; male's and female's notes, calls, alarms.

4. Color: Relation to song, to sex, to protection, to location of nest; variation with season.

5. Food:—Fruit, seeds; insects, mice, fish, other birds; how the food is obtained. This is an economically important topic. Some insect-eaters will take tent-caterpillars, for example, but will not touch cut-worms. Discovering what insects any particular bird will eat is good practice in both bird and insect study. Encourage children to feed birds in severe weather.

6. Relation of Birds to Man:—Checking insects and weeds; scavenging; value for plumage, for song, for food as flesh and eggs.

7. Different kinds of Birds:—Distinctions based on externals, as bills, feet, wings, size, colors; based on habits of life and adaptations, as divers, swimmers, waders, shore-haunters, scratchers, birds of prey, perchers, etc.

8. Description of Externals:—Size, color, markings and peculiarities, shape of bill, feet, body, wing, tail, flight; technical terms are applied to the different regions of the bird's body and the feathers are correspondingly named.

Insects.—In individuals and species insects outnumber every other subdivision of the animal kingdom. They inhabit all climes and live in all kinds of situations—in air, on the earth and in the water. As flyers, crawlers and swimmers, they mark the highest degree of animal evolution. They include the most beautiful objects in creation, and exhibit the most remarkable adaptations to modes of life. Some of these specks of animation so skilfully adapt means to ends that one hardly knows whether to ascribe their actions to instinct or intelligence. Mankind is indebted to them directly for important articles of food and clothing, for drugs and dyestuffs, and indirectly for his most beautiful flowers, delicious fruits and seeds, for his clover and other important crops; per contra, he must charge them with incalculable destruction of these and other forms of his property. Scientifically, esthetically and economically, insects lay strong claims upon the attention of the student of nature.

A little child studying a strange animal thinks first how the animal's actions may affect himself. He asks—will it bite? can it hurt me? then how he may affect it—can I catch it? how can I play with it? third, how it can do things that he can do—how does it eat? what food does it like? how does it rest and play? In short, the child is interested in it not as a machine but in the work that it can do. Later he will inquire how it does the work. His interest will carry him along the steps of the vital activities, functions of organs and structure, particularly if guided in comparing these features of one animal with similar features of another animal. The attitude of a Fourth Form pupil to an ordinary insect is that of the First Grade pupil to a larger animal, such as the dog or the cat. Here, as elsewhere, a hard and fast line cannot be laid down; knowing the child is necessary to determining the material and method to use.

There are events in the lives of some insects that excite the wonder and may profitably engage the attention of young children. Examples of these have been referred to, (p. 49). If a house-fly or a clothes-moth were as large as a kitten it would be an object of absorbing interest to every one, but its minuteness unsuits it for Nature Study work in junior classes. In general, public school pupils will reach the higher forms before they can profitably enter on the serious study of insects. One way *not* to begin, even there, is upon dead specimens, whether fresh, or bottled in ill-smelling preservatives. A teacher of a Second Reader class, who had taken science in her senior-leaving course, describing her Nature Study work, said "The high school teacher spared me enough pickled grasshoppers to go round the class. The children made drawings of the parts and learned their names and uses." How did they learn the uses? "I told them those that they could not infer." . . . "They made good drawings and seemed to enjoy the work." The same work in the high school was called zoology; repeated in the public school it is called Nature Study. But giving the name does not make it the reality; perhaps it might better have been called object drawing. The heuristic quality of Nature Study was absent.

The Nature Study of insects should begin, then, with what they do and how they live. The silkworm has been referred to on page 48. Most other kinds of insects have to be caged in some way if they are to be studied in the school room. The most convenient insectary for plant-feeders is a lamp or lantern chimney set over a potted plant which may have been raised to feed insects, or transplanted when the insect was found, or it may be used over twigs set in a tin-can filled with wet sand. The captor should collect food of the kind the insect was found feeding upon. The glass chimney must, of course, be covered at its top with netting to admit air and prevent the escape of the insect. Another easily improvised insect cage is made from any suitable box, as a soap-box, from which a part of the side has been removed and a glass slide substituted therefor. The writer has successfully used a paper hat-box, with a netting cover, for carrying certain kinds of insects through their metamorphoses. The best cheap insectary is made of a box 2 or 3 feet long, ends 18 to 24 inches high, and 6 or 8 inches wide, sides of wood only 3 or 4 inches high, glass being fitted on these to carry them up to the height of the ends. This is No. 2 in the photogravure, opposite page 46. The cover consists of a strip of wire gauze. Soil to the depth of 3 or 4 inches should be put in the bottom of the insectary; besides that some insects pupate in the soil, it is useful in maintaining the desirable condition of moisture. This box, with glass sides, may be screwed on the window sill, the soil put in place, and bottles of water or tin cans of wet sand, with food plants in them suited to the captured insects, set on the soil. A variety of insects may be observed, fed, and studied in this observatory, where they will enjoy ideal conditions of light and air.

The "Puddle" Butterfly. – "What's the matter with your hat, Charlie? How did you get the mud on your hair and neck?" "Please, teacher, he was catching puddlers," said his younger brother, using the schoolboy's name for the greenish-yellow butterfly that hovers with its merry companions over every little puddle along the road.

That was the morning for the teacher to say "I wish you would catch a few of these sulphur butterflies without hurting them to put in our insectary."

MALE. SULPHUR BUTTERFLY. FEMALE.

Prepare to receive them by having clover plants transplanted into pots. When the willing boys bring in their captives some of the latter will show a narrow dark band around both pairs of wings. These are males, and they may be allowed to escape. The others, having a wider, yellower, more irregular and yellow-spotted margin on their front wings are the females. Put these in the insectary along with the living clover plants and announce the expectation that in two or three days bright yellow eggs, standing on their ends on the clover leaves, may be sought for. It would be a mistake to announce the eggs in advance of their appearance if they were likely to be observed without special effort.

1. Study one of these eggs under the lens and make an enlarged, colored drawing of it.

2. What change of color takes place in them on the second day?

3. On the third day what color are they?

4. Before evening or on the fourth day note their color.

5. On the fourth or fifth day watch for a pair of black jaws. What are they doing?

6. How long does it take a Clouded Sulphur to eat its way out of the shell?

7. What does it do with its empty shell?

8. Measure a newly hatched larva.

9. Describe its colors.

10. Using a lens observe the spots and hairs on its body.

11. Where on the leaf does it begin to feed?

12. What path does it make?

13. Does it always remain out at the edge of the leaf?

14. What color is its body now?

15. For three days it has been feeding and growing. Why has it suddenly stopped and gathered itself into that little bunch?

16. It seems to be getting two heads. What does that mean?

17. What change has the moult made in its color?

18. Measure it now. How much larger is it?

19. How long time between the first and second moult?

20. What changes occur with the second moult?

21. Going into a third moult! How long since the second?

22. They are getting these leaves pretty badly eaten. Let us change them to a fresh plant by nipping off the leaf they are resting upon and placing it among the leaves on another plant.

23. The third moult is over. They are feeding again. How large are they now and what color changes have occurred?

24. Still another casting off! What about the colors and size now?

25. Again they have ceased feeding and have begun wandering as though in search of something.

26. Watch the performance going on now beneath that branch. The larva is changing into a pupa. Describe the process.

27. This kind of pupa is called a chrysalis. Describe and draw it.

28. Make daily observations to note when any change occurs. When and what is the first one?

29. At last some child exclaims "O Teacher! see the butterfly coming out!"

These questions are based on a sketch of the life-history of the familiar Clouded Sulphur, by Dr. Fletcher, in the "Ottawa Naturalist," and are intended to show how a teacher may use such excellent helps to the knowledge of insects or any other class of objects. 1st, carefully study, read and re-read, the writer's account; 2nd, work out a clear idea of the material required; 3rd, devise the means of having the pupils collect or provide the material, if possible; this part is usually one of the most educative; 4th, give directions and questions to stimulate investigation, but give no information that you can get the children to discover; 5th, investigate every point yourself; take nothing on trust; you will find out now and again, maybe often, that the phenomenon is quite different from what you supposed from the book account, but when you go back and read the book again you may find that it was right, but you had misunderstood it; 6th, as opportunity offers, judiciously excite the sympathies of the pupils and warmly express your admiration of beauty in their hearing; 7th, require a full and independent expression of the study by each pupil, calling into exercise as many modes of expression as are applicable.

Besides the dates and drawings the following, if read with the questions, may be the substance of a pupil's expression of the study of the "puddler":—

(1) Shows a yellow, beautifully marked, fusiform object. (2) Pink. (3) Crimson. (4) Leaden. (5) Eating a hole in the end of the shell. (6) An hour. (7) Eats it for its first meal. (8) 2 mm. long. (9) Body

olive-green; head black. (10) It is crossed with dotted ridges bearing club-shaped hairs. (11) At the edge. (12) It moves along a silken strip. (13) It returns along its silk to the middle to rest. (14) Nearly the same color as the leaf, making it hard to find. (15) The teacher says that it has grown too large for its skin and that it is going to get out of its old skin; also that it has a new skin ready. This change is called moulting. (16) The front one is its head-case; it rubbed it off. The old skin opened down the middle of the back and the larva twisted itself out. (17) Brighter, and the new head-case is green. (18) 3 or 4 mm. now. (19) 3 or 4 days. (20) Doubles its length, color is darker and shows a stripe. (23) 15 mm. long, striped on sides. (24) More beautiful than ever; a crimson line on the side stripes; an inch long. (26) It has made a mat of silk; hind feet are tied into a little pad of pink silk; it is holding to the mat with its front feet. It is spinning a hammock to lie in. It is getting a shell over its body. The teacher says it is a *chrysalis* now. (27) The color sketch shows an elongated angular object, colored green with yellow stripes. (28) Sixth day it is getting yellow. (29) The case is split open and a beautiful yellow butterfly is coming out. The teacher says this is the Clouded Sulphur butterfly, and that its Latin name is Colias or Eurymus Philodice. After making this water-color of it we let it fly away to be a puddler with the other yellow butterflies.

Were the class studying this insect from the point of view of science the imago would very properly be put into the cyanide bottle and later be duly pinned, spread and labelled. From the Nature Study view the sympathy called forth by the imagined enjoyment of its liberty is worth more than the manual exercise of spreading and mounting it.

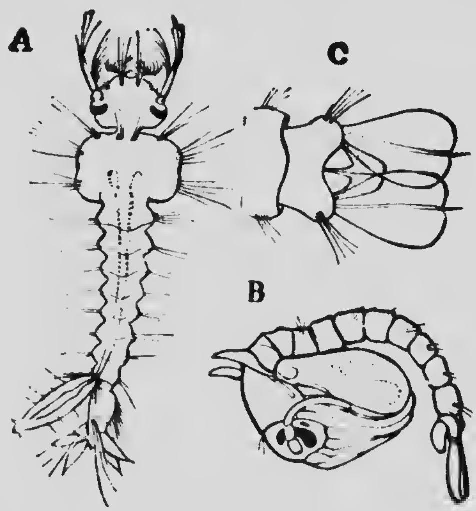
While the above treatment of the Clouded Sulphur shows how the book or printed help may be used, there is a better way for the teacher to prepare the lesson than from the book, that is, by studying the insect or animal or plant at first hand in his own original way and noting every point that he thinks he can turn into direction or question to guide his pupils in their investigation. In view of this fact a hint to start with is given on the grasshopper, mosquito, and a few other common insects.

Grasshopper or Locust.—Put green oats or grass stems in a bottle of water and set them in the insectary. Capture a few grasshoppers or locusts and put them in with the oats. Their

"GRASSHOPPER" or THE RED-LEGGED LOCUST. *(Caloptenus.)*

method of feeding and moving can be well observed there. The true grasshoppers have very long antennæ.

The Mosquito.—The mosquito although so minute is a very interesting insect, and on damp summer evenings is sure to



MOSQUITO. (A) Full-grown larva. (B) Pupa. (C) Posterior segment.

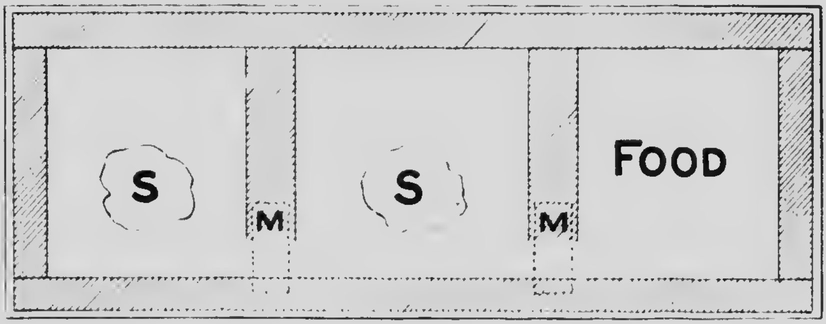
pay us attention whether we welcome it or not. A pocket lens will enable one to observe its life-history with considerable satisfaction. Collect the wigglers and little floating boats of eggs in a rain-water barrel. Put these with some of the water in a tumbler and tie a cover of fine netting over it to retain the mosquitoes as they emerge. Then on the window-sill there may be observed the hatching of the eggs, the breathing and swimming of the larvæ, the changed and shortened form of the pupa, and the emergence of the perfect mosquito. The breathing organs of the larva are attached near the tail end; those of the pupa are like donkey's ears, near the head end. Both forms come to the surface to breathe.

The Honey Bee—An observation beehive may be attached to the window-sill outside of the window-sash, or better still, to the sill inside of the window with an opening under the sash to permit egress and return of the bees, but so protected at the sides that a bee cannot enter the room. In most school-sections some one will be found able and willing to assist the teacher in directing the children's observations. A Langstroth observation hive, stocked with one frame and "nucleus hive," can be securely screwed to the window-sill as suggested. Even if everything has to be bought the cost need not exceed three dollars. See photogravure, opposite page 46, No. 6. If the teacher has not had experience with bees he should study them at some local apiarist's, or at least get the latter's assistance in setting up the observation hive. Any of the books on apiculture will be helpful. Benton's Bulletin on the "Honey Bee" can be obtained for 25 cents from the Document Depository of the U.S. Dept. of Agric., Washington.

A Formicary.—Easier to obtain than an observation beehive, but no less interesting to study, is a colony of ants at work. Miss Fielde's ant-nests, described in the current volume of the "Nature Study Review," 1905, pp. 37-40, can be made by any teacher. One may be constructed with either two or three rooms. A pane of glass, 12 by $4\frac{1}{2}$ inches or smaller, is laid on a sheet of blotting paper and on it, near the edge, a wall is built to the height of a quarter inch with cement and strips of glass a half-inch wide. If three-roomed, two cross-walls an inch wide are built in the same way, leaving a passage at one end which is bridged with mica.

AN ANT COLONY. Sunning the Eggs, etc.

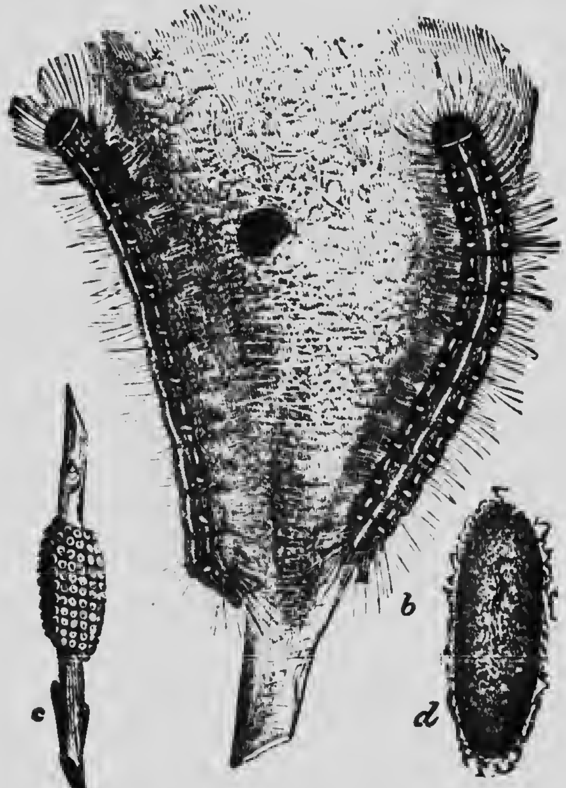
For ventilation, a strip of Turkish toweling is cemented along all the walls and partitions. Three panes of glass, one for each room, are used for roofing. Two of the panes are covered to make them dark and the walls are blackened



Mrs. A. M. Fielde's Ant-Nest without toweling or roof; pane of glass 12 x 1[illegible]; wall of glass, ½ inch strips; 2 cross partitions, 1 inch strips; M, mica over passages; S, flakes of wet sponge.

outside to shut the light out there. Food is given, a little at a time, in the light room. A flake of fine sponge, one eighth of an inch thick, is kept moist in each of the dark rooms. When a room is to be cleaned the light is let in. Then the ants quickly remove all their belongings to a dark room and leave the space ready to be uncovered and brushed out. If orange-tinted or other non-actinic glass be used for roofing for one of the dark rooms, the ants will go on working under it for a time without much disturbance and then they may be well observed. Food is placed in the lighted room in minute bits. Try various kinds to find their favorites: try morsels of sweetened cake, crushed walnut, banana, etc. The sponges referred to are their watering troughs: these should be scalded once a week and filled wit[h] two or three drops of clean water twice a week. In conn[ecti]on with a study of ants, read Lubbock's "Ants, Bees, and Wasps."

The Apple-tree Tent Caterpillar. Preferably start with the eggs which will be found as a cylindrical mass glued to a twig

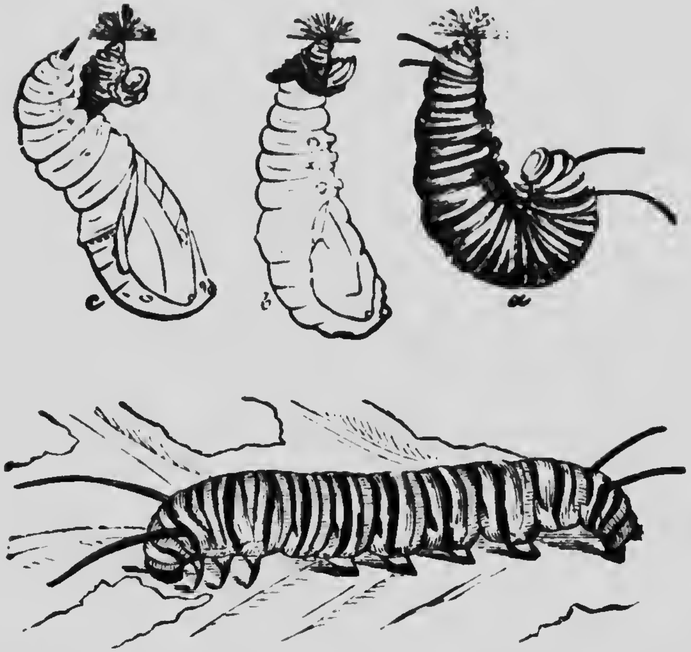


(a) The Caterpillar. (b) The Caterpillar. (c) Eggs. (d) Cocoon; all of the Apple-tree Tent Caterpillar. (*Clisiocampa Americana.*)

of the apple or wild cherry. Failing to find that, cut off the first branch on which you see a new tent. Set the twig in a bottle of water in the insectary and supply the larvae with apple or cherry leaves. The larvae molt about five times changing their color somewhat each time. When they cease to eat fresh food they are ready to pupate. Place chips or bark on the floor of the cage for them to creep under to make their cocoons. The moths emerge about the end of July.

Swallow-tail Butterfly.—The larvae are found on carrot-tops and allied plants. They are green with black bands across the back, somewhat like that of the milkweed butterfly on the next page. The eggs, placed singly, are smooth round, yellowish, finally brownish. The young larva is a hairy, black, white-banded animal. Transfer the larvae to the insectary. Try, however, to find some eggs so that the complete development may be observed. The larva changes its markings with every molt. For the chrysalis stage it attaches itself to a stem or post; if of the first brood the butterfly will emerge in two weeks. The butterfly is black with yellow spots.

Giant American Silkworm. The cecropia emperor is conspicuous as larva, cocoon and moth. Collect the large, green, spiny-warted larva and leaves of its food plant,—apple or maple or other kind. It is harmless to handle. The warts are colored blue, coral red and yellow. Notice the pairs of conspicuous breathing spiracles on each segment, except the second and third. It can eat its own weight of leaves daily. The cocoon attached to a twig is 2½ to 4 inches long, of tough papery texture on the outside. It should be kept in a cool dry place all winter. In late May or early June the moth will emerge. Its wings are rich brown, marked with half-moon spots, and have a spread of from 5 to 7 inches. See "Public School Nature Study," pages 74-76, for an illustrated lesson.



Larva and stages in development of the Chrysalis of the Milkweed Butterfly. (*Riley.*
(*a*) First Stage; (*b*) Second Stage; (*c*) Third Stage.

The Milkweed Butterfly, the Monarch. A "four footed" butterfly. (*Danais archippus* or *Anosia plexippus.*)

The Milk-weed Butterfly.—The marvellous beauty of the green and gold chrysalis of the monarch butterfly will never be forgotten by any one who has once observed it. Collect the banded larvæ on milk-weed leaves. Place them in any box, keep them supplied with fresh milk weed leaves, and when ready they will suspend themselves to the roof of their cage. If they are kept in an insectary, with glass sides and gauze cover, attach a piece of paste-board to the gauze for a roof to which the chrysalids may attach themselves.

Chrysalis of the Milk weed Butterfly (*Riley.*)

The "Tomato-worm."—The large green larva found on the tomato is perfectly harmless to handle. Place it in the insectary and feed it on tomato leaves. It goes into the ground to pupate, that is to form its chrysalis, which is a smooth, brown, segmented object, two inches long, bearing a jug handled tongue-case. In the following summer a handsome moth, often called the humming bird moth, emerges. The "rice-grain" bodies often seen on the green larva are cocoons of parasites that have fed in its body. These parasites in their adult stage look like small black wasps. The "tomato-worm" is known in science as the tomato sphinx, (*Macrosila quinquemaculata* or *Phlegethontius celeus*).

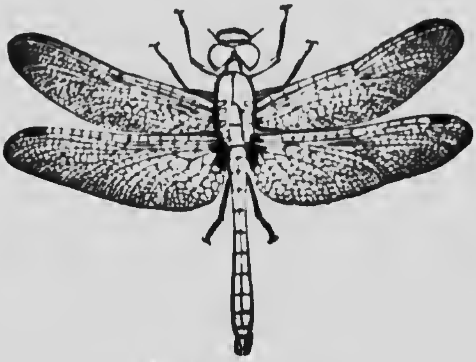
Observing a large larva of any kind making its pupal case or spinning its silken cocoon is a most interesting and instructive experience.

Comparison.—After the life histories of one or two insects have been observed refer to these for comparisons. If, for example, the grasshopper is known and the children are observing the dragon-fly, lead them to note that the *habitat* of the first is among grass while that of the second is the air, generally near or over water, that of its nymph is in water; in

"Grasshoppers" (locusts) among grass

Nymph seizing its prey by its extended lower lip. DRAGON FLY Imago emerging from the pupal case.

respect to *food* one is a vegetable feeder the other preys upon insects; the second requires keen sight on account of its feeding habits, its *eyes* are twice as conspicuous as those of the grass feeder; the differences in their *legs* strikingly reflect the differences in their habits but not more than the *wings* do.



Female Dragon-Fly.

Have the pupils imagine a grasshopper and a dragon-fly exchanging wings and then how the exchange would handicap each in its feeding habits.

Topics for Study of Insects.—Appearance, form, motions; food; means of escape and defence; structure in general outline. True insects have six, jointed legs, spiders have eight legs, worms lack jointed legs.

Metamorphosis:—Complete—egg, larva, pupa, imago—as in butterflies, moths, beetles, flies, bees, ants, etc.; incomplete—egg, nymph, adult—as in grasshoppers, may-flies, dragon-flies. Molting of larvæ and nymphs. Pupa as chrysalis, cocoon.

Modes of life:—individual, communistic—as illustrated by house-flies, tent-caterpillars, cabbage-worms, plant-lice, hive bees, ants, etc.

Modes of feeding:—Many insects, as potato-beetle, tent-caterpillar and tomato-worm, bite their food; others, as the squash bug and plant lice, have their jaws modified, to form sucking tubes. Knowledge of mouth structure is necessary in studying methods of combating injurious insects.

Relations to man :—Beauty of color and motion ; honey ; silk ; scavenging ; pollinating flowers ; destroyers of other injurious insects ; food for poultry ; destruction of fruit-trees, garden and farm crops, forests ; conveyors of disease ; injuries to large animals and annoyance to man.

Relations to flowers as pollen carriers.

Relations to animals, as food of birds, bats, fishes, toads and snakes.

Predaceous and parasitic species :—The larvæ, and to some extent, the adults of lady-bugs, lace-wings, syrphus and dragon-flies prey upon their fellows ; ichneumon flies deposit their eggs in the larvæ of other insects ; ant-lions and spiders make traps to catch insects.

Study the relations of injurious insects to the plants upon which they feed, as the potato-beetle, the squash-bug, cabbage-butterfly, tomato-worm, grape-sphinx, etc. Observe the different kinds of insects that feed upon particular plants, as the rose, the apple, the maple.

Books from which assistance may be obtained :—"Guide to Nature Study," pp. 274-308 ; "Public School Nature Study," pp. 60-81, 108 ; Silcox and Stevenson's "Modern Nature Study," pp. 129-187 ; S. J. Hunter's "Elementary Studies in Insect Life" ; C. M. Weed's "Nature Biographies" ; W. H. Gibson's "Blossom Hosts and Insect Guests" ; and Comstock's "Insect Life." Mary C. Dickerson's "Moths and Butterflies," with 200 photographs, is a Nature Study treatment of these two groups.

Other Animals. Other animals, higher and lower than insects, may happen to be convenient subjects for Nature Study. In preparing your lessons, should you desire any book help on *squirrels* and *mice*, McMurry's "Special Method in Natural Science" gives a winter study of the fox-squirrel, the first three months in the life of a gray squirrel, and "Our Mouse, Jim," pp. 207-222.

Consult "Public School Nature Study," pp. 42-44, for assistance in directing a study of the *garter snake*. This harmless, beautiful and useful animal ought to be better known and less abhorred. If you feed a captive specimen with earthworms or can train it to take bits of raw meat, you can easily study it. The writer has kept one in apparent good health and comfort in the school-room for over five years, most of the time in a jar such as is described on page 68. During that period it has sloughed its skin over a dozen times but has increased only slightly in size and weight. In Blatchley's "Gleanings from Nature," pp. 27-74, there is an interesting account of the harmless snakes and of the rattler. Abbott's "Naturalist at Home," pp. 282-307, has also a good chapter on snakes.

Hodge's "Nature Study and Life," pp. 405-6, will assist you in studying another misunderstood and curious animal—the common *bat*.

A helpful treatment of the *earthworm*, which Darwin showed to be so indispensable to agriculture, will be found in "Public School Nature Study," pp. 56-59.

Plant Ecology.—Plants may be regarded as machines consisting of parts such as roots, stems, leaves, flowers, etc., which in life carry on two kinds of work, one—a set of internal activities such as circulating sap, making starch, etc.,—which we study under the term *physiology*; another—a set of external activities or environmental re actions such as efforts to get light, air, moisture and food, to distribute their seeds and to adapt themselves to external conditions. This study is called *ecology*, meaning literally the study of living plants "at home" whether in forest, field, or garden.

It will be noticed that the plant studies in Grade Seven of the Manitoba Course are largely of this character. After the common plants of a locality can be recognized and the functions of the members of the plant body have been studied objectively in an elementary way, the most interesting and profitable subsequent plant studies in the public school will be chiefly ecologic.

Plant Societies and Zones.—If the pupils can be taken to a height of land rising not too abruptly from a bog or weedy pond which is partly enclosed by woods they are on the ground where in small space the richest lessons in plant ecology can be studied. First, there is the zonal distribution of plants. Centring in the deepest part of the pond, circle after circle of plant communities will be disposed before them. Nearest the centre will be found the submerged milfoils, bladder-worts and eelgrasses, needing little light and getting their gaseous foods by direct osmosis, and requiring for apparent reasons little or no root.

In the zone of comparatively shallow water the water-lily group trail their stout rootstocks along the muddy bottom, and on spongy petioles long enough to reach the air float their ample leaves upon the surface of the water. A wider circle still growing in the water but with narrower leaves held above it contains the pickerel-weeds and lizard-tails, the arrow-leafs and bur-reeds. Farther out, sometimes in water, sometimes in mud, stand the bulrushes and cat-tails, the sedges and swamp-grasses in a compact and irregular zone, each struggling with the other, one gaining an advantage here, another there according to some accident of environment. On the firm ground, but within root-reach of the water, grow the bonesets and vervains. From the foot of the hill right up to its crest, on slope and terrace, community after community may be distinguished.

In one such delightful situation that the writer often visits the wooded slope presents a zonal series of trees, another of shrubs, and a third of herbs. Tamarac and willow reflected in the water are backed by basswood and soft maple, and these in turn are surmounted by oak, hickory and hawthorn. The shrubbery begins with heaths and poison sumac, high cranberry and dogwoods; it ceases in the close shade but re-appears at the summit in gooseberry and witch-hazel. The low plants, beginning with the half afloat sphagnum, in whose bosom nestle cranberry and sundews, pitcher-plants and orchids, lead on to a splendid company of shade-loving ferns and water parsnip, turtle-heads and labiates up to golden-rods and asters.

What qualities in these plants and what elements in the environment combine to bring these different species so frequently together? These questions challenge our attention with ever increasing interest.

Relations to Moisture.—In such a situation as the one just referred to one may see plants in a great variety of relations to moisture, light, air and food. Another view is obtained by studying them in extended areas of particular kinds. Those that favor dry sandy tracts possess the means of retaining the water they absorb from the scanty supply. Some of them curl their leaves backwards to close their transpiring pores; some have thick succulent stems or leaves that store water against the drying days; others have their pores deep sunk and protected by scales and hairs that control their transpiration. When plucked such plants wither slowly. Technically they are called *xerophytes.*

Plants that love damp soil and moist air and are hence called *mesophytes* or *hygrophytes*, usually have large or very many thin leaves with numerous pores that transpire freely.

Trees and other plants with deciduous leaves are called *tropophytes* because they *turn* from a condition in summer when they require and transpire much water to one in winter when they use little. Plants that flourish on salty or alkaline lands are called *halophytes.* They also have their peculiar characteristics; they strongly retain their hard-earned water in ways similar to desert plants.

Where the Roots Drink.—Plants with wide branches and ample flat leaves shed the rain like an umbrella and carry it away from the central axis. Some plants have semi-erect leaves and channeled petioles and direct the rain towards the stem. Infer the differences in the root-spread of these kinds of plants. In this respect compare the beet and Indian corn with the potato and sunflower.

Relations to Light.—Observe the struggle of plants to reach the light. The dandelion and plantain press their leaves close to the ground to prevent other plants from growing up around them and shutting off their view of the sun. Contrast two trees of the same species—one growing in the open field, with another in the thick forest. Note how the leaves and flowers of some plants follow the sun from morn till eve, also how leaves that are bunched or rosetted vary the lengths of their petioles to bring every leaf-blade into the light. A pumpkin vine partly in the open ground and partly among long grass affords an instructive study. The leaves of house plants not regularly turned become strongly "drawn" to the light.

Propagation of Plants.—Plants are propagated in various ways but chiefly by spores, seeds and separation of parts.

Spores.—Spores are merely particles of the plant's protoplasm protected by a special covering. They lack an embyro, are extremely minute and very numerous. Fungi, algæ, mosses, ferns and horsetails reproduce by spores. Some kinds may be germinated on a porous brick resting in water so as to keep the surface damp. A microscope is needed to study them.

Seeds.—Seeds are like eggs in that they contain an embryo and a certain amount of food stored to serve the plantlet until it can work for itself. Were the seeds to fall and remain under the branches that bore them, the young plants would crowd each other and their parent so hard as to starve them all out of existence; consequently plants have developed a great variety of means of distributing their seeds.

It pleases the fancy of the children to represent the different kinds of seeds from the point of view of their distribution as flyers, skaters, sailors, balloonists, riders, walkers, creepers, etc.

Flyers.—What are wings for but to fly? Many seeds or fruits have wings, among which are those of the maples, ashes, tulip-tree, blue beech, pines, spruces, and catalpa. The wings are differently adjusted and shaped in the different kinds, and each kind of seed named has its own way of flying or whirling. They detach not in calm weather, but when the wind is high, so that they may fly far from home before they reach the ground.

Skaters and Sailors.—Although it is midwinter still some of the pods are hanging on the locusts. A smooth crust is on the snow, the high winter wind snaps or twists off a number of the pods, and carried by the gale they skate a mile or more from where they grew. Observant eyes will see several kinds of seeds that, remaining on their parent stalks until winter, are moved far and wide by the wind that drifts them over the snow-crusts. Many plants, such as the sedges and grasses that grow near water or on land that is flooded, bear their seeds in water-tight capsules. When these fall into ditches, water-courses or floods they are carried to their distant homes. To other seeds or fruits are attached life-preservers, bits of spongy or pithy or corky substances sufficient to float the seed. Examine a seed of the narrow-leafed dock for three little spongy floats, or a fruit of the bur-reed for its lining of cork that keeps it up in the water.

Balloonists.—The basswood places each little cluster of nuts on a bract which may serve for a toboggan, or a sail or a wing. The dandelion, the poplar, and the thistle have a host of imitators that in dry weather spread their downy parachutes to be caught by the wind, carried aloft and floated until a shower wets their sails and brings them to the earth, rain-softened to receive them

Riders and Creepers.—Some of the riders pay their way like the cherry, hawthorn and ivy, whose fruits the robin or crow may eat for the pulp but whose seeds are protected from digestion by their stony walls; or like the euphorbia whose caruncles reward the busy ants for their share in the distribution of such seeds. Others like the burdocks and pitchforks and stickseeds steal their rides. With sharp hooks they catch the wool of the passing sheep or the hair of the shaggy dog. The hooks or barbs of such kinds of seeds or fruits are as curious as they are effective for their purpose but many of them require a good lens or microscope for their examination.

Some of the grass seeds like those of porcupine grass and wild oats have twisted awns which straighten or curl and twist according as they are wet or dry. Each act of straightening and contracting moves the seed a short distance, enough to suggest walking or creeping.

Shooters and Rollers.—Touch-me-not gets its name from the irritability it exhibits when its seed-pods are touched. The gas-plant (*Dictamnus*) has a mechanism in its pod which forcibly discharges the ripe seed. I have known such a seed to be shot out a distance of thirteen feet. Balsams, sages, and violets are shooters but the witch-hazel is the prince of vegetable catapultists.

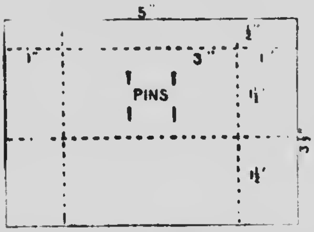
The Russian thistle, the tumbling pigweed and the old witch-grass cannot project their seeds but they have another means of scattering them far beyond the range of their shooting companions. When these plants ripen and dry they break off at the ground and before the high winds they roll and tumble and drift across fields and along highways, shedding a seed or two here and a few more there and so on for weeks or even months.

A good way to study the dispersion of seeds in the higher classes is to take the seeds as they are captured on their travels. In rural districts a collection may be made of those that are found on one's clothing after a trip to the woods, or on the covering of animals that pasture in thickets or weedy fields. A large variety of seeds more difficult to identify will be found in coves or bays off water-courses and ditches. An instructive study may be centred on the distribution of the seeds of plants that are particularly troublesome to the farmers, such as mustard, thistle, rag-weed, ox-eye daisy and wild oats.

Expression.—The expression of a study of seed dispersion should give: 1st, a brief description of each producing plant, accompanied by a dried and neatly attached specimen of the same, or of some important part of it; 2nd, a statement of the time, place and circumstances of the collection; and 3rd, specimens and drawings, enlarged if necessary, of the fruits or seeds, or both, and of the mechanisms that specially promote dispersion.

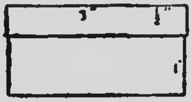
Parts or wholes of green plants should be dried under heavy pressure between frequently-changed, warm, dry, drying papers, and attached to the page with very narrow strips of tough gummed paper.

Small specimens, such as seeds or detached parts, are usually placed in pockets, to be pinned or gummed to the page. The standard specimen-pocket is made of an oblong of paper of suitable size—say, for example, $5 \times 3\frac{1}{2}$ inches. Fold it lengthwise 2 inches from the upper edge, and turn the top half-inch down to make a flap.



The dotted lines represent the fold.

The end-folds, an inch in length, are turned back. This gives an envelope or specimen pocket $3 \times 1\frac{1}{2}$ inches. It is attached by the middle of the back to the record page, and the end-flaps are turned below, to keep them closed. The pocket can be opened and closed easily without removing it from the page.


The pocket ready for filling.

Collections of Seeds.—There is danger of mistaking the mere making of collections for real Nature Study. (See p. 28). Collecting specimens has, however, certain incidental values. It exercises discrimination, leads to classification, and takes people afield. Manual dexterity and artistic taste are required in the proper arrangement and mounting of some kinds of objects.[1] All these are desirable results, but from the Nature Study point of view they are more than counterbalanced if the collecting becomes an end in itself or involves destruction

[1] Bulletin No. 134; of the Ontario Agricultural College, Guelph, on the Making of Collections of insects, plants, woods, etc., by the late Dr. Muldrew may be had on application to the President of the College.

of life, happiness and beauty, such as the poisoning and pinning of harmless and beautiful insects, the robbing of birds' nests – not to speak of the killing of the birds themselves, – and the tearing up, root and branch, of rare and rapidly disappearing wild flowers. Kept in time and place there is nothing to be said against making properly labelled and neatly mounted collections of such objects as seeds and woods, weeds and minerals.

Common methods of mounting seeds are by putting them in small homeopathic vials or in numbered pockets like those described on the preceding page arranged in boxes. Less expensive than bottles, more convenient to examine, more artistic and requiring more manual ingenuity to put up are the methods illustrated in "Correlation of Nature Study and Manual Training," Nos. 12 and 13, opposite page 46. The engraving shows plaster plaques glazed over the seeds and rubber washers glazed back and front. A wooden plaque may be used instead of plaster, but it is difficult to make the pane of glass fit close enough to the wood to keep minute seeds in their respective places.

Propagation of Plants by Separation of Parts.— This section subdivides into *natural* and *artificial* separations. Many of the submerged water-plants multiply freely by detachment of buds and branches. Several shore plants, while relying on other means, are distributed to some extent by the rooting of detached parts. Bulblets in the axils of the leaves of the tiger-lily, among the flowers of the cinnamon vine, wild onion and water-hemlock and beneath the pennæ of the bladder-fern are the chief means of multiplying these plants. Strawberries send out runners, blackberries root at the tips, potatoes and Canada thistles send out underground bud-bearing branches, the silver-poplar buds from its roots and squirrel-corn and lilies have other peculiar ways of increasing their numbers underground. Refer to any well-known plant of a type and ask for observations of other plants employing similar means of multiplication.

Artificial Separation.—Leaving the field for observation we enter one for experiment—for education by doing. In the school-garden, or the home-garden or window-garden,—in seed plot or sand-box or flower-pot, experiment with different ways of raising the same plant. Geraniums may be grown from seeds or slips; potatoes from seeds or tuber-cuttings or stem-cuttings.

Cuttings.—In moist sand, at the proper season try cuttings or slips of geraniums, carnations, chrysanthemums, oleanders, wandering-jew, tomato, etc. Experiment with cuttings of wild plants and young-wood cuttings of willows, spiræa, currants, gooseberries, etc.

Do not leave much leaf surface on geranium and other leafy slips, as the leaves may transpire water faster than the rootless cuttings can supply it. Partial shading checks too rapid transpiration.

Begonias and other plants having thick leaves may be propagated by cutting the leaf into triangles and planting or pinning the points into moist sand.

Attractive as the foregoing exercises are they yield in fascination of the older pupils to practising the arts of budding and grafting.

Budding.—School is usually closed for the holidays at the best time of the year to do budding, although successful results may be obtained in early September. The art may be taught in the early summer and practised by the pupils in July and August on orchard trees, rose-bushes, or wayside shrubs. A slit, an inch or more in length, is cut with a sharp knife in a clean, smooth, healthy part of a branch. Near the top of the slit make a cross cut as shown in the illustration, and open up the bark to permit the admission of the "shield" of the bud. Seek a healthy bud of the same species; begin to cut at about an inch below the bud and extend the cut to a quarter inch or more above it. Cut deep enough not to injure the bud and shallow enough to avoid much wood. Insert the shield into the opened slit; close the opened bark of the stock over the shield and tie in position with raffia or soft cord. In two or three weeks there ought to be union of the parts; but the bud will not grow until the next spring, and then the part of the branch above it should be cut off.

A shield bud and twig with slit on side prepared to receive the shield.

Grafting.—The art of grafting may be practised in the school-room upon detached branches and twigs. When the pupils have learned how to cut and fit the scion and stock they may use their knowledge in the home orchard or upon road-side maples or poplars or basswoods.

The common forms of grafting are known as cleft or wedge, splice or whip, saddle and side. The first is the kind most practised in the orchard. A branch, an inch or more in thickness, is sawn across and split towards the trunk for an inch or two. Into the cleft a twig of the preceding year's growth, the scion, is carefully inserted. The scion should be a bit of healthy twig bearing two or three buds and cut at

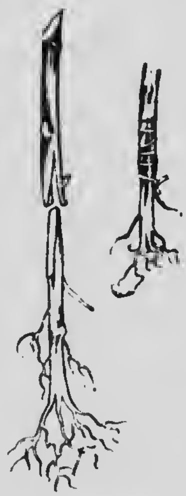
An American elm stock with a European elm scion set in the cleft.

its lower end to a wedge-shape, having the outer side of the wedge somewhat thicker than the inner. When inserted the bark of the outer side of the wedge of the scion must adjoin the bark of the stock. It is between the soft bark of the scion and the soft bark of the stock that union starts. To prevent the parts from drying out before they unite all the wounded parts must be protected from the air. For this purpose grafting wax is generally used.

A tongue splice-graft.

When the stock is little, if any, larger than the scion they are usually spliced by apposing long slanting cuts and tying. Each slanting surface may have a tongue cut in it, and one tongue slipped behind the other to keep the parts in place. These are called splice or whip-grafts.

A variation of the whip or splice-graft is made by cutting the stock to a long wedge, splitting or cutting a corresponding wedge out of the scion and fitting the scion over the wedge of the stock. This variety is aptly called a saddle-graft, and is frequently done upon roots.



A saddle-graft.

Full instructions on all kinds of grafting, budding, etc., may be found in L. H. Bailey's "Nursery Book." A chapter on the details of grafting and budding the peach is given in Hodge's "Nature Study and Life."

Grafting-Wax.—Melt together eight parts of rosin, five of beeswax and three of tallow. When melted and mixed pour out slowly into a pailful of cold water. Smear the hands with softened tallow or lard and knead or pull the mixture until it becomes like pale yellow taffy. Make it into rolls and wrap with parafflned or tallow-coated paper. It will keep for years. The proportions of ingredients may be varied. Adding tallow softens wax, adding rosin hardens it. Before applying it rub the hands with tallow. A good way to soften it for working is by putting it in warm water.

Regions of a Woody Stem.—In connection with grafting teach the nature and use of the regions in a woody branch—pith, wood and bark. Pith consists of empty cells that were once full of living protoplasm like the cells among the bark fibres. The wood shows annual additions produced in the cambium layer. It is in the young wood that the raw fluids from the root ascend to the leaves, see experiment with willow twigs, page 157. Outside of the cambium layer are the bundles of fibres and vessels, making a path for the circulation of the digested liquids, and the thin-walled cells filled with living protoplasm protected externally by the cuticle or scaly bark. The union in grafting begins in the thin layer from the cambium to the cuticle.

For further study of the rings and grain of wood see "Public School Nature Study," pp. 113-116, with plate.

Exogenous Stem.—An apple stem, showing pith, nineteen annual rings of wood, cambium film, soft bark and hard bark. If this were grafted the soft uninjured bark of the wedge of the scion would have to be set against the cambium and the soft bark of the stock.

Planting a Tree.—Few more educative days will occur in a pupil's school-term than the one on which he or she is well taught how to transplant a tree.

1. Why be so careful to get as many small rootlets as possible when we are digging up the tree?

2. Why cover the roots while carrying the tree from the woods?

3. Why dig that hole in the hard clay so wide and deep and then half-fill it again before planting?

4. Why dig that second hole near the first one and leave it empty?

5. Why prune all the bruised roots?

6. Why prune off nearly all the branches?

7. Why put in more black earth in the hole to set the tree on?

8. Why use earth so fine and dry that it can be shaken in amon[illegible] roots?

9. "My father," said one pupil at this stage, "scatters a dipperful of oats over the small roots. How does that help the tree?"

10. Why jar the tree and tread the soil when the hole is filled just above the roots?

11. Why put chips and stones around[1] the tree?

12. Doesn't it need a pailful of water around the roots to finish the planting?

The pupils may not ask all these and other questions of their own accord but the skilful teacher will try to get them to investigate and discover the answers whether they or he or no one asks the questions. The children should do the work—the pruning and the planting, the digging if they are able and all the rest—they like to do it; the teacher should see that they also do the thinking. By questioning and suggesting, and perhaps experimenting, he can lead them to answer the above questions.

(1) The large roots support the tree and conduct the liquid nourishment; the small rootlets absorb it. (2) The fine thread-like roots

quickly dry out and die. (3) The rootlets cannot find enough nourishment in the subsoil so the bottom of the hole is lined with sods or humus to nourish them. (4) In this hard undrained soil water would 'stand' around the roots, preventing their getting air and warmth. The second hole drains the one the tree stands in. (5) To prevent decay. (6) Most of the rootlets were left in the woods. The few on the tree cannot absorb water fast enough for all the leaves that would have grown. The leaves transpire faster in the open field than they would have done in the woods. (7) To raise the roots as near the surface as they were before transplanting. (8) To get it in among the rootlets. (9) The germinating oats cause warmth; their roots help to hold the roots of the tree; their subsequent decomposition fertilizes the soil. (10) To bring rootlets and soil into close contact. (11) To check excessive evaporation in dry weather. (12) The watering may be beneficial if there is drainage.

Propagation Reviewed from the Point of View of Science.—The writer's class after a season's nature study of propagation of plants made the following table inductively, that is by generalizing the examples experimented upon or observed.

Plants propagate by :—

—spores	as horsetail
—seeds	bean
—root-sprouts	poplar
—divisions of the plant :—	
(A) natural separation of parts :—	
(*a*) bulbs	gladiolus
(*b*) bulb scales	lily
(*c*) bulblets	Chinese yam
(*d*) tubers or corms	squirrel corn
(*e*) layers	black raspberry
(*f*) detached tips of branches	water milfoil

(B) artificial separation of parts:

(*a*) layers . . . . . tomato

(*b*) cuttings:

(i) stems . . . . wandering-jew

(ii) tubers . . . . . potato

(iii) roots . . . . horse-radish

(iv) leaves . . . . . begonia

(*c*) budding . . . . . peach

(*d*) grafting:

(i) cleft . . . . . . apple

(ii) splice . . . . . willow

(iii) inarch . . . heliotrope

(iv) root . . . . . dahlia

How Plants Work.—To show how plants drink, take a pickle-bottle nearly filled with water to the cornfield. With a sharp knife cut off two or three feet of a green corn-stalk and at once set the cut end in the bottle of water. When brought to the school-room the pupils will observe the rapidity with which the stalk takes up the water. Infer that its transpiration through its minute stomates must keep pace with its absorption, also that a growing crop of corn takes from the soil a great quantity of water.[1] Infer the need of making and keeping the cornfield mellow. Apply conclusions to other plants.

The roots of a willow tree have been known to penetrate a fire-brick soil-pipe cemented at the joints and to choke the pipe. Two willows standing at the east side of a farm-house kept a well over twenty feet deep situated on the west side dry during the summer. After the willows were cut down the

[1] The average of a number of experiments determined the fact that it requires 270 lbs. of water to mature one pound of dry corn-stuff.

well's former usefulness was restored. Set pupils inquiring about and observing the work done by plant roots.

The growth of potato stems in a cellar illustrates how the plant strives to reach the light.

Setting a freshly-cut stem in water colored with red ink or aniline blue for a few hours will enable one to trace the paths taken by the raw fluids that enter a plant. Balsam or nasturtium stems are suited to this experiment. Cut off a thin willow branch; two or three inches from the lower end carefully girdle a ring a half inch wide without cutting the wood. Set it in water that does not reach the girdling. Note how long the leaves remain fresh. Similarly girdle another willow twig and keep it, the girdling being immersed, with a third ungirdled twig in water. Note where roots begin to grow in each case. Infer that the raw fluids traverse the wood and the digested fluids the bark.

Nutrient Solution for Plants.—All solid plant food must be dissolved before it can be absorbed. By analysis, the elements of the substances that green plants require for food have been discovered. The experiments made by Sachs led to his discovering that if the following quantities of the substances named are dissolved in a gallon of water, the solution will nourish plants from germination to flower, or in some cases to fruit: One-twelfth of an ounce of each of—table salt, $NaCl$; phosphate of lime, $Ca_3(PO_4)_2$; gypsum, $CaSO_4$; Epsom salts, $MgSO_4$; one-sixth of an ounce of saltpetre, KNO_3; a bit of chloride of iron about the size of a small pea. If you have not the means of weighing a smaller quantity than a quarter of an ounce, either divide it by inspection into three equal parts, or make up three gallons of the solution. Plants may be grown in this solution, changed occasionally as it weakens, supported on a piece of muslin tied over a tumbler or in sawdust, or clean sand, or sponge regularly watered with the solution. Each plant may be set in an eggshell half-filled with broken glass or sand, or in a small bottle, always taking care to renew the solution occasionally, or frequently if the vessel be small.

Plant Life-Histories.—The beginner, who desires to teach the life-history of plants, but lacks confidence in his own eyes and judgment, can find a large and increasing literature to help him. If he uses such helps in a few examples, after the manner that the Sulphur Butterfly was treated, page 128, he may hope soon to be able to deal with any common plant from original investigation. M. W. Morley's "A Few Familiar Flowers" will direct you in the study of the morning glory, pp. 1-67; nasturtium, pp. 107-153; geranium, 181-215. C. B. Scott's "Nature Study and the Child" devotes 37 pages to the Dandelion. Wood's "How to Study Plants" and nearly all the books mentioned on pages 24 and 25 give lessons on plants or histories of them. In "Public School Nature Study" there are catechetical lessons on clover, trillium, dandelion, horse-chestnut, maple, apple, potato, grass and plantain.

School Gardens.—In Ontario and New Brunswick government grants are given to boards of trustees making provision for school-gardens that come up to a prescribed standard of area and equipment. Through the munificence of Sir William C. Macdonald, administered under the energetic initiative and wise direction of Dr. Jas. W. Robertson, a group of five school-gardens has been established as examples in each of the Provinces named above and in Nova Scotia, Quebec, and Prince Edward Island. In the *Queen's Quarterly*, 1905, pp. 390-419, Inspector Cowley has given an account of the work accomplished in these twenty-five schools, dwelling particularly on the results in the Ontario group in Carleton County. Besides the Macdonald School Gardens, Nova Scotia has

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From "Queen's Quarterly."

Bowesville School Garden.

Opposite Page 159

upwards of seventy school gardens established without any special grant or help, and conducted solely, to use Supt. MacKay's words, "to make the educational work of the school more useful." And this is the aim with which every school-garden should be managed. As Inspector Cowley, writing of the Macdonald School Gardens, says:—

"While designed to encourage the cultivation of the soil as an ideal life-work they are intended to promote above all things else symmetrical education of the individual. They do not aim at education to the exclusion of utility, but they seek education through utility and utility through education. The garden is the means, the pupil is the end."

A union convention of the teachers of six of the eastern counties of Ontario, after visiting[1] and inspecting the Bowesville school garden adopted a resolution approving of the introduction of such gardens into both urban and rural districts.

The Values of the Right School Garden.—These claims are not too strong when one considers the kinds and extent of education for which the school-garden may give opportunity.

Physical conditions are favorable—exercise, fresh air, sunshine.

Intellectual powers are exercised in the planning of the work, in distinguishing causes and effects among a complex of contemporaneous phenomena, in understanding the science or theory of the different arts mentioned under "Exercises for the School Garden," and thereby contributing to the habit of inquiry—to the scientific attitude of mind. Learning to recognize species and variety of plants, and distinguishing weeds from economic seedlings, exercise the senses and judgment.

[1] The visit was made in the last week of May, '05. About 300 teachers drove out from Ottawa eight miles to inspect the garden.

The executive powers are called out in devising, choosing and executing means to ends that the child deems worthy.

On the moral side, the ideal garden inculcates system and order, develops a sense of personal responsibility and appreciation of property produced by one's own effort, disposes to manual exercise and leads to respect for honest toil and toilers. A beautiful garden has a strong influence in the right cultivation of the esthetic nature.

In respect to manual skill and knowledge that will prove useful in an agricultural country, it is worth something to acquire the deft use of garden tools, and much to study the science, as well as to learn the art, of the following exercises :—

Exercises for the School Garden.—Preparing the soil,—digging, draining if necessary, fertilizing, making it mellow.

Laying out the garden to scale on paper or blackboard; determining the use to be made of each part. Laying out the plan on the ground.

Procuring the seeds; testing the vitality of the seeds in seed-testers; germinating the tender kinds in pots or boxes.

Planting seeds in the open ground and transplanting from the seed-boxes.

Care of the growing plants—thinning, weeding, hoeing, watering, pruning.

Studying the kinds and nature of weeds and methods of eradicating them.

Studying the beneficial and harmful insects and methods of controlling the latter.

Experimenting with the effects of cultivation upon wild plants.

Studying the methods and advantages of rotating crops.

Artificial pollination. This can be done by the older pupils.

Budding, grafting and otherwise experimenting with the problems of plant propagation.

Correlations.—"The children were most interested," said an art teacher, "in the modellings, drawings, and color work upon objects brought from their own garden plots." Another teacher writes:—"The keeping of a diary by each child (of his own home garden) proved the best kind of composition. They wrote and dated their accounts of seeding, appearances of seedlings, thinning, weeding, cultivation, etc., on separate sheets first, and corrected them before they put them in their 'garden-books.'" An example of correlation to arithmetic and book-keeping is given on page 162.

Your school need not be deprived of the advantages and opportunities afforded by a garden, though it cannot get government aid or even a small grant from the board of trustees. It is possible to accomplish a good deal with only a couple of square rods of ground and borrowed implements. As in other things, where there's a will there's a way. But have a definite purpose for its establishment. Do not undertake a garden simply because another school has one. From the beginning have your eye on the end. Do not overlook the dangers to the garden attendant on the long summer holiday. Better have no school-garden than an abandoned and unsightly weed-plot from vacation to the end of the season. Enlist the sympathy of trustees and parents if possible.

School-gardening may be conducted along one or more of three lines—the individual home gardens (see pp. 17, 49, 83), the co-operative garden, and individual plots on the common ground. This last is the method employed in the Broadview Institute, described and illustrated on pp. 150-152 of "Public School Nature Study." The best school-garden consists of a common co-operative and experimental part and individual plots. In the Macdonald gardens each pupil is given a plot of his own, varying according to age and strength, from 72 square feet to 120 square feet. Instead of a single plot for flowers and vegetables two half-plots may be given to permit all the flower gardens to be placed together and separated from all the vegetable gardens. The following, from the *Queen's Quarterly*, is the financial statement of a plot, 10 by 20 feet, at the Bowesville school. Time is charged at ten cents per hour. Early crops of radish and lettuce were succeeded by beans and turnips.

Cost.		Proceeds.	
To preparing ground . .	.10	By 20 bouquets flowers .	.60
" stakes and labels . .	.10	" 2 quarts peas . . .	.20
" planting, 2 hours . .	.20	" 5 bunches carrots .	.15
" weeding, etc., 5 hours	.50	" 5 quarts beans . .	.15
" harvesting, 5 hours .	.50	" 10 bunches radish . .	.20
" seed: peas 5c., beans 2c.	.7	" 8 bunches of beets .	.16
" carrots 1c., beets 2c., onions 1c.	.4	" 3 bunches of onions .	.15
" parsnips 1c., radish 1c., lettuce 1c. . . .	.3	" 5 bunches of parsnips	.20
" flower seeds	.8	" 12 heads of lettuce .	.36
	$1.62		
Net profit	.55		
	$2.17		$2.17

Spiræa	Rose or Pyrus.	Weigelia or Deutzia.	Hydrangea or Cytisus.
Red Currant	Goose-berry	Black-berry.	Red Raspberry.
Black Currant	White Currant	Blackcap.	Straw-berry.

Meadow Fescue.	Satin Grass.
Awnless Brome Grass.	Orchard Grass.
Wheat	Rye.
Barley.	Oats.

Tomatoes	Potatoes.
Beans.	Pease.
Beets.	Parsnips.
Lettuce. Turnips	Radish Spinach

A followed successively by B C D.
B followed successively by C D A.
C followed successively by D A B.
D followed successively by A B C.

E followed successively by F G.
F followed successively by G E.
G followed successively by E F

Verbena.	Petunia
Aster.	Zinnia.
Phlox	Salpiglossis.
Mignonette.	Scabiosa
Pansy	Sweet Pea.

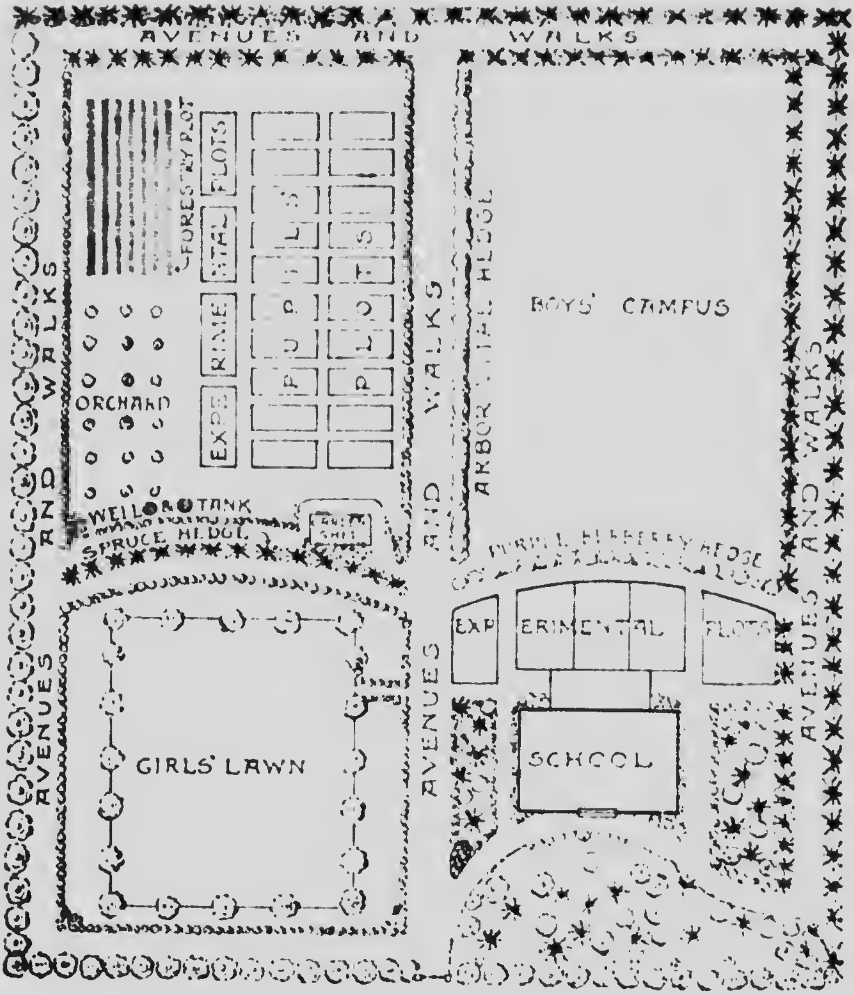
From "Public School Nature Study," p. 151.)

The plan given on page 163 was laid on a plot 42 ft. by 28 ft. (8 ft. 1 inch). A was a plot of wheat; B, grass seeded the preceding year when in wheat; C, grass to be broken in the fall; and D, root crop to be sown in the fall with winter wheat. E, F, G were fields showing a different kind of rotation—one suited to a stock farm. E was oats and peas followed by rape in the fall; F, oats followed by rye in the fall; and G, rye turned down in the spring and followed by corn. This is an example of a small co-operative garden like the one shown opposite page 16. It may be supplemented with the individual home-gardens. Conditions vary so much with locality that the garden successful in one place may be quite unsuited to another.

Aim to have as fine a garden as the Bowesville one. Failing that, you can surely, if you try, have one at least as good as that described above. This year, 1905, the students at the London Normal School laid out on a plot, 88 by 26 feet, one central, circular flower bed 12 feet in diameter, four triangular, six square, and twenty-four oblong plots, and planted therein a good variety of flowers, grasses, forage plants, sweet herbs, and garden vegetables not generally cultivated. See illustrations, opposite pages 16, 50, 159, 164.

If there is not room to spare on the playground, a few square rods can be rented in the corner of a field adjoining the school-yard.

Field Excursions.—Most of the outdoor studies suggested in this book are supposed to be done by the pupils at home or on their way to and from school. Many school-houses, however, are so favorably situated for co-operative outdoor work that it would seem neglect not to undertake it. Circumstances are so various that particular rules cannot be given. For the sake of suggestion, what is being done in the Ottawa

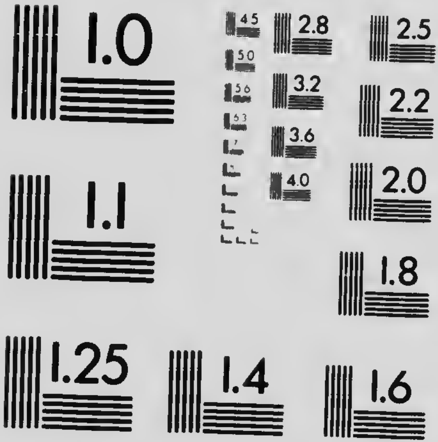


BOWESVILLE SCHOOL GROUNDS.

Opposite Page 164.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



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Model School is printed below. Reference has been made (p. 23) to the objection of parents who do not understand the educational value of properly conducted field excursions. In the example under notice, to inform the parents of the uses to which it is proposed to turn these excursions, Principal Putman addressed the following circular to them:—

In order that pupils may have opportunity for accurate observation of Nature, each class of Forms I, II, and III will devote ten afternoons from April to October to field work. The regular teacher will divide the class into four groups and give each in charge of a student teacher. The regular teacher will then be free to exercise general supervision.

It is hoped that the field excursions will furnish a basis for language lessons both oral and written, and also for drawing and color work. While every field day will furnish opportunity for a variety of work and for observation of many phases of nature, yet it is expected that when a class goes out for study the pupils and teachers go with well-defined plans, and with one or more definite objects in view. Where possible, teachers should make a visit to the locality to be studied before they take their classes.

1. STUDY OF TREES.—Buds, how developed and how unfolded; leaf forms; bark of trees; arrangements of branches, inclination of branches to trunks; common names of trees. Are certain trees always found in certain places? Are all trees of the same species of the same general shape? If not, why not?

2. SOIL.—By using a strong trowel or spade they will study soil to the depth of a foot or more. Pupils will get an accurate knowledge of such things as humus or vegetable mould, sand, gravel, clay, hard-pan loam, and evidences of animal life in soil.

3. PLANTS.—As the wild plants appear the pupils will study them in their natural surroundings. The parts, root, stem, leaf and flower will be carefully examined, habit of plant carefully noted, effect of sun on time of bloom. Specimens may be carried home for use in the next drawing lesson.

4. ANIMAL LIFE.—Every wild or domestic animal seen by the pupils will receive some attention. If domestic, its use to men will be noted: if wild, its home and habits will be an instructive lesson. Birds will receive special attention, and the time between April 1 to May 10,

before trees are in leaf, is best for observation. Teachers will have opportunities to observe with their classes such birds as robin, crow, swallow, hawk, blue-bird and flicker. Insects will be found in abundance, and prove a source of great interest. One or two nets should be provided for each class.

5. GEOGRAPHY. —A very important use of these field days will be the aid pupils will receive in Geography. They will get elementary notions at first hand. The compass will be consulted to teach direction. Such natural objects as soil in all its forms, rock, granite, limestone, boulders, brooks, swamps, springs, rivers, waterfalls, hills, valleys, shore, river-bed, beach, bluff, island, cape, peninsula, bay, watershed, river-mouth, tributary lake, outlet and bog—all these are within reach and may be studied at first hand.

The most uncompromising "anti-faddist," self-styled, would find difficulty in framing an objection to using ten afternoons in the year in the manner proposed above, especially by children brought up in a large city. Rural school children have less urgent need of this important kind of education at first-hand and by direct contact, but even they would be greatly stimulated and quickened by the competitive observation called out in a properly conducted field excursion. The importance of planning an excursion for *a definite object* cannot be too strongly emphasized, (p. 118).

Phenochrons and Phenology.—*Weather records* have been described (p. 91). The most advanced classes, particularly if the school is supplied with a barometer, may extend the schedule there proposed. Besides the kind of cloud, the extent may be added, by writing in a circle the estimated number of tenths of the sky that is clouded at the time of observation. If three-tenths be the estimated clouded area, it is written thus: (3). A column may be headed "Estimated Hours of Sunshine per Day." The difference between the readings of a dry thermometer and one whose bulb is covered with cotton batting conveying water to it by capillarity, and then called the wet bulb, varies as the moisture in the air. This difference may be daily recorded. If weather be studied inductively, the barometric readings of pressure are very important. After the record has been kept for two weeks or a month by the same class or in parts making when put together a continuous record, by different classes, summaries may be made and investigated. A graphic way of showing a summary is by a method called "plotting a curve." To mark the curve of temperature, for example, the range of temperature in degrees would be written in a vertical column on the left, and the days of the month in a horizontal line as the headings of the vertical columns, one for each day. A zig-zag line across the table would indicate the ups-and-downs of temperature as they occurred under the respective day-headings.

Phenochrons.—An admirable means of maintaining the observant attitude is by requiring pupils to report and record phenochrons of wild and cultivated plants, farming operations, meteorological events and bird migrations. Nova Scotia's experience, extending now over several years, has proved this statement, and demonstrated the practicability of the method. The forms sent out from the Chief Superintendent's Office mention a hundred events to be observed at each school, and suggest the adding of others according to opportunity. As was suggested on page 121, associations of teachers in the other provinces of Canada might do well to take this subject up, with a view to securing co-operative work throughout an inspectorate or group of counties.

The Nova Scotia Schedule.—The following are the headings and a few of the events noted in the Nova Scotia schedule:

The estimated length and breadth of the locality within which the following observations were made........×........miles. Estimated distance from the sea coast........miles. Estimated altitude above the sea level........feet.

Slope or general exposure of the region ....

General character of the soil and surface ....

Proportion of forest and its character ....

Does the region include lowlands or intervales? ....and if so name the main river or stream ....Or is it all substantially highlands? ....

Any other peculiarity tending to affect vegetation? ....

....

The most central Post Office of the locality or region ....

NAME AND ADDRESS OF THE TEACHER OR OTHER COMPILER OF THE OBSERVATIONS RESPONSIBLE FOR THEIR ACCURACY.	When First Seen.	When Becoming Common.
(WILD PLANTS, ETC.—NOMENCLATURE as in "Spotton" or "Gray's Manual.")		
12. Dandelion (Taraxacum officinale), flowering...		
13. Adder's Tongue Lily (Erythronium Am.), flowering		
14. Gold Thread (Coptis trifolia), flowering.......		
15. Spring Beauty (Claytonia Caroliniana), flowering etc., etc.		
FARMING OPERATIONS.		
66. Plowing begun......		
68. Planting potatoes..............................		
69. Shearing of sheep..............................		
etc., etc.		
METEOROLOGICAL.		
73. Opening of (*a*) Rivers, (*b*) Lakes without currents		
74. Last snow to whiten the ground..............		
78. First snow to whiten the ground......		
80. Dates of thunderstorms......................		
etc., etc.		

	Going North or Coming in Spring.	Going South or Leaving in Fall.
(MIGRATION OF BIRDS, ETC.)		
81. Wild Duck migrating		
82. Wild Geese migrating		
83. Song Sparrow (Melospiza fasciata)		
84. American Robin (Turdus migratorius)		
.....		
99. Piping of Frogs		
100. Appearance of Snakes		

[Day of year corresponding to the last day of each month.]

Jan. 31.	April 120.	July 212.	Oct. 304.
Feb. 59.	May 151.	Aug. 243.	Nov. 334.
Mar. 90.	June 181.	Sept. 273.	Dec. 365

(For LEAP years increase each number except that for January by 1.)

In reporting the dates, the day of the year is preferred to the day of the month.

To the forms, Dr. McKay, Superintendent, prefixed the following notes:—

"What is desired is to have recorded in these forms, the dates of the first leafing, flowering and fruiting of plants and trees; the first appearance in the locality of birds migrating north in spring or south in autumn, etc. While the objects specified here are given so as to enable comparison to be made between the different sections of the Province, it is very desirable that all other local phenomena of a similar kind be recorded. Each locality has a flora, fauna, climate, etc,, more or less distinctly its own; and the more common trees, shrubs, plants, crops, etc., are those which will be most valuable from a local point of view in comparing the characters of a series of seasons.

"Teachers will find it one of the most convenient means for the stimulation of pupils in observing all natural phenomena when going to and from the school, some of the pupils radiating as far as two miles from the school-room. The Nature Study under these conditions would be mainly undertaken at the most convenient time, thus not encroaching on school time; while on the other hand it will tend to break up the monotony of school travel, fill an idle and wearisome hour with interest, and be one of the most valuable forms of educational discipline. The eyes of a whole school daily passing over a whole school section will let very little escape notice, especially if the first observer of each annually recurring phenomenon receive credit as the first observer of it for the year. The observations will be accurate, as the facts will have to be demonstrated by the most undoubted evidence, such as the bringing of the specimens to the school when possible or necessary. To all observers the following most important, most essential principles of recording are emphasized: Better no date, no record, than a wrong one or a doubtful one."

For the purpose of dealing with these reports the Province is divided into ten regions. A specialist in each region receives the reports from the schools of his region and makes a summary for the Education Department at Halifax. One hundred phenomena are mentioned in the printed form, but in the general summary for 1904 several schools reported over 200—the one at French River, Miss McLaren's, led with 272. Think what it means to a group of children that they have in a year observed, discussed and named or expressed over 200 noteworthy natural phenomena. British Columbia and Denmark, it is said, have adopted this feature of Nova Scotia's Nature Study work.

Minerals and Rocks.—The uses, physical properties and natural history of some of the common minerals may be studied in an elementary way with much profit and interest by the higher grades. In some school sections the materials are varied and abundant, and may be studied in their native situations as well as in the school-room. So far as practicable the materials should be collected by the pupils. Something to start upon may be found in every section, and fortunately it is not difficult to obtain from outside sources specimens enough of a few kinds to go round the class.

Where to get Minerals.—Minerals are to be had by searching in the fields, river banks, gravel pits, quarries, stoneyards and marble cutters' yards. Certain dealers keep them for sale. Bituminous coal, anthracite, rock salt, gypsum, asbestos, sulphur, graphite, soapstone, and mica are generally procurable. Variety may be increased by exchanging specimens that you can spare. A small collection of minerals, properly boxed, is ornamental as well as useful. See the engraving of such a box in "Correlation of Nature Study and Manual Training," opposite page 46.

Mineral Study and Physiography.—The study of that part of physical geography called physiography, the part that is concerned with the dynamic and chemical effects of water, atmosphere, and change of temperature upon the solid substances that form the earth's surface—is interesting, useful and educative. It cannot be prosecuted very successfully without some study of the nature and properties of these substances; and just as the sciences of botany and zoology should be founded upon the nature study of plants and animals so should physics and inorganic chemistry and geology grow out of the similar study of the forces and materials of the inanimate world within the circle of the learner's observation. Physical and chemical experiments made to discover or establish truths related to objects the pupils are studying are more educative, at least to beginners, than if performed apart from their applications like so many imaginary problems in mathematics. (Page 10.)

Elementary Lessons on Minerals.—In "Public School Nature Study," pp. 157-165, there are given introductory lessons on ice and mica, limestone and quartz, and a topical scheme for the deeper study of any mineral. At the start, choose from the scheme the topics that present the least difficulty in investigation and expression; gradually increase the number and difficulty of the observations and experiments. The pupil's vocabulary of technical terms will enlarge and clarify with experience. Terms and definitions either here or elsewhere should not be taught in advance of their use. Paddock's "Mineral Schedules"[1] bear the following headings: hardness, form, structure, cleavage, fracture, tenacity, color, streak, lustre, diaphaneity, touch, magnetism, electricity, specific gravity (or weight), chemical properties, composition, formula, classification, tests, variety, uses, how extracted, natural history. The series of minerals which that teacher recommends, arranged in the order of hardness, is: 1, steatite, graphite; 2, gypsum, rock salt, mica; 3, limestone, coal, cryolite, galena; 4, fluorite, azurite, zincite; 5, apatite, hematite; 6, feldspar, magnetite, pyrite; 7, quartz.

Sample Lesson on Coal.—The expression of a study of *anthracite*, for example, along these lines would read something like this:

Hardness.—It can be scratched with the point of a pin; it cannot be scratched at all with the finger nail, therefore it is between 2 and 3,

Scale.—1, talc or steatite, scratches easily with the finger nail; 2, gypsum, scratches hardly with the finger nail; 2½, mica, scratches with copper wire; 3, calcite, scratches with point of pin; 4, fluorite, scratches easily with point of a well-tempered knife blade; 5, apatite, scratches hardly with point of knife or hard glass; 6, feldspar, scratches with a file; 7, quartz, hardly with corner of hard file; 8, topaz; 9, sapphire or corundum; 10, diamond.

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[1] "Minerals in the Public Schools," No. 1, a Pupil's Manual with Outline Blanks, by M. H. Paddock, Providence, R.I., 25c.

Form.—The exterior form is irregular, therefore it is *massive.* (Had it had plane surfaces set at definite angles it would have been a *crystal.*)

Structure.—The broken surface is irregular, hence *amorphous.* (Rock salt shows *crystalline* and marble *crystallized* structure.)

Cleavage.—Lacking, although some specimens cleave along the natural lines of formation and therefore simulate crystalline structure and basal cleavage.

Fracture.—It breaks something like glass with shell-like surfaces, therefore *conchoidal.*

Tenacity.—It cannot be hammered into thin plates like copper, therefore it is not *malleable;* it cannot be shaved into plates, hence it is not *sectile;* such operations would break it into little bits, therefore it is ***brittle.*** (Why is it not *elastic* or *flexible?*)

Color.—Black.

Streak.—The powder when obtained by scratching or filing shows black on a white surface, therefore the streak is *black.*

Lustre.—*Metallic, shining.*

Diaphaneity.—Light does not penetrate it, hence it is *opaque.*

Touch.—It feels *smooth.*

Magnetism.—A magnet has no effect on [illegible]ther the fragment of coal or on its powder even when the [illegible] heat[illegible]d.

Electricity.—When a piece of coal is [illegible]n a woollen cloth it does not move a bit of paper or [illegible] near which it is held.

Weight.—*Light* when compared with [illegible] *[illegible]dium.*

Specific Gravity.—A lump of hard coal [illegible] $8\frac{1}{2}$ ounces weighed in water $3\frac{3}{4}$ ounces; hence its s.g [illegible] and by dividing 8½ ounces by the loss of weight in water, 4¾ ounces.

Chemical Properties.—Not affected by hydrochloric or other acids. Burns giving off gases.

Composition.—

Formula.—

Classification as a Mineral.—These three topics can hardly be studied by the Nature Study method. Items entered in the record that are not discovered by investigation should be credited to the teacher or other source of information.

Tests.—Color; it burns without melting. Asphaltum resembles coal but it fuses with heat.

Varieties.—There are many grades between bituminous coal and the brightest, hardest anthracite. Shale, pyrites or other impurities are mixed with coal in some specimens.

Uses.—The uses that are stated upon the authority of observation or experience should be distinguished from those that are learned second-hand.

Natural History.—What most pupils will say about the mining and formation of coal will be derived from their reading. The sources should be acknowledged. Pupils should be shown where and how to obtain information in which they are interested but which they cannot discover for themselves.

Rocks.—The recognition and nature of the commoner rocks should be taught in this connection. Quartz, feldspar and mica can be recognized in many specimens of granite. Gneiss is usually coarser and layered and is of similar composition. Schists, slates and shales are layered rocks. Sandstones and limestones, explained by their names, were laid down in water; specimens of these rocks can often be picked up around buildings in course of construction where stone is used.

Examine a bit of granite or gneiss with a lens. How many kinds of minerals can you see? Break it up with a hammer. Pick out bits of mica; of feldspar. The feldspar is the source of clay. What becomes of the disintegrated quartz?

Powder a bit of limestone and place in a bottle or test-tube. Add some dilute hydrochloric acid. Note the effervescence. Use dilute sulphuric acid, also strong vinegar, and compare the results obtained in the three cases. Apply heat and note effects if any. Experiment similarly with slate, gypsum, egg-shells, quartz, clay, marble. Select the substances containing lime.

If the school is equipped with the means of using a Bunsen burner, or even a blowpipe with a grease-lamp, the number of interesting experiments upon and tests of minerals and rocks may be much enlarged. Crosby's "Determination of Minerals," 106 pages, will be found a helpful book.

The Atmosphere.—In most public schools the means of teaching the composition of air by the Nature Study method will not be available. Lavoisier's experiment of separating the gases and investigating each separately can be repeated in a small laboratory, but the steps would hardly be understood by pupils at this stage. It may be shown by burning a candle in an inverted gem jar over water, still better by supporting a piece of phosphorus in a similarly inverted jar for a few hours, that about one-fifth of the air in the jar has been displaced by water. The pupils may be told that the fifth that combined with the phosphorus is called oxygen and that it is the life-giving, flame-supporting element of the atmosphere, and that the remainder is mostly nitrogen. A fraction, four ten-thousandths, is carbon dioxide, which though small is very important because it is necessary for plant food. There is always some water-vapor in the air. It has important uses, too, one of them being to equalize and distribute heat.

Combustion and Candle Flame.—The growing tree fed upon the carbon dioxide in the air and out of the elements of that gas and water made its wood. The part that remains as ash when the wood is burned came from the soil. When you burn a match you set in operation a partial reversal of the operations that produced the wood. This process restores the carbon dioxide to the air and is called combustion.

Light a candle and observe three zones, a dark central zone where there is little or no combustion, a radiant zone where there is partial combustion and a mantle where the combustion is perfect. Place the tip of slow-lighting matches successively in these three zones and observe the differences in the times of lighting. Place a matchstick across the flame and observe where it burns most. Place a piece of white cardboard over the flame almost touching the top of the wick; remove carefully and observe the differences in the soot rings.

Carbon Dioxide.—Burn a candle for a few minutes in a gem jar. Remove the candle, put in an ounce of limewater and shake the jar. Observe the milkiness in the limewater. With a tube or straw breathe into a bottle containing an ounce of limewater. Account for the similar effects upon the limewater in each case. The milkiness is due to the formation of fine particles of limestone by the carbon dioxide and the lime dissolved in water.

Fire needs Air.—Light a short candle, set it on a smooth surface and invert a tumbler over it. The flame soon goes out. Infer what should be done when clothing catches fire. Water puts out fire by cutting the air supply off from the coal that it surrounds and by cooling the carbon. Carbon does not burn when the temperature is reduced below a certain degree.

Mechanics of Implements and Tools.—The Ontario Course suggests the study of the applications of mechanical principles in the construction of farm and household implements and tools. Some pupils are very strongly attracted to this kind of investigation. "I reformed him," said the teacher of a rather incorrigible boy, "by the accident of asking him to show to the class and explain a telephone he had made." Making tops, kites, pumps (p. 23), motors, etc., and studying the principles of their action is excellent education. Important facts in physical science are taught very effectively if these home-made or purchased toys are subjected to discussion and explanation in the class-room. Keep eye and ear open for opportunities to introduce such lessons.

All the tools and machinery used on the farm and in the household and shop can be analyzed into six simple forms—the lever, the wheel and axle, the pulley, the inclined plane, the wedge and the screw. By the Nature Study method the teacher would not start out by describing the lever, defining weight and fulcrum and then seeking applications, but would begin with the last and lead to the discovery of the principle and recognition and definition of the parts. How is power applied with a spade, with a pick, with a crowbar? When enough examples have been compared to discover the principle it may be sought in less explicit cases—in scissors, pincers, steelyards, balances, pump-handle, claw-hammer, etc. Another type of lever is used in nut-crakers, lemon-squeezers, wheelbarrow, boat-oar, turnip-cutter, and a third type—the power between the fulcrum and the weight—in ladder-raising, shutting a door by pushing near the hinge, pitching hay, lifting a weight in the hand, holding a foot off the ground. A type lesson on the lever is given in "Public School Nature Study," pp. 191-194.

The wheel and axle is seen in many of the farm machines, usually in combined wheelwork, as in a fanning-mill or reaper, and in a watch. Simple examples are the windlass of the well-digger and the capstan of the house-mover or anchor-raiser.

Every farmer's boy is familiar with the *pulley* in the "block and tackling" of the horse-fork. City pupils often see cranes and derricks in use to move heavy merchandise or building material.

Loading-planks, hillside roads and stairways are *inclined planes.* When the inclined plane moves against the weight it is called a *wedge.* The wedge used in cleaving wood consists of two inclined planes back to back. Axes, knives, chisels, jack-planes, and needles apply the principle of the wedge. If the inclined plane winds spirally around a cylinder the machine is called a *screw.* The screw-nail, boring auger, letter-press and cider-press are examples.

Now and again the teacher will witness or hear of some circumstance that may open the way to teach a lesson in physical science as for example, when it was reported that one of the girls had dropped her brooch in a cistern, the loss was made the opportunity to give an elementary lesson on *reflected light.* A hammer that fell in a well while a man was repairing the cover was brought to the surface by a *magnet.* The circumstance was related during the Nature Study period and the interest it excited was utilized in the teaching of a lesson.

A picture fell because a pupil tied a "granny" knot on the hanging cord. The accident started a series of short lessons and exercises that ended after a week or two in a knotting competition The honor of being most expert was awarded to the one who could make the longest cord out of ten pieces, each four inches long, strong enough to hold up a fruit basket filled with bricks, and at the same time have the greatest variety of knots in it. It is worth while to know how to tie a shoelace properly, and to tie a horse safe to a post by a rope that is to go around his neck. It takes some thinking to tell why one knot holds while another nearly similar one slips. The teacher who knows the topic and knows his profession can make good lessons out of such commonplaces even as tying knots. This is not an argument in favor of teaching Nature Study lessons on subjects that are not "worth while." When there is so much to choose from, there is no need to give a single worthless lesson. But the title of a lesson does not tell its merit; a topic that may be valuable in one teacher's hands may be worth little in another's.

Sun and Moon.—That the Sun is our chief source of light and heat, and that it remains above the horizon longer and shines more nearly vertically in summer than in winter is about all that can be taught of it in the public school by direct observation. Its disc may be looked at through dark brown or smoked glass; sometimes there are spots on its surface large enough to be thus made visible to the eye. A good deal may be done with the shadow cast by a fixed or definitely placed object as the angle of a window frame[1]; even the imaging of the ecliptic can be taught to an advanced class by reasoning from the observed westerly progress of the stars. For a lesson on the use of a "shadow-stick" see pp. 182-4 of "Public School Nature Study."

In the study of the Moon there are a few facts that must be given by the information method, such as that the moon shines by reflected light and that its path passes monthly between us and the sun. Working from these facts excellent lessons may be taught by observation, including the period of time and direction of the moon's circuit, and its monthly swing from tropic to tropic. Evening after evening the changes of its position relative to observed stars may be noted and interpreted as its easterly motion by children even as young as those in the Second Form. In the book last named there are directions for observing the lunar motions and phases.

[1] Poising a drain tile or a square box, without ends, parallel to the sun's rays on a horizontal sheet of paper, and drawing the inside shadow line at different times of the day, and at the same time of day in different seasons of the year, will show the scattering of light and heat due to obliquity of the rays.

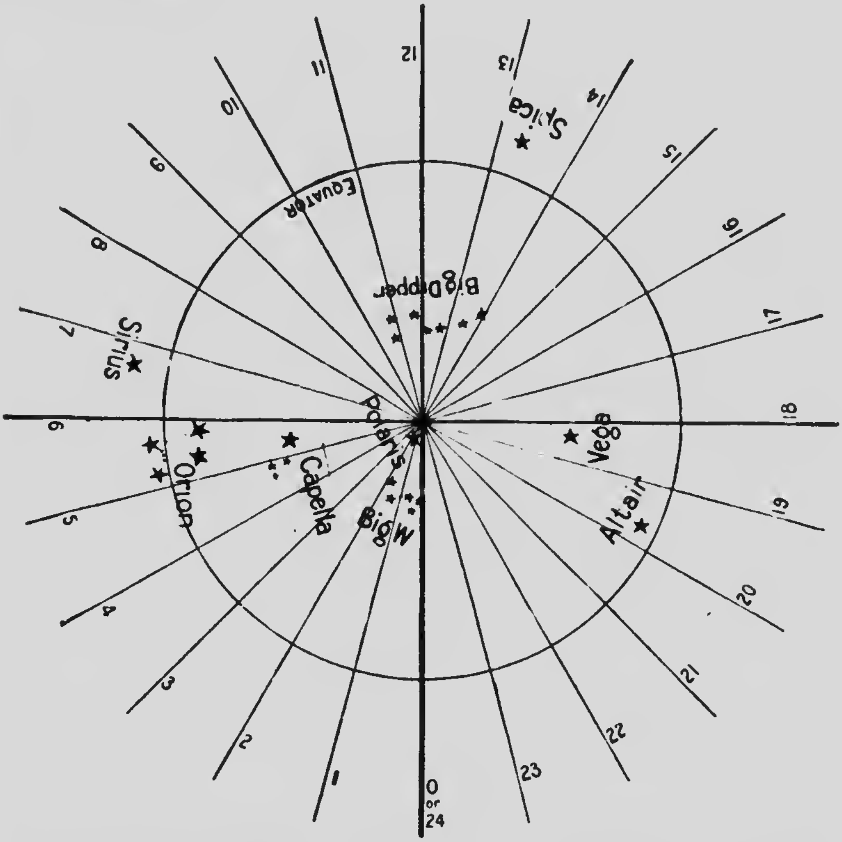
Constellations and Planets.—No child in the school is too young to begin to observe the beauty and motions of the more conspicuous objects in the evening sky with some degree of intelligence and a greater degree of pleasure, and no student in any school is so far advanced that in the same field there is nothing left to excite his wonder and engage his most serious intelligent efforts. The reply of the ancient philosopher, Anaxagoras, to the question, "what makes life worth living?" was "the contemplation of the heavens and of the universal cosmic order." The author[1] of a book going through the press as this is written says: "I was happy in having parents that watched over my infancy in such an intelligent manner that I hardly felt their supervision. A great deal of time was given for looking and listening round about in garden and fields. No screen in the shape of a prematurely given book came between me and the living book of the universe. I walked through nature like the ancients through sacred woods. Especially at nightfall the stars impressed me exceedingly. They spoke to me and I to them. I still remember the little gallery where I used to kneel and worship the moon. . . . So parents . . . if you can, put them soon, often, and for as long a time as possible, in contact with nature, with mountains, woods, fields, and with that glorious firmament on high which is the marvel of marvels."

Several teachers have told me of the delight with which the pupils have returned to the school-house on appointed evenings to observe and talk about the stars, and of the evenings at homes where the children of the respective immediate localities had gathered for the same purpose.

How to Obtain Assistance from Star-Maps.—In using astronomical maps the teacher is at first embarrassed by the fact that the east is towards the left hand side of the map and the west towards the right. The North-Star, when it appears on a map, should be regarded as the top; when it is turned

[1] Rev. Charles Wagner.

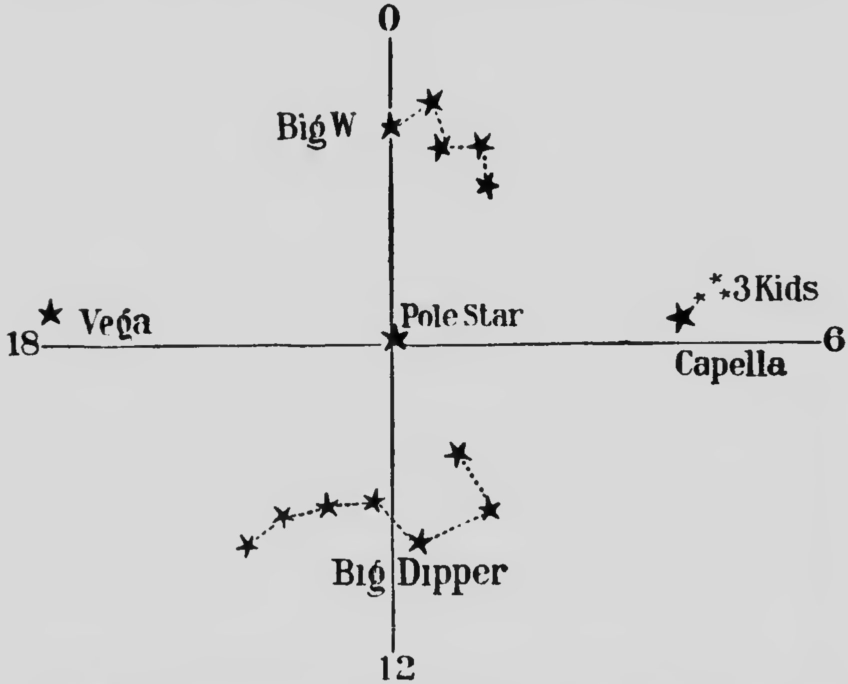
away from the observer the part of the map towards him has its east to the left and its west to the right. The reason may appear if the map is looked at while held overhead in such a position that *Polaris* is in a line from the eye to the North Star. Observe then that the name-numbers of the meridians decrease towards the left, the west, and increase towards the right, the east.



About the 21st March, the Sun is on line 0 which is therefore overhead at mid-day; line 12 is overhead at midnight. About the 21st of April, line 14 is overhead at midnight. About the 21st of May, line 16 is overhead at midnight. And thus throughout the year, every 30 days the Sun and the midnight zenith move across two meridional spaces towards the east.

Latitude in the sky, called *declination*, is counted from the equator north and south. The parallel overhead in the sky has the same designation as that of the observer, *e.g.*, the zenith-parallel at London is 43°, at Toronto 43°40′, at Halifax 44°39′, at Winnipeg 49°53′.

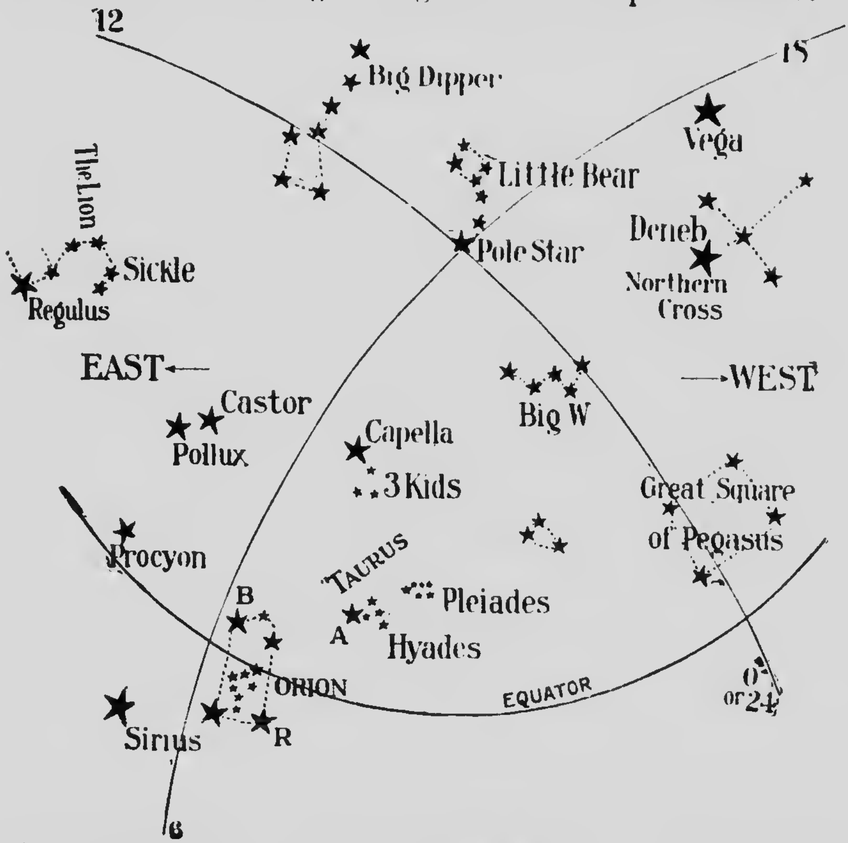
Longitude, called *right ascension*, is measured either in degrees or circular hours, from the meridian drawn from the North Star through the point on the equator where the sun crosses at the vernal equinox, on or near the 21st of March. Twenty-four equidistant meridians, numbered from the initial one as they pass overhead from the east, mark the sky off into that many meridional regions. The initial one, No. 0 or 24, passes near the outer star of the sharp V of the Big W; No. 12 passes near the middle star of the Big Dipper. The meridians at right angles to these, No. 6 and No. 18, can easily be imagined, and these four mark the sky off into four quarters, which can be learned by pupils in the higher grades.



Begin Observation with Ursa Major, Polaris and Cassiopeia. The best group of stars to begin with is the Big Dipper.

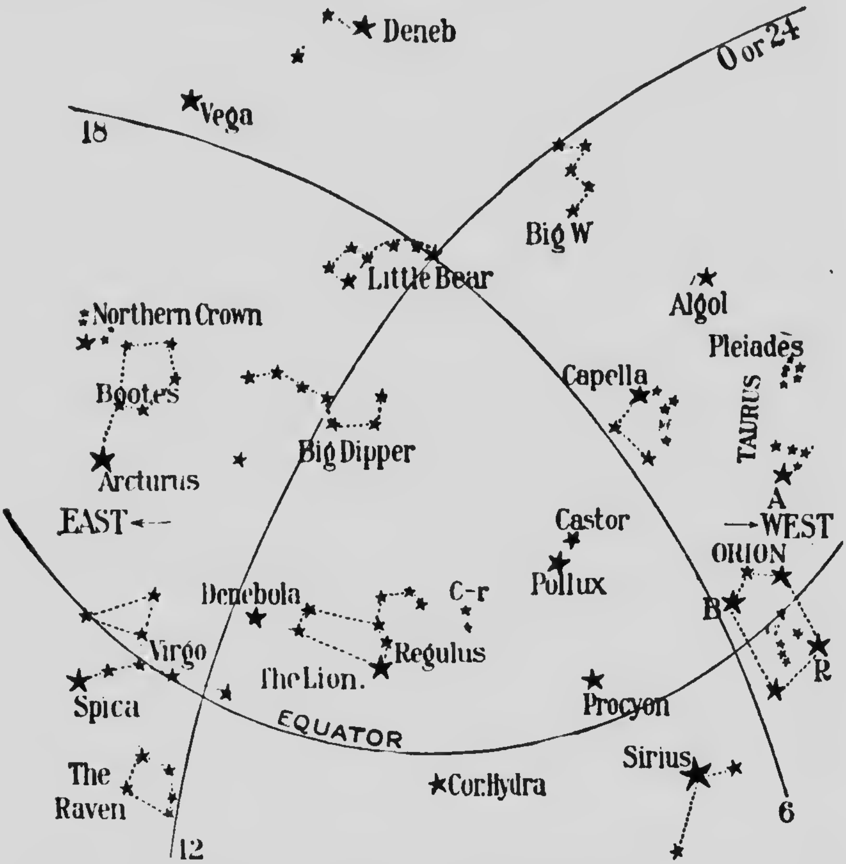
On any clear night it is visible in any part of Canada. Observe it at an early hour and again at a later hour in the same evening, and, if practicable, on the following morning, to learn the circuit that it appears to make. The two outer stars of the bowl always point to the North Star. The Big W, Cassiopeia's Chair, is on the opposite side of the North Star and about the same distance from it as the Big Dipper, as shown in the following diagrams :—

The Winter Evening Sky.—Capella is overhead between 10 p.m. and 11 p.m. in early January, between 8 p.m. and 9 p.m. in early February, and between 6 p.m. and 7 p.m. about the beginning of March. At 9 p.m. about the 1st of January the sky shows the following arrangement of conspicuous stars :—



The 0 to 6 Quarter. Line 0 is overhead at 8 p m. about the 22nd of November. Line 6 is overhead at 8 p.m. about the 21st of January.

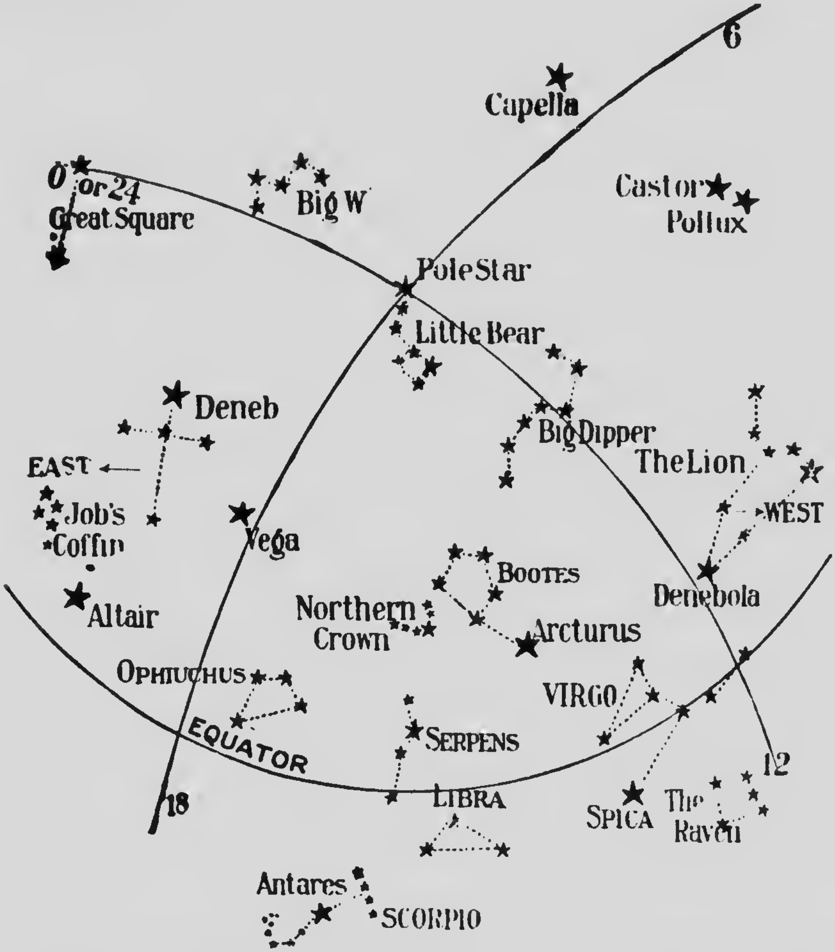
The Sky in the Evenings of Spring.—The Big Dipper is overhead at 11 p.m. in early April, at 9 p.m. in early May, and at 7 p.m. in early June. The conspicuous stars and groups then are the Lion, containing Regulus and Denebola, the Virgin containing Spica, the Raven (Corvus), and Boötes containing Arcturus. The following map shows the arrangement at 9 p.m. about the 1st of April:—



The 6 to 12 Quarter. Line 6 is overhead at 9 p.m. on the 1st of February. Line 12 is overhead at 9 p.m. on the 6th of May.

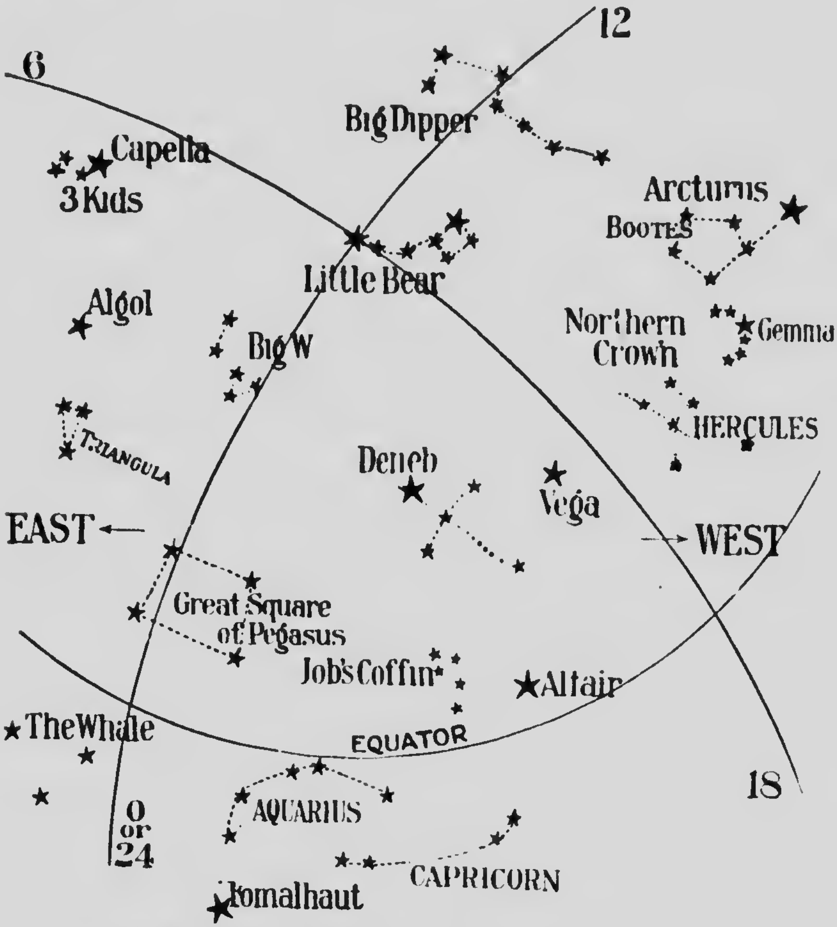
The Sky in the Summer Evenings.—Vega is overhead at 11 p.m. in the first half of July, at 9 p.m. in the middle of

August, and at 7 p.m. in the middle of September. The star features of this quarter are the Scorpion in the south-west containing Antares, and an immense isosceles triangle nearly overhead made by Deneb in the Swan, Vega in the Harp, and Altair in the Eagle. The following diagram shows the sky at 9 p.m. about the 1st of July, and at 6 a.m. about the middle of February:—



The 12 to 18 Quarter. Line 12 is overhead at 9.30 p.m. on the 28th of April. Line 18 is overhead at 9.30 p.m. on the 28th of July.

The Sky in the Evenings of Autumn. The Big W is on our zenith meridian at 11 p.m. in mid-October, at 9 p.m. in mid November, and at 7 p.m. in mid December. Fomalhaut is in the south-west. The great square of Pegasus is overhead and the Pleiades and the Bull's Head are well up in the east. At 9 p.m. about the 1st of October the sky appears as in this map:—



The 18 to 24 Quarter. Line 18 is overhead at 8 p.m. on the 22nd of August. Line 0 or 24 is overhead at 8 p.m. on the 22nd of November.

At 9 p.m. (solar time) in the middle of September, the line drawn from the North Star, due south—the zenith meridian—

passes through Deneb in the Swan, sometimes called the Northern Cross, and through Job's Coffin (the Dolphin). The great triangle of Deneb, blue-eyed Vega and Altair, is conspicuous in the Milky Way. Arcturus and red Antares are passing out of sight in the west. The Northern or Ariadne's Crown, with its brilliant Gemma, is in the north-west. Between the Northern Crown and Vega, a beautiful constellation called Hercules, containing the Flower-pot, can be studied. The brilliant star in the south-east is Foma[illegible] About two hours east of Deneb and the Dolphin you [illegible] the west side of the great square of Pegasus. (See map, p[illegible]

At 8 p.m. on the 1st of January the zenith meridian [illegible] through Perseus, containing Algol, the Demon Star. [illegible] Great Square is passing to the west, and the No[illegible] Crown, Job's Coffin and Fomalhaut are setting. A gl[illegible]ous [illegible]mbination is coming up in the east. The six Pleiades, [illegible]alled [illegible]roneously by some people the Little Dipper and the Bull's Head, also known as the [illegible]es or the Big A, containing Aldebaran the Bull's Eye ar[illegible] [illegible]ly overhead, and close following them comes Orion, the giant, the most brilliant constellation in the sky. North-east of the Pleiad[illegible] observe Capella attended by a little triangle known as the T[illegible]ee K[illegible] Further to the east may be seen the Heavenly Twins, called Castor and Pollux, the Little Dog Star (Procyon), and the Great Dog Star (Sirius), by far the most brilliant fixed star in the firmament. Aldebaran, Betelgeuse, Sirius and Rigel form the outline of a beautiful lozenge. (See map, p. 183).

At 8 p.m. on the 1st of April the zenith meridian passes through the front of the Great Bear whose hind-quarter and tail make the Big Dipper and also through Cancer, the Crab. Two of the stars called the Asses in Cancer are easily identified; they are in line just south of the zenith. Between them is a faint cluster called the Beehive or Præsepe that may be used as a test for eyesight. In the western half of the sky make out the Twins, the Little and Great Dogs, Capella, Orion and Taurus. On the east the Lion is well up, in the south-east notice the Virgin and Corvus, and in the north-east Arcturus and the Northern Crown. Arcturus is easily indicated by following the curve of the handle of the Big Dipper around to the Tropic of Cancer. Arcturus, Spica and Denebola make a great equilateral triangle. (See map, p. 184).

With a little assistance these groups can be easily identified by a Second Reader class, and if the teacher has access to any of the numerous elementary books on stellar astronomy he will be able to maintain an educative interest in the subject all the year round and in all the classes.

The planets cannot be located on perm ent maps because they are always changing their relative positions among the stars; one or more of them is seldom absent from the evening sky. They vary in brightness according to their relative position in respect to the earth and the sun. They are easily identified from the table of latitude and the meridian passage, that is the time of day when they are directly south or on the zenith meridian, published annually in the "Canadian Almanac." This table gives the position of Mercury, Venus, Mars, Jupiter and Saturn, every tenth day in the year.

An astronomical almanac, or the "Canadian Almanac," is almost indispensable to a teacher who is directing Nature Study observations on the phenomena of the celestial luminaries. There are three good chapters in "Public School Nature Study." Among elementary books, Steele's "New Astronomy," Todd's "New Astronomy," Bowen's "Astronomy by Observation," and Ball's "Starland," may be recommended. Mary Proctor's "Stories of Starland" is suited to readers in the Second and Third Forms.

Physiology. The best modern text books on physiology for public schools make liberal use of the Nature Study method; the latest Canadian work—Knight's "Introductory Physiology and Hygiene"—may be cited as an example. Objective instruction in this subject should not be limited to the amount indicated in even the best of books. Some means may be found in nearly every lesson to appeal to observation or experience. The teacher who causes his pupils to learn as much of this subject as practicable by the investigation method is doing two good things for them—namely, giving them excellent training, and leading them to the acquisition of highly useful knowledge, learned in a way to be remembered and applied.

Objective Aids.—Means of objective illustration may be grouped as follows:—The children's own bodies; articles obtainable at the meat market or from the butcher; the living and dead bodies of the smaller vertebrates; physical and chemical experiments; models and experimental apparatus.

The Children's Own Bodies.—From the beginning to the end of the subject, opportunities to refer to the children's own bodies will come very frequently. A number of good lessons may be taught by the observation of the hand alone. The movements of the different kinds of joints can be discovered by experiment and comparison. As the bones and other parts are learned and named, their positions may be pointed out on the body just as rivers and mountains are pointed out on a map. As was stated on page 13, it is better to teach lessons on the teeth, tonsils, and other parts of the mouth cavity, by the aid of mirrors than from descriptions and definitions in a text-book. When studying breathing, the pupils may time and count their respirations, measure with a tape-line the chest, expanded and depressed, and test to some extent the impurities in expired air.

Aids from the Butcher.—The best practical way to convey concepts of the internal organs is from specimens which may be obtained from the butcher. The lungs and trachea, the liver and pancreas of a sheep, the heart of the same animal with its surrounding sac and two or three inches of the large vessels left attached are far more effective aids in teaching the analogous human organs than the best pictures ever made. On request, a butcher will saw a sheep's skull and carefully remove the brain with a few inches of the spinal cord; and he will think it little trouble to cut out its shin bone, saw it across, and saw the upper half lengthwise through the cavity and joint. He can easily supply you with specimens of joints and tendons and muscles. With the aid of a good lens you can show the openings of the little glands that secrete the gastric juice in a bit of the wall of a pig's stomach. Using a bicycle pump you can illustrate the expansibility of the lungs. Obtain specimens of the different kinds of teeth from the butcher or from the dentist or both. Break one of them with a hammer to show the nerve paths in the roots and the pulp-cavity; reduce another on the grindstone lengthwise to show cement, enamel, dentine and pulp-cavity, and grind a third transversely to show a cross-section of these layers and parts.

The Smaller Animals.—In teaching lessons on the cat and dog, rabbit and guinea-pig, frog and bird, make numerous comparative references to the human body. The child's lower jaw, for example, admits of movement in three directions; the dog's moves up and down only; the squirrel's or rat's moves vertically and forward and backward; while the sheep's has a vertical and a wide sideways movement. With specimens of the proper parts of these different types to study, the pupils will discover that the molars of the dog and other carnivores act like scissors, and the lower jaw is attached to the skull by a simple hinge-joint; the molars of the gnawers are grooved from front to back, and the jaw slides in a groove in the base of the skull; while the sheep's molars are cross-grooved, and the jaw has a sliding articulation that permits the molars to act opposite each other with a sort of millstone movement. The human jaw is articulated so as to have all three movements. What is the inference? It is said that a great naturalist modelled from a single tooth a kind of animal that he had never seen.

The lungs of a small animal, a frog's for example, may be inflated and dried; they will retain the inflated form. The viscera, brain and sense organs of small animals may be well preserved, if kept from freezing, in sealed gem jars of water containing three or four per cent. of formalin. Each time before handling, the formalin should be well rinsed off as it is injurious to living skin.

Skeletons, or desirable parts thereof, may be prepared by removing the skin, viscera, and most of the flesh and boiling the remainder in water to which a small quantity of borax or ammonia has been added. If necessary repeat the boiling until in cold water all the bones may be cleaned off. Bones of animals as small as a frog or mouse are glued or sewed in proper position on cardboard. Wilder and Gage's soap may be used for larger animals. To make this soap dissolve 5 oz. ammonia, $\frac{1}{4}$ to $\frac{1}{2}$ oz. saltpetre, and 3 oz. white hard soap in 4 lbs. of water. Boil the half-cleaned rat's or rabbit's skeleton for a half-hour or longer in one part of this soap to four of water and then for 20 to 30 min. in equal parts of the soap and water. Clean by picking or brushing in repeated changes of clear, cold water; rinse and dry. The half-cleaned skeletons may, instead of boiling, be buried for a few weeks in summer near the surface of the earth, when decomposition, absorption, and the action of worms will remove all the soft tissues.

Physical and Chemical Experiments—To illustrate digestion prepare an artificial stomach by dropping seven drops of hydrochloric acid into a bottle containing two ounces of water and adding as much pepsin as will lie on the point of a pen-knife. Put in this mixture, and observe the digestion of, a little bit of minced lean meat, or a bit of boiled white of egg sliced, or better than either the flaky white of egg coagulated by stirring it as it falls drop by drop into slightly acidulated boiling water. Set the bottle in water at blood heat.

The cooling of the body by perspiration may be explained or illustrated by laying wet muslin or wet batting on a thermometer bulb and observing the descent of the mercury. This descent will take place even if the muslin or batting had been wet in warm water.

Carbon dioxide in expired air may be demonstrated by passing the breath through a tube or straw into limewater. (Limewater may be made by putting a cupful of freshly slaked-lime into a quart of water; stirring it well three or four times in an hour and then settling it. Siphon off and bottle the clear limewater below the scum on the surface.) It is estimated that a person exhales about a half-pound of carbon per day. Weigh out that quantity of charcoal to show the pupils that its conversion into gas by burning would be the equivalent of the CO_2 exhaled by each one in twenty-four hours.

Iodine in a water solution gives a blue color to any substance containing starch. Fehling's solution boiled with any substance containing grape-sugar gives a reddish-orange re-action. These re-agents may be used to show that complete digestion by saliva converts starch into grape-sugar.

The coagulating effect of alcohol on albumen is shown by putting some white of egg into brandy or whiskey.

Apparatus and Models.—The demonstration of the circulation of blood in the capillaries of a tadpole's tail or a frog's foot has been referred to on page 70. A considerable number of the illustrations in all the text-books are made from microscopic sections. The technical skill required to make instructive preparations of animal tissues is not yet possessed by many teachers.

The fluids of the body pass through membranes by an obscure process called osmosis. It may be demonstrated by dissolving off the shell of an egg in dilute acetic acid or vinegar, and then immersing it for a day or two in water or dextrose solution. Measurements taken before and after treatment show a marked increase in the dimensions of the egg, and if dextrose has been used its presence in the egg may be tested with Fehling's solution. A simpler method is to remove a half-inch circle of the shell from the wide end; also the membrane over the cavity, without wounding the inner membrane. Rest the narrow end of the egg on a napkin ring in a glass of water. By and by the inner membrane will protrude through the opening, and stretch until it finally bursts.

Reflecting sunlight upon the wall from a half-inch square of mirror pressed by its lower edge against the pulsing artery in the wrist, will show that the artery fills suddenly and contracts comparatively slowly.

Starting Investigations.—It cannot be emphasized too strongly that the teacher should seek in the children's interests for the lines along which he should pursue nature studies—for the topics of Nature Study lessons. Even when the study starts under the impetus of native interest it may often tax the teacher to maintain the interest until a substantial educational end is gained.

Besides watching the children's actions and conversations to discover points of interest the teacher may awaken it by proposing questions. Out of every three or four questions or investigations proposed one or more may prove fruitful. A boxful of miscellaneous objects, picked up from time to time, will be found helpful. It may contain a snail's shell, a horse's tooth, a lichi nut, a duck's and a chicken's foot, a feather, a martynia pod, a bottle of pebbles in water, a peanut, a bit of amber, an acorn, a tough fungus, a flint arrowhead, etc. If it should happen some day that you run short of subject matter to fill the twenty minutes or half-hour devoted to Nature Study take out one of these objects, make remarks, ask questions, and offer suggestions about it in the hope of exciting an interest that you can seize and maintain.

Object Exhibitions.—Once a month the Nature Study half-hour may be given over to an exhibition of interesting or curious objects. Every child brings something, either his own or a borrowed object, and writes a brief account of it or at least a label for it. Among the articles shown at one such exhibition in a certain school were five kinds of seeds with hooks for dispersion glued on a card, a piece of nickel ore from Sudbury, a bootjack that the child's grandfather had made from a sapling's crutch, a book printed more than two hundred years ago, a rubber bottle, a skate's egg, a watch chain plaited from horse-hair, an ear of corn with purple grains mixed with white grains, a large shell that "echoed the ocean's roar," a photographic picture of high diving, a dandelion that seemed to be two stems and flowers grown together, a weaver's shuttle. On that occasion each child came forward, held up his exhibit and made a little speech about it. After the speeches the articles were laid on their labels on the desks and the children were given liberty to pass around and inspect them. Out of an exercise of this kind the teacher should be able to get a few studies worth pursuing to educative ends.

Discover the Answer.—Another method of starting of discovering interests is by proposing questions the answers of which are to be learned by investigation or reflection upon experience. A few are suggested here.

What advantage is it to animals to have the nose situated so near the mouth?

Why have pigs very muscular necks?

Why is there so much bleating among sheep and lambs just after shearing?

How is it that sheep can crop grass closer or shorter than cattle?

The bill-scale drops off soon after the young bird or chick is hatched. What is its use?

What are the rice-like bodies seen quite frequently on the back and sides of the "tomato-worm" and other similar insect larvæ?

Which opens farther apart—the toes of the cow or of the sheep? How is the difference related to the wild life of each?

Draw the tracks made in light snow by cat, dog, pigeon, hen, mouse, etc.

How are the handles of tea-pots and some stove-pokers prevented from burning the hand?

Why are glass tips put on telegraph poles?

Why does a silver spoon blacken when used with egg, cabbage, or horse-radish?

A certain Woman's Association in Maryland sent out a series of questions to all the schools in that State. They asked:—

Why does a cat have whiskers?

Do robins and chickens walk alike?

How many more legs has a spider than a fly?

Why does a rabbit wobble its nose?

Why is a fish dark above and pale beneath?

How many times does a crow fold its wings after it alights?

When sheep are getting up do they rise on their fore-legs first?

Do rabbits ever run?
Why do horses turn their ears?
With which end does a wasp sting? a mosquito?
Do little pigs show any signs of affection?

The subjects and topics listed in the *Courses of Study* have nearly all been reviewed in these pages. Limitations of space and lack of knowledge on the writer's part are not the only reasons why the treatment of the topics has been suggestive rather than exhaustive. Two of the photogravures in the book have been introduced to emphasize the important fact that the best part of the teacher's preparation to conduct any particular Nature Study lesson is his own first-hand investigation of the object or phenomenon, and not the browsing he may do in a library. But that the library may furnish, if not the most important, at least a very useful supplementary aid is recognized in the references to nature literature with which the paragraphs abound. The books named under the respective topics are the most helpful, inexpensive ones known to the writer.

Nature Study is more method than subject-matter. It should be judged by quality, not by quantity. The highest criterion of success in teaching it is increase of power rather than of knowledge,—of power to observe, judge, act, sympathize and enjoy. You should not be expected to hurry your class over the whole course; a life as long as Methuselah's would be too brief to study it thoroughly by the discovery method. Determine how much time should be given each day to this kind of work, and select from what is available that which seems to promise the best results. Aim to train the children for useful and happy lives by exercises that seem to them to be "worth while" now, and that bring them happiness in the doing. Study the tastes, interests, and environments of the pupils to guide you in choosing the work. This book is put forth in the hope that if the exercise or object you select is named in its index you will there be referred to pages that may render you assistance in realizing the right ideal.

CORRELATION OF NATURE STUDY AND MANUAL TRAINING.

(*See plate opposite page 46.*)

1. Soil-box with glass front, showing five strata of soil—clay loam, brown sand, fine white sand, coarse gravel, blue clay—obtained in an excavation near the School. A scale-label attached to the side of the box gives the thickness of each stratum.

2. *Insectary.*—The sides of glass, 12 × 32 inches, above wood 5 × 32 inches. Four inches of soil in the bottom. The cover a movable lid framed on fine wire gauze.

3. A box containing sixteen samples of soil.

4. A box with slanting glass front, showing the development of seedling roots against the glass.

5. A mineral box containing 42 small boxes bedded on excelsior, each containing a different labelled mineral and covered with glass, so that the latter makes a lid for the specimen boxes. Each mineral is bedde. below, so that the specimen is held up against the glass.

6. An observation beehive with ventilation, suited to receiving one Langstroth frame. In use, this is set against a locked window-sash, with an opening for the admission and exit of the bees. The bees cannot enter the room, although the hive is set inside on the window-sill. Side-flaps of wood or cardboard, or a draping of cloth, may be used to keep the hive in darkness when not under observation.

7. An aquarium containing two mud-puppies, a crab, and some water-weeds. The mud-puppies could not be kept still, hence their forms are not defined in the photograph.

8. A slat plant-press, 12 × 18 inches, with straps for pressure.

9. An insect spreading-board.

10. A box containing the stages of an insect from egg to imago. This box rests upon exhibit No 3. The one beside which 10 is placed is a weed-seed plaque similar to No 12.

11. The prepared skin of a "hog-nose" snake, which a farmer taking to be a venomous species, speared with a fork. It lived a few months at the school, but finally succumbed to the injuries received at the time of its capture.

12. Weed-seed plaque for thirty kinds of seeds, made of plaster of Paris, the receptacles being shallow holes bored with an inch auger. The plaque is covered with the glass upon which the plaster was poured to set. The seeds can be studied with a lens through the glass cover.

13. Weed-seed holder, made by attaching rubber washers to a pane of glass, covering them with another pane, and "passe partouting" the panes together.

SOURCES OF ASSISTANCE.

In using books remember the cautions and directions given on pages 25, 34, 58 and 129. According as they are rightly or wrongly used will they prove a help or a hindrance to Nature Study teaching.

The books named at the foot of page 24, except Nos. 4 and 7, contain a number of lessons many of which have been referred to in their appropriate places in these pages. "Public School Nature Study," see page 25, presents fifty-nine lessons on the most common topics by the catechetical method, the only method for the pupil and usually the best one for the teacher. References to lessons (for which see Index) in these and other books have been made throughout the pages.

On the following topics, which are either specifically mentioned in the *Courses of Study* or which are very likely to engage attention, assistance along Nature Study lines may be obtained as indicated:—

Hepatica, spring-beauty, adder's tongue, jack-in-the-pulpit, in Mrs. Comstock's "My Own Book of Three Flowers in April and May" (pp. 60, illus.; 25c. Am. Bk. Co.)

Jewel-weed, in Morley's "Few Familiar Flowers" (see p. 158; pp. 274, illus.; 60c. Ginn & Co.)

Anemone, crowfoots, shepherd's purse, violets, oak, grasses, and about sixty other plants. The treatment is systematic and morphologic: not suited to the lower grades. In Woods' "How to Study Plants," for Teachers' Reading Circles (pp. 308, 53, 30, illus.; $1.00. Am. Bk. Co.)

Indoor Studies of the pea, onion, apple, potato, etc., in Carter "Nature Studies with Common Things" (pp. 150, illus.; 60c. Am. Bk. Co.)

Mushrooms, golden-rod, pine, and thirty other lessons in Overton and Hill's "Nature Study" (pp. 142, illus.; 40c. Am. Bk. Co.)

Food, nests, nestlings, etc., of cat-bird, flicker, and nineteen other birds, in Walker's "Our Birds and Their Nestlings" (pp. 208, illus.; 60c. Am. Bk. Co.)

The downy and all the other woodpeckers in Eckstorm's "Woodpeckers" (pp. 131, illus.; $1.00. Houghton & Mifflin).

Teeth, bones, fish, hen's egg, etc., in Payne's "One Hundred Lessons in Nature Study" (pp. 200; $1.00. Kellogg & Co.)

"Interdependence of Insects and Flowers." How the mints, composites, clovers, etc., entice and reward insects, in Gibson's "Blossom Hosts and Insect Guests" (pp. 197, illus.; 80c. Newson & Co.)

A list and brief description of injurious insects under the plants respectively affected—33 pages—also carpet-beetle, clothes moth, cockroach, etc., in Hunter's "Elementary Studies in Insect Life" (pp. 344, illus.; $1.25. Crane & Co.)

Golden-rod visitors, gall-makers, dragon-flies, chipmunks, etc., in Needham's "Outdoor Studies" (pp. 90, illus.; 40c. Am. Bk. Co.)

May-flies, cockroaches, true grasshoppers, crickets, bed-bug and other bugs, cicada, etc., in Morley's "Insect Folk" (pp. 196, illus., 45c. Ginn & Co.)

The monarch, promethea, polyphemus, the sphinxes, and about twenty shorter studies in Dickerson's "Moths and Butterflies" (pp. 344, illus.; $2.25. Ginn & Co.)

The crayfish, earthworm, perch, etc., in Colton's "Zoology, Descriptive and Practical" (pp. 375 and 204, illus.; $1.50. Heath & Co.)

Annual Reports of the Entomological Society, and Mr. Nash's Bulletin on the Birds of Ontario, free to schools on application to the Minister of Agriculture, Toronto.

Minerals, rocks, soils, pp. 10-63, in Brittain's "Teachers' Manual of Nature Lessons" (pp. 118; 50c. J. & A. McMillan, St. John, N.B.)

Logs and lumber, snails and slugs, snow-storm, farm operations, scarlet-runner, etc., are catechetical lessons in Lochhead's "Outlines of Nature Studies." Bulletin No. 142, O.A.C. (pp. 48; free on application to the Ont. Agric. Coll., Guelph).

Weeds of Ontario. Bulletin No. 128, O.A.C., Guelph (pp. 95, free).

Stories of a cabbage butterfly, of a pound of butter, of an apple, of a grain of wheat, of bees, etc., in "Stories in Agriculture." Bulletin No. 124, O.A.C., Guelph (pp. 79, free).

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(N. S. = Nature Study ; (*r*) indicates simply a reference to a source of assistance).

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