A NATURE STUDY GUIDE

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by

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PREFACE

The value of nature study as a means of training children to observe and investigate is now fully recognised by the majority of our best teachers, with the result that the careful study of natural things and phenomena takes a very prominent place in the school curriculum; and the object of this little guide is to assist the teacher in his attempts to obtain for the children the maximum benefit of the thoughtful observations of their physical environment.

The purpose of the book is not to supply the teacher with information on all the various aspects of Nature, for an attempt to attain this end in a single volume would necessarily result in a most scrappy and unsatisfactory summary of Nature's works. The aim is rather to lead the teacher to the best methods of treating his subjects, and to supply him with such practical suggestions as will help him in providing and maintaining a suitable supply of material for both occasional and continuous observations.

Thus, while a certain amount of information is given with the object of calling attention to various things of special interest, and to phenomena that are not always understood, the space is devoted mainly to the

treatment of nature lessons within the school building, to seasonal studies out of doors, and to the preparation and management of valuable aids to the study of Nature, such as the aquarium, the vivarium, the school garden, and the school museum.

Although but little space is devoted to the descriptions of natural objects, it is hoped that the numerous photographs and other illustrations will enable the reader to identify the majority of the things named.

W. S. F.

London, 1911.

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CHAPTER I

NATURE STUDY
WHAT IT IS—ITS VALUE

The study of Nature now takes a prominent place in the curriculum of many schools, and while many teachers regard it as being a valuable aid in the training of infants and junior scholars, others have fully recognised its usefulness as a study for children throughout the whole period of their school life.

But we must, at the outset, state precisely what we mean by the term 'Nature Study.' It is the careful and thoughtful observation of natural objects and natural phenomena by the children, under the guidance of the teacher—a process of research on the part of the children by means of which natural objects and phenomena acquire meaning.

It will be clearly seen from the above definition that we have nothing whatever to do with the old type of object lesson in which information acquired by the teacher is imparted to the class, not even if such a lesson is illustrated by the exhibition of the object in question, as well as by the best of pictures or diagrams.

Such a lesson is merely a lesson of information, in which the children gain second-hand knowledge; and the acquisition of the facts given is only a matter of memory, unaccompanied by those important mental processes which assist in the development of the growing mind. The true nature study lesson is one in which each child closely observes an object placed before him, or studies a phenomenon that presents itself to him at the time, and in which he is encouraged to form his own conclusions, and to realise, as far as possible, the true nature of the thing seen.

Thus nature study, as we are to understand it, is to be looked upon rather as a method than as a subject. It is, with the teacher, an effort to bring the children in direct contact with things, to cultivate the habit of careful observation and discrimination, to create a living interest in the surroundings, and to encourage independent thought. It teaches the child not only to see, but to recognise; and it produces a habit of sensory alertness at a period during which the mind is particularly plastic and impressionable.

There is a vast difference between nature knowledge and nature study. The former simply denotes facts acquired, while the latter is rather a spirit of inquiry and research by which natural objects and phenomena arouse a living interest and encourage investigation. In the latter case the work of the teacher is not to give information, but rather to stimulate the children to observe and discriminate for themselves, and to form their own conclusions.

Of course, in the case of young children, the ideas formed and the conclusions framed will always be more or less vague and imperfect; but since these ideas and conclusions are the result of the children's own efforts, they are of far more value than the clearer conceptions imposed by the teacher on a class that is merely passively receptive.

The value of nature study as a means of training children can hardly be overestimated. The habit of close and thoughtful observation that it cultivates will not only have a great influence on them during their period of school life, but will also assist them in their future careers. It will help them to see and understand various natural objects and the phenomena associated with them that would otherwise remain practically unnoticed, and will have a very great influence in determining their tastes and pursuits.

This cultivated habit of closely observing natural objects and phenomena will give the child a practical grasp of the whole physical world, enabling him to recognise all things and occurrences as a set of conditions that form his own environment. It will produce a keenness of the senses and precision of observation that, coupled with an appreciative interest in the surroundings and a natural inquisitiveness concerning things in general, will put him in a much better position to carry out the work demanded of him in his future career with initiative, self-reliance, and a productive method.

The training which nature study gives not only

causes the child to see with the mind as well as with the eye, but teaches him to observe with a purpose; and the mental discipline it enforces provides a splendid foundation for the future study of the experimental sciences. A good systematic course of nature study will also lead to neatness, accuracy and dexterity in all work undertaken, and do much towards the cultivation of patience and perseverance in the worker.

If the effect of a good course of nature study is to produce in the child all that we claim for it, it is clear that the training must have more or less influence in connection with the teaching of all school subjects. But some of these subjects are so closely allied to this study that they should be worked hand in hand with the latter. Thus the drawing lessons and the clay modelling exercises may be continuations of the study of the natural objects examined, and the teaching of geography may be conducted as an extension of the outdoor observations of natural objects and phenomena.

Then, again, a very large proportion of our best literature teems with references to natural objects and phenomena, and thus the study of Nature enables us to understand and enjoy much that would otherwise be meaningless or vague.

There is yet another aspect of the subject well worth consideration. Nature study is certainly of great value as an aid towards the culture of æsthetic tastes, and many of our best teachers further recognise in it a powerful aid in moral training. It cultivates the judgment and the imagination, and thus leads to such

thoughtful and intelligent observation that the child not only becomes acquainted with the facts of Nature, but sees and appreciates her beauties and realises her wonders. This appreciation of the beauties and wonders of Nature leads to a sympathy with all living things, thus correcting the natural tendency to destructiveness; and it also tends to create a broad human sympathy. No study so thoroughly arouses the æsthetic and emotional elements of a child's character, and no school study can do more to brighten the lives of the children.

CHAPTER II

NATURE LESSONS

1. Choice of Subjects—Schemes of Work

In selecting subjects and in making out schemes for a course of nature study it is absolutely essential that we follow the course of the seasons, so that each of the studies may be made direct from the fresh or living material, and the various natural phenomena engage attention at the times of their occurrence.

The work should not consist of a series of set lessons, rigidly defined as to time and character, with no logical connection between them; but of a carefully prepared scheme of observations, drawn up in perfect accordance with the succession of the seasons, and so arranged that each portion naturally evolves itself from that which precedes it.

Such a scheme, while systematic from beginning to end, must not be too rigid. The very seasons on which it is based are themselves so variable that it would be very unwise to fix the date on which each portion of the work is to be done; and it would be equally unwise to attempt to decide how much should be done in a given period.

The most experienced teacher is unable to foresee the many difficulties which may arise in the minds of the children—difficulties that should, as far as possible, be cleared away before the next steps are taken in hand; nor can he foresee the occasional disappointments that sometimes occur in connection with the collection of material for his work, and, on the other hand, the unexpected wealth of material that will now and then fall in his way.

Further, whatever may have been the care bestowed on the preparation of a scheme of nature observations, in the hands of a thoughtful teacher, new ideas and developments are sure to present themselves; and, for this reason alone, the teacher should have perfect liberty to adjust the work as it proceeds, rather than feel himself compelled to follow a stereotyped course in which his own initiative and that of the children are more or less restrained.

Again, the work laid out should never be excessive. The value of the work done is not to be gauged by the number and variety of subjects compressed into the scheme, but rather by the thoroughness of that which has been done. And, as regards the nature of the work introduced, it is probable that nothing is more effectual in the training of young minds than the continued observations of a progressive series of events such as those exhibited in the development of seedlings under varying conditions, in the varied aspects of trees at the different seasons of the year, and in the life-history of an insect or other creature traced from the egg to the adult or perfect stage.

Many of the subjects that may well form part of a nature study course are such that they can only be successfully dealt with on certain rare or special occasions. Thus, we take the opportunity of studying the snow-storm while such a storm is in progress; and, similarly, the thunder-storm and other occasional atmospheric disturbances at the times when they occur. We also call attention to the differences between stars and planets during a period when one or more of the latter are conspicuous in the sky. The migrations of birds are studied at those seasons when the movements are taking place; and the hibernations of various animals during the autumn, when they are making preparations for the long winter sleep, and during the winter itself, when they may be observed in their snug hiding-places. In short, as previously laid down, every subject must be taken in its proper season, so that the whole scheme is in perfect harmony with the daily experiences of the children.

It is the writer's experience that most teachers find a greater difficulty in the selection of suitable subjects from the animal than from the vegetable world. This is partly due to the fact that common British animals are not so generally studied as are the common flowers and trees. The lower animals—the invertebrates—are especially neglected on account of the general aversion towards creeping things.

The old-fashioned, so-called nature lesson, illustrated only by a picture and, perhaps, a fragment of skin, hoof or horn, is of very little educational value. The cardinal feature of animal life is motion; and if

the children have not the opportunity of observing the interesting habits of the animal in question, and of working out the striking relation that exists between the habits and the structure, the charm and value of the lesson are lost.

Seeing that the object of the nature lesson is not to supply information, but to encourage independent observation and discrimination, it is clear that one animal is practically as useful for the purpose as any other; and, therefore, there is no reason why, as a rule, the lesson should not be based on some form of animal life that can be conveniently studied within the schoolroom, or that may be observed in the neighbourhood of the building.

Of course we do not mean that no information should ever be given on foreign animals and on those British species which can seldom or never be seen alive by the children. Such information may often be extremely useful in connection with the teaching of geography—a subject that is very closely allied to nature study. But the information so given should not constitute a set lesson in itself, for the mere presentation of facts by the teacher is not of sufficient importance to demand much time, and a lesson partaking of the character referred to is entirely foreign to the spirit of nature study.

An enthusiastic student of Nature will soon discover that there is a wonderful wealth of animal forms among British species which are eminently suitable for study by children; for, in addition to our familiar mammals

and birds, we have many interesting fishes in our ponds and streams, a few amphibians (frogs, toads and newts) with exceptionally interesting life-histories, harmless reptiles, and many invertebrates, such as insects, spiders, snails, earthworms, etc., the majority of which may be easily kept in captivity for constant observation, or studied in their natural habitats in the neighbourhood of the school.

The scheme of nature study set out on future pages will, we hope, give many useful suggestions to the teacher; and the various hints on the treatment of creatures that may be kept in captivity either in the school garden or in the schoolroom itself will enable him to maintain a wealth of living material for close and systematic observation.

The collection of specimens for the study of Nature need not, and should not, devolve entirely upon the teacher. Let the children once get an insight into the wonders of natural objects around them, and they will always be on the alert for new sources of delight, with the result, especially in the case of schools in the country or on the outskirts of towns, that more than sufficient material will generally be forthcoming for the nature study work.

It is well to encourage this propensity for the collection of natural objects on the part of the children, providing it is properly directed. Care should be taken to secure that the children do not develop into mere collectors of material without discrimination as to the usefulness or otherwise of the specimens acquired.

Their labours in this direction should be so controlled that they bring in only such material as is necessary in the working of the nature study scheme of the school, together with those objects concerning which they desire to gain information.

This latter point is one of considerable importance, for it is the duty of the teacher to encourage the natural curiosity of the children under his charge; and it will be well, now and then, to devote a little time to pleasant chats on their observations and specimens, even though they do not fall within the range of the course planned for the school work. Such chats will not only be a source of much delight, but will also be a wonderful stimulus to keen and thoughtful observation in the future.

2. Nature Lessons

Let us now pass on to consider the matters which relate more directly to the regular lessons that make up the nature study course of the school, leaving, for the present, those occasional observations which, though forming an important part of the scheme in operation, do not require set times and periods.

In accordance with the old plan which insisted on some kind of 'introduction' to the lesson, the question is often asked: 'How shall I introduce this lesson?'

A nature lesson requires no formal, spoken introduction by the teacher. Set the object to be studied before the class, and let the observations commence at once. The commonest form of introduction to a lesson is, perhaps, a series of questions put by the teacher with the

object of encouraging the children to guess what he is going to talk about. This is, of course, an absolute waste of time; and even where the lesson naturally evolves itself from a preceding one, and it is necessary for the children to see the connection between the present subject and the last, this connection is often best seen after the present lesson has been practically concluded and the relation between the two should be worked out by the children, and not by the teacher.

Certainly one of the best ways in which to start a nature lesson is to place the object of study before the children, and then tell them to observe carefully, the teacher himself being careful to allow ample time for a very thorough inspection of the specimens.

Some would insist that this introductory observation of the specimens should be perfectly silent, the view being entertained that children should not be allowed to talk in school—that the discipline of the school—the power of the teacher over his class—would suffer if such liberties were allowed; but if the tone of the school is what it should be, the dignity and power of the teacher will lose nothing from the permission given to the children to exchange observations and thoughts with one another. It is astonishing, too, to observe how children, left for a time to themselves, can help each other in the discovery of facts and in the solving of little problems, to say nothing of the increased interest in their subject brought about by communication of their discoveries and ideas.

Of course the observations of the children, under

these conditions, will be carried on regardless of any definite order; and the ideas framed may often be somewhat confused and incorrect. But the children should have the first opportunity of seeing, and the first opportunity of investigating. Where necessary, the teacher may, by an occasional remark, direct the observations into some desired order, and any confusion of ideas may afterwards be corrected.

After the interest of the class has been thoroughly aroused by a preliminary observation of this kind, the teacher demands the attention of the children and, by a carefully planned series of questions, discovers what observations have been made, and draws attention to other points which should have been seen.

Further questions will be asked with the object of encouraging the children to think out simple problems with regard to the habits and mode of growth of the thing before them, and to work out the uses and functions of its various parts.

Throughout the whole lesson the teacher should be careful to do nothing for the children which they can do for themselves—to tell them nothing which they themselves can discover, and to offer no explanation where it is possible for them to solve the matter themselves. He should give the required assistance only where the children fail after every possible encouragement has been given, and remember that the inability of the children to observe certain points of structure and to think out the problems involved is often due to more or less impatience on the part of

the teacher, resulting from his desire to get on with his subject in order that the lesson may be completed within a given time.

This latter error is a grave one. It is quite right that a teacher should carefully plan out his work, and form some kind of estimate as to what he is likely to do in the time at his disposal, but he should never attempt to adjust the progress of the lesson in order to make it coincide with the time. It matters not whether a lesson is completed according to the plan laid out, but it is most important that the work done is done thoroughly.

For this reason the teacher has a right to demand the fullest liberty in dealing with his subject. He never knows what difficulties will arise during the progress of the lesson. Many unexpected points of interest will frequently present themselves. Occasionally it will happen that a topic, concerning which the teacher anticipates a difficulty, turns out to be less formidable than was supposed. Hence he should have full power to expand or omit any portion of the work previously planned, and even to change the order originally proposed, when he is of opinion that by so doing he can make his work more productive.

We have spoken of the importance of careful questioning on the part of the teacher, but we must note that the children should be allowed and, indeed, strongly encouraged to put questions to their teacher. Such questioning must not be permitted at all times during the lesson, or it will tend to break the continuity of the work. At certain stages, however, and particularly at

the end of the lesson, it will be well to give the children every opportunity of satisfying their natural curiosity. Each question asked is, to the teacher, an encouraging proof of the interest taken in the lesson; and the more thoughtful ones give evidence as to the working of the minds of the children, and also serve, to an extent, as a measure of the value of the work done.

Of course it will frequently happen that even a young child will ask a question which the teacher cannot answer, but this is not necessarily a proof that the latter is not properly qualified for his work. Nature is so varied and so full of changes that even after many years of close and constant study of her productions and phenomena one is always finding some object which has not been seen before, or noting some phase which has never before presented itself; and it is always possible for a child to discover what a naturalist has never seen. But even so, a teacher should put himself in the best possible position to deal with the various questions the children may ask by keeping his knowledge as far as possible in advance of that which he desires his children to acquire.

Should it happen, as it sometimes will, that the teacher receives a question he cannot answer, he should not fear any loss of respect on that account. If the relation between the teacher and the class is such as should exist, the latter will never withdraw its confidence and respect because, occasionally, the former is unable to give an honest answer to a question asked.

It is not at all an uncommon thing to hear a teacher

say: 'One of my children asked me so and so, and I gave such and such a reply; was that right?' In a case like this the teacher is probably ashamed to admit that he does not know, and so he frames some kind of answer and presents it with a hope that it may possibly turn out to be correct. This should never be done. The teacher's information must be accurate, and he himself must be true.

Again, in order that a teacher may be able to carry out a nature course successfully, he must himself be a student of Nature. If he is to arouse enthusiasm in the children under his care, he must himself be an enthusiast. This same remark also applies, of course, to the other subjects he is called upon to teach; and thus we come to the logical conclusion that every teacher must be an enthusiast in everything he undertakes to teach. This is, as we know, almost impossible in the case of a teacher who has to deal with all the subjects belonging to a modern curriculum, but still there is no reason why the teacher should not do his best to make the nearest possible approach to this ideal condition.

In some schools an attempt is made to increase the quality of the teaching by allotting to each teacher a subject rather than a form or class. Thus each member of the staff is, or becomes, to a greater or lesser extent, a specialist in his particular work.

There is a great deal to be said in favour of this arrangement; for if, as should be the case, each teacher is occupied in dealing with his favourite subject, the energy and enthusiasm naturally put into the work

must necessarily be greater.

This system, however, has at least one drawback. The teacher, having no fixed form of his own, but passing continually from one group of children to another, has not an opportunity of acquiring that intimate knowledge of the habits and dispositions of the children which is necessary in order to mould their characters.

Nature study seems to be one of those subjects for which a special teacher is more particularly advantageous; for while the majority of teachers possess a satisfactory knowledge of most of those subjects that form part of the ordinary curriculum of nearly all schools, the study of Nature has received but little attention until recently, and thus fewer teachers would consider themselves suitably qualified for dealing with it.

Reverting now to the subject from which we have slightly digressed, we next draw attention to the desirability of always encouraging the children to sketch what they observe, and thus to keep both eye and mind working together. Of course many of the attempts on the part of the children, and especially of the younger ones, to represent what they see will be very crude and inaccurate. That, however, is a matter of but little importance. It is sufficient that they have made a good attempt. The results will gradually, perhaps rapidly, improve as time goes on; and we may be sure that most children at least have observed the object before them much more closely than they would have done had they not been told to give a graphic representation of it.

Again, if the object selected for a nature lesson is to be thus represented by the class, the drawing need not necessarily be part of the lesson itself, but may form an entirely separate lesson in drawing, either on the same or another day. The two subjects, nature study and drawing, should run together; and it is of little importance whether the drawing lesson precedes or follows the corresponding nature lesson. If the former, the nature study will probably progress a little more rapidly because much of the observation has been previously done; if the latter, the drawing will be more accurate, especially in matters of detail, on account of the previous minute examination of the object during the nature lesson.

As regards the teacher's own drawing and illustrations we shall have many remarks to make; but we may set it down as a general rule that a nature lesson, based on specimens which have been distributed to the children for study, or on a large object placed before the class for the observation of all, requires but little blackboard illustration, if any at all. No sketch or picture should be presented that merely 'illustrates' that which may be observed in the object itself, not even if the former displays certain particular features more conspicuously than the latter. Let the children have the full opportunity of searching out the features for themselves. Do not attempt to save them any trouble, for this will deprive them of the pleasure of finding out for themselves. It is close observation that we desire to encourage, and, therefore, we do not tell them what they ought to see, but rather let them have the pleasure of

telling, in their own simple language, what they have discovered.

At times, however, pictures are very useful aids. Thus, after it has been made clear that the general form of a certain tree must necessarily depend to a great extent on the arrangement of the buds as seen in the twigs placed before them, a picture of the whole tree may be shown as a means of demonstrating the conclusion; but even this is unnecessary and unadvisable where it is possible for the children to observe the tree itself within a reasonable distance from the school or their homes.

Diagrams are often useful to the teacher himself in assisting him to direct the observations of the children. It is often necessary to call special attention to some particular part of the specimen that is being examined, if only because it is advisable to secure some definite order in the work—to see that all the children are giving their attention to the same part at the same time. It is often somewhat difficult, especially with junior classes which are unacquainted with the names by which the parts of an object are denoted, to specify the particular portion requiring attention; but a diagram, even a very simple one, will enable the teacher to point it out immediately.

The same purpose may also be served by the use of a model instead of a diagram. Thus, in calling attention, in order, to the parts of a flower, a model of the flower, sufficiently large to be distinctly seen by all the class, will prove much more useful than the best of diagrams.

With the aid of such simple materials as plasticine,

pieces of paper of various colours, wood splints, pieces of wire, etc., exceedingly useful models of various natural objects may be put together in a very short time.

Both diagrams and models should be used sparingly. They are not to be employed for the observation of the children, but as an aid to the teacher. They should be out of sight except at the short period or periods during which they are actually necessary, or the children's attention, which should be devoted entirely to the natural object before them, will be divided between the two, thus helping to destroy what should be the main aim of the nature lesson.

A thoughtful teacher can often foresee some of the difficulties that are likely to arise during the course of a lesson—difficulties that may require the aid of a blackboard sketch, and will prepare what is necessary beforehand; but even the most experienced teacher cannot foresee all that is required, and therefore he should be able to produce a satisfactory sketch, in the shortest possible time, to satisfy the exigency of the moment. Without such skill the lesson is liable to run slowly at times, and the laboured production of a simple drawing will demand a pair of eyes that should be ever directed to the class and its working.

Really good pictures representing natural scenes and phenomena are very valuable both in connection with, and apart from, the nature lessons of the school, especially in populous towns, the children of which seldom have the inclination or opportunity of taking a ramble in the country. Such pictures enable the teacher

to broaden the scope of his lessons, and to illustrate those casual, pleasant chats about the ever-changing drama of the seasons, and the general aspect of wood, wayside, meadow, moor, and mountain, that create a desire to stray from the crowded streets to open spaces where the realities of Nature may be enjoyed.

The instrument formerly known as the magic lantern and used for entertaining purposes, but now designated the optical lantern and recognised as a valuable aid to education, is an appliance to be found in almost all well-equipped schools. It is often employed in connection with the subject we are now considering, but its use is decidedly wrong if the pictures exhibited take the place of natural objects or illustrate scenes such as may be observed within a reasonable distance of the school.

However, the remarks made above concerning the use of good pictures apply, of course, to the use of suitable lantern slides. Beautiful photographs illustrating all kinds of natural scenes and phenomena are to be obtained in this form, and the use of the lantern has the distinct advantage that a number of pictures, magnified to suit the size of the school or class, can be exhibited in succession on the screen.

And here we must note the close relationship existing between nature study and geography, the latter being really a branch of the former, so that the rules laid down with regard to the illustration of nature lessons should be observed as closely as possible in the study of geography. Direct observation, carried on as far as

may be in the open air, will certainly produce the most beneficial results on the minds of the children; and this may be supplemented by the use of good pictures, including photographs from Nature, exhibited either with or without the aid of the lantern.

The lantern may be made to serve yet another purpose in connection with nature lessons. It not infrequently happens that several diagrams are required for the purpose of aiding the teacher in his directions and explanations during a single lesson. In this case the necessary drawings may be made on small pieces of glass, instead of on the blackboard, and then projected on the screen as required. And it does not appear to be generally known that the classroom need not be darkened for this purpose. If, instead of throwing the light on an opaque screen with the lantern at the back

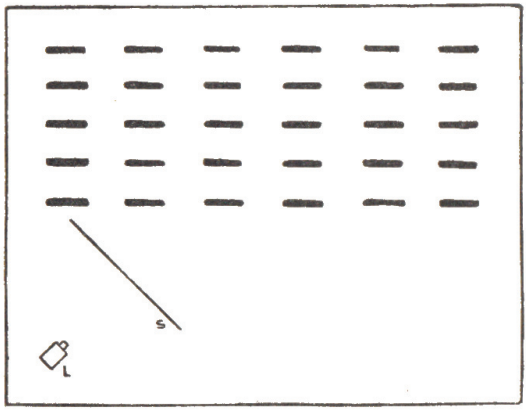

FIGURE 1. *Diagram showing how the optical lantern may be used without darkening the room. L, Lantern; S, Screen.*

of the class, we have the lantern behind a translucent screen consisting of a sheet of tracing paper or tracing

cloth, or even of a sheet of ordinary drawing paper that has been rendered translucent by painting it over with melted paraffin, and project the picture through it from behind, the light of the room need not be reduced any more than it is by letting down the ordinary window-blinds; and thus the teacher can make use of his diagrams while the children are still observing the natural object or objects placed before them.

With such an arrangement in a rather small class-room it will not be possible to throw a large disc on the screen; but then, in such a room a large disc is not at all necessary. The diagrams need not be any larger than the blackboard sketches for which they stand as substitutes, and thus a disc of about two feet in diameter will be ample.

What a stimulus, too, to the children, to encourage them to study and sketch natural objects at their own leisure, and then to allow them to project their drawings on the screen and to tell their mates of their discoveries and experiences! Give each child who desires it a little square of glass, with the few necessary instructions and, when the drawings have been brought in, note the delight with which the children exhibit their handiwork and explain what they saw, and the intense, stimulating interest displayed by the others as they observe what their classmates have discovered and accomplished.

An occasional half-hour spent in this way will do wonders in encouraging keen observation and in promoting accurate representation; and not only will the success of the experiment frequently come as a great

surprise to the teacher himself, but he will sometimes find that the researches of his children include some little matters of structure or habit that he himself had not previously noticed, or give rise to some little thought or opinion which he himself can appreciate.

There are certainly a few little difficulties in the preparation of the simple lantern slides we have mentioned, and a few little knacks to be observed; but the latter will be quickly overcome if attention be paid to the hints in the chapter on Nature Lantern Slides.

Before quitting the subject of the uses of the lantern in nature study we would like to give one other illustration. Let us suppose that the children have received a more or less systematic training in nature observations as they passed through the junior classes, and that the course included, among other things, the study of various common plants and animals. As these children reach the higher forms they are in a position, from the knowledge gained, to arrange the various objects they have seen into natural groups—to plan out, with the aid of the teacher, an elementary system of classification. In such a case it would be well to recall the various observations made in the past by means of pictures thrown on the screen, thus aiding them in the useful exercise of classifying and grouping.

Returning again, for a moment, to the ordinary nature lesson of the school curriculum, we desire to say a few words concerning blackboard notes and recapitulations.

As regards the former, it should be definitely decided

whether the notes are intended for the aid of the teacher himself, or for the observation of the children. If they are intended to be a guide to the teacher, and to consist of the headings and main points of the lesson, they are entirely out of place. In this case they should not be necessary, for the teacher should have so carefully planned his work as to require no such aid. And again, they distract the attention of the children from the object they should be closely examining, especially if they are written before the class and during the lesson.

If, on the other hand, the blackboard notes are intended for the sole use of the children, it is still difficult to see their value or of what they should consist. It may be said that all hard and unfamiliar words used should be written on the board. Not so. Hard and unfamiliar words should not find a place in a nature lesson. The descriptions and other statements are given by the children, in their own simple language, and technical terms should never be substituted by the teacher for the corresponding names or phrases of the child. Questions which turn upon words rather than upon things should always be carefully avoided. It does not matter much what a child calls any particular thing or part, providing the name given is fairly appropriate. Our aim is to get the children practically acquainted with things, not names. Many a child has developed a great distaste for such a study as botany because the work set him was to learn the names of the parts of flowers and to learn to give descriptions in the technical expressions of certain text-books. The effect would have been very different had he been taught to look upon flowers as

living things with beautiful forms, lovely colours, and interesting habits.

It is usual to set apart a portion of the time allotted to a lesson for purposes of recapitulation, and this practice is often so rigidly observed that the notes demanded from young teachers are regarded as incomplete unless some provision for recapitulation has been arranged. This is quite unnecessary, and even inadvisable as far as our present subject is concerned.

Ordinary lessons of information require more or less repetition. The teacher's chief aim in such lessons is to impart to the children some of the knowledge he himself possesses, and a recapitulation serves to drive home the facts that have been given. But, as we have already pointed out, the purpose of nature study is not to give information on natural objects and phenomena, but to encourage careful observation and independent thought. Our aim is, or should be, to assist the children in making discoveries for themselves, and it is for this reason that we are careful to tell them nothing which they can be made to find out for themselves. Let the whole of the lesson be spent in these observations and discoveries, and you will find that the children do not readily forget what they have found out by their own efforts.

Should the teacher desire to ascertain how the minds of the children are working, he can do so by means of suitable questioning as the study proceeds; in fact, such questioning should form an important part of the lesson. And here we may note how closely

nature study comes in touch with the teaching of English; for not only do the descriptions and thoughts of the children, expressed in their own words, form valuable exercises in oral composition, but nature study provides a wonderful wealth of material for the children's essays.

Nature reading books are sometimes used as a substitute for nature lessons. This is undoubtedly a very great mistake, for while there is no reason why descriptions of natural objects should not be read as much as descriptions of anything else for the general purposes of the reading lesson, it must be noted that the aims of the reading lesson are quite foreign to those of nature study. Considered apart from the mere mechanical functions of the reading, the matter of the lesson simply tells the children what they may see, or what somebody has previously seen, while in the nature lesson they see for themselves; and the former explains those problems which, in the latter, are worked out in the minds of the children.

If a nature reading lesson is accompanied by the observation of the natural object which it describes, and if time is allowed both for the examination of this object and for questions and remarks on the part of teacher and children, it will still constitute a very feeble substitute for the real nature study lesson, for it will still possess the defects we have just mentioned.

Where nature study forms part of the school curriculum, however, it will be well to encourage the children to read, in their own time, any good books of

travel, and the popular works of eminent naturalists; and such books may also be used to advantage in the ordinary reading lessons of the school. The teacher, too, may do much to increase the general interest in Nature by telling of his own experiences and discoveries, by imparting some of his book-lore, and by giving occasional Nature stories and biographies, especially to the junior classes.

CHAPTER III

OUTDOOR WORK

Up to the present we have been dealing more particularly with nature lessons as given in the school building, but the most valuable part of nature study is undoubtedly the outdoor work—the study of things in their natural surroundings; and advantage should be taken of every available opportunity of rambles in lane, field or wood; or, in the case of town schools that are too remote from wild Nature, in any neighbouring parks and open spaces.

Such rambles may be frequently organised and personally controlled by the teacher, but it is by no means necessary that such should always be the case. In fact, the teacher should do all he can to encourage individual and independent observations, and should allow a little time occasionally in school for chats on the observations made by the children and for the asking and answering of questions relating to them.

Every school ramble must be arranged with some definite object in view, otherwise much valuable time may be lost in aimless wanderings and disconnected observations. Although we lay this down as a fixed

rule, we do not, of course, wish it to be understood that objects of interest which lie outside the range of the proposed work are to be ignored. While we have determined on a particular series of observations, all related to some definite portion of our subject matter, we must be careful that we do not suppress the individual enthusiasm of the children; but, at the same time, we must be equally careful that the object of the ramble is properly carried out.

Thus, if we go out, on a certain day in spring, for the express purpose of studying the bursting of the buds and the folding and unfolding of the young leaves, we ramble from tree to tree in the course of our work; but as we pass from point to point in our journey, neither teacher nor child will close his eyes to the many interesting objects that thrust themselves on their view. During these intervals we note the early spring flowers—how and where they grow, observe the first butterfly of the season as it flies across our path, watch the queen humble-bee as she searches out a suitable spot for her nest after a long winter's sleep, and pause to look at the little lizard as it basks in the warm rays of the sun. So, at the end of the ramble we shall have carried out our object as regards the bursting buds, and also learnt much concerning other interesting things.

Each child should be provided with a note-book and pencil for the purpose of recording what is seen. Even the youngest of the children should be encouraged to do this, and although the result may be very disappointing to the teacher, he must be satisfied, for the present,

that an attempt has been made, and that every such attempt must have some effect in forming the habits of the child.

The nature of the entries will vary according to the age and capabilities of the class. Encourage all children to make a sketch of at least those objects which have been specially selected for the observation of the day, and see that all entries are made under their proper dates, so that they may be transferred, in the case of the senior classes, to a well-kept nature diary. The systematic entry of observations made is a matter of such importance in the training of the child, and is likely to be of such great value and interest in years to come, that we think it necessary to devote a short chapter exclusively to the consideration of the manner in which note-books and diaries should be kept.

In addition to note-book and pencil, each child should be provided with a box in which to take home those objects that are required for a more detailed examination than could be given during the excursion, and any specimens that are to be preserved for future study. The children of senior classes will require a pocket-knife. A few small trowels may also be necessary for the collection of roots that are required for the school garden; and a magnifying glass and a compass will be of great value in many cases.

We have just referred to the collecting of material during the progress of the nature study ramble, but it must be remembered that the object of the ramble is not the collection of specimens for the illustration of

the lessons to be given in the school, but rather the close observation and study of natural objects in their natural surroundings; and we must be careful that the children do not develop into mere collectors, but rather into keen observers.

It is true, as we have already hinted, that it is often advisable to take home specimens for a more detailed study than could be given in the field, and we shall often meet with things of an imperishable nature that are of such interest that they may with advantage be given a permanent place in the reference museum of the school.

Further, we shall find many living objects, both of the animal and the vegetable worlds, the growth and life-histories of which are of great interest, and provide favourable opportunities for series of continuous observations and records. Thus, the roots of wild flowers may be transferred, in their earlier stages, to the school garden, in order that the future development of the plants, their flowers and their fruits, may be observed day by day; the fruits and seeds of trees and herbs may be secured for the same purpose; and the fronds of ferns may be collected for the spores, in order that the cultivation of the ferns and the observation of their interesting life-histories may be closely and continuously observed in the classroom. Also, to give a few similar illustrations on the animal side, a caterpillar, together with a sprig of its food-plant, may be taken for the purpose of studying the interesting metamorphoses through which the creature passes to its perfect state as a butterfly or a moth; various small animals of a

suitable nature may be secured for the observation of their habits in the school vivarium; and many species of aquatic animals may be collected for the school aquarium, in which they can, as a rule, be far more easily observed than in the natural pond.

If such material as the above is to be collected during the school ramble, the teacher should see that he or the children are previously provided with suitable accommodation for the specimens that are required. For plants and flowers a moderately large tin box, containing a little damp moss, will answer all purposes. For dry material, such as seeds, fruits of a non-succulent nature, fern fronds required for their spores only, and various objects of the mineral world, any kind of box, or even strong paper bags, will suffice; though it frequently happens that a special box with a loose packing of cotton-wool for delicate objects is extremely useful. Small living animals are conveniently transmitted in wooden or tin boxes in which a few holes for air have been made with an awl; but if a tin box is to be used for the conveyance of active little animals, the holes should be made by pushing the awl outwards from within, so that there are no rough edges of metal projecting inwards to the injury of the occupants.

We do not recommend the preservation of animal and vegetable specimens for school nature study. Our object should be to create an interest in *living* Nature by the observation of living things and their ever-changing aspects, and for this purpose we do not require the aid of preserved specimens. Dried plants and flowers are so unlike the original objects which they represent, that,

although they may be of some use for certain scientific purposes, they should hardly be needed in a school for the young. Similarly, preserved animals are of no value in connection with our work. Nature is always interesting because she is ever changing. Illustrate a nature lesson by means of preserved specimens and its interest is usually as dead as the illustrations.

We have often seen classes at work on nature study, both within the school building and out of doors, and have noted that, in almost every instance, the subjects studied belong almost exclusively to the vegetable world. This, we think, is a great mistake; for, in addition to marvels of structure and development common to both animal and vegetable beings, the former possess the additional feature of the power of movement and the interesting habits resulting therefrom. And there seems to be no reason why the observations should be confined to living beings only. The characteristics of the various rocks, and the soils derived from them, are worthy of some attention; also the movements and varying conditions of the atmosphere; and the face of the sky, with the movements, apparent and real, of the different heavenly bodies.

It is in the study of these latter objects and features that we realise the very close relationship between nature study and geography, the one merging into the other without any line of demarcation.

The study of plant life is hardly complete, even in its most elementary stages, without some appreciation of the relation existing between the character of the

vegetation of the districts traversed and the nature of the soil. Many plants are so partial to one particular kind of soil that we may often note a marked change in the nature of the vegetation as, in our ramble, we pass from one kind of soil to another. As a single instance we may note how the beautiful foxglove, often so abundant on clay or gravelly soils, suddenly practically ceases to make its appearance as we stroll from these soils on to a chalky or limestone district.

Children have often to walk some little distance in order to reach the locality in which their studies are supposed to commence, and to wander still further while their observations are in progress. In such cases they should be taught to observe the nature of the ground covered—the various slopes and aspects, the principal features of the vegetation in different districts, and the characters of the soils on which they tread.

On passing a quarry or a railway-cutting they should be encouraged to observe the underlying rock from which the soil has been in part derived, and compare the former with the latter. They should note those localities in which the soil bears no relation to the rock beneath it, and thus be led to inquire into the origin and mode of formation of vegetable soils, and into the various ways in which certain soils are transported from one place to another by the action of water and other denuding agencies.

As soon as the children are sufficiently advanced, let them sketch a simple plan of the route taken, and enter on this, on both sides of the route, the general

characters of the adjoining ground—the positions of hill, valley and stream, of field, wood and moorland. Encourage them also to mark, as accurately as possible, the spots where the principal objects of interest have been seen, and to enter any observed changes in the nature of the soil.

The elder scholars, after having become more or less expert in the preparation of rough plans as indicated above, may be taught the use of the pocket compass, and also simple methods of measuring approximately the ground traversed. Thus they become initiated into the art of map-making. Also, they should be encouraged to find their way about the neighbouring country with the aid of a compass and the ordnance map of the district.

Very interesting observations may be made during a ramble along the banks of a river or small stream. The moist banks are the special habitats of certain water-loving wild flowers, shrubs and trees; and in the stream itself we find several species of aquatic plants with a structure peculiarly adapted to their watery home.

In such a ramble attention should be called to the varying velocity of the stream at different points, and the relation which the velocity bears to the gradient of the bed and to the transverse sectional area of the stream should be worked out. Further, the different kinds of material forming the bed of the stream should be observed—the stony character where the stream is rapid, the sandy bed where the current is not quite so swift, and the muddy bottom of the sluggish parts. Thus

the processes by which the stream tends to reduce the level of higher ground, and to fill up the hollows, may be worked out. All the important features and functions of a mighty river may be observed, on a small scale, by the study of an insignificant rivulet.

Much valuable study may also be done, in the case of the schools of seaside towns and villages, during a ramble along the coast. Here we may observe the result of the denuding action of the sea, and watch the waves as they do their work; while the bare cliffs give us ample opportunities of studying the rocks of the district.

The sea cliffs, too, have their own special vegetation, as have also the salt marshes that are to be found on low parts of the coast. Some interesting flowering plants grow only near the sea, while others, that are common inland, become much altered in growth and habit when they find a home on the cliffs.

On the beach itself the children may observe some of the results of the mechanical action of the waves in the rounded outline of the lower rocks, the pebbles, and the particles of sand. Here, too, the movements of the tides should be noted; and the times of ebb and flow, as well as the limits of the advance and retreat of the water on different days, entered in note-books for future reference. Side by side with these entries the condition of the moon at the same time should be noted. Thus the children are led to see that the hour of high tide and the amount of advance and retreat of the water are always the same for the same condition of the moon. So they are led to look upon the moon as the prime agent

in the production of the tides, and are put in a better position to understand the theory of those movements when they are old enough to grasp it.

Marine life provides a wonderful store of material for nature study. Let the children observe the general features of sea-weeds—their varying forms and colours, their mode of growth, the absence of flowers, roots and true leaves. In the case of those larger species that are provided with air-bladders, let the children observe the plants as they hang over the rocks at low tide, and again their position when submerged. They will then be able to see the function of the bladders in supporting the plants in such a manner that they receive a maximum of light and a free supply of dissolved air, and thus they become acquainted with yet another example of adaptation of structure to habit and habitat.

At low tide they may examine the various forms of animal life—molluscs, crustaceans, worms, jelly-fishes, sponges, etc.—that live attached to the rocks; the various creatures—crabs, small fishes, etc.,—that conceal themselves beneath stones and weeds while they wait for the return of the water; and the many active animals that people the rock-pools.

Here they will have the opportunity of observing many examples of animals that are protected by hard external coverings; many also that are provided with ample means of defence and offence; and quite a number which are protected from their enemies, or enabled to lie concealed in wait for their prey, by a remarkable resemblance to their environment. Equally interesting

and instructive are the varied organs of motion and locomotion possessed by the creatures of the sea—the fins of the fishes, the jointed legs of crabs, shrimps and prawns, the gliding 'foot' of the winkle and the whelk, and the swaying tentacles of marine worms and anemones.

Even on those less productive shores where there are but few rocks to afford attachment to weeds and give shelter to animal life, much may be gained by a careful examination of the line of debris washed up by the waves to form the high-water mark, and this is more particularly the case just after a storm. Many forms of both animal and vegetable life that live and grow only in places that are perpetually covered with water are detached and thrown on the beach by the waves; and thus much may be learnt of marine life during a stroll along the line of material which marks the limit of the flood of the recent tides.

If possible, a little time should be set apart occasionally, say about once or twice a week, for a general chat on the observations of both teacher and children, made during the last few days. This will greatly encourage the children to observe, and probably add much pleasure to their work; while, at the same time, the relating of their experiences will give the teacher very favourable opportunities of developing their power of expressing themselves in correct English.

Again, the teacher will often be able to make use of the children's observations out of school hours as a basis for definite nature lessons in the school building.

Suppose, for example, it is proposed to give a lesson on some domestic animal that could not be conveniently studied within the schoolroom. Then, tell the class, a few days previously, to watch the particular animal closely, whether it be in the home, the field, the stable, or in harness, and to be prepared to give a description of its structure and habits. It would be well in such an instance, for the teacher to give some definite instructions as to the principal observations that should be made, e.g.:

1. The general form or build.
2. The character of the natural covering.
3. The limbs, especially in motion.
   (a) The movable joints.
   (b) The feet and their hoofs or claws.
   (c) How far the limbs resemble, and how far they differ from, our own.
   (d) How the animal moves about.
4. The head and neck.
5. The ears (compare with the human ear).
6. The eyes: where situated; lids and lashes.
7. The mouth.—
   (a) The lips.
   (b) If possible, the teeth.
   (c) How the animal feeds. Its food.
8. In all matters enumerated above, how the animal is peculiarly adapted to its habits and mode of life.

Then, when the time appointed for the lesson has arrived, the teacher will receive from the class all the observations made and the conclusions at which the children have arrived. He will not give information himself, as a rule, but rather encourage the children to observe again in matters where their observations have been imperfectly made. Nor will he offer explanations too freely, but cause the children, with as little aid as possible, to work out for themselves the little problems concerning the relation between structure and habit.

Such a lesson ought to be quite as valuable as one in which the object selected is examined in the presence of the teacher himself.

We may cite an example of another object that may be dealt with in much the same way—the obnoxious but interesting little house-fly. This insect is much more conveniently observed at home than in the school. It should not be captured, but rather observed at liberty. Encourage the children to note:

1. The divisions of its body—the division of the body into distinct segments.

2. The large eyes, little feelers (antennæ), and the sucking organ belonging to the first segment or head; also the food required by the fly and the manner in which it feeds.

3. The legs: where situated; how the fly walks, and its power of walking on very smooth surfaces, even in an inverted position.

4. The number and nature of the wings, and the wonderful power of flight.

In this instance the aid of the teacher's knowledge will be necessary in explaining exactly how the fly feeds, and why it is unable to devour food in the solid state; also, how it is enabled to walk on perfectly smooth surfaces. Diagrams or, better, photographs from Nature might be shown to demonstrate the wonderful structure of the foot and the proboscis. The subject might also be extended by rearing some flies (the common meat-fly or blow-fly is, perhaps, best for the purpose) in a suitable cage (see page 340), in order that the children may be able to trace the whole life-history and metamorphoses.

There are many other nature subjects that lend themselves particularly well to this mode of treatment, and they have the distinct advantage that they greatly assist the teacher, in that they give the children useful and interesting employment for their leisure hours, and thus allow of more actual study than would be the case if all observations were made under direct supervision.

In this chapter we have endeavoured to point out a little of the work that may be done out of doors, but much more will suggest itself to a teacher who is interested in his class, the nature of the work varying according to the situation of the school.

Where nature study has formed part of the school curriculum, and where the subject has been taken on the lines we have laid out, there will be but little fear that the children will cease to interest themselves in their surroundings as they get older and eventually leave school. Often we find them organising themselves

into little societies or clubs for the express purpose of continuing the work that has given them so much delight in the past, and it will be well if the teacher does his best to foster this tendency by helping the elder scholars and the old boys and girls to establish, organise and maintain a field club or natural history society in which they can continue the study commenced in their younger days.

It must not be supposed that this mode of treatment is exclusively adapted to the study of animal life, for it is equally applicable to all branches of Nature. The general study of our forest trees and shrubs, the habitats of flowers, the general aspect of hedgerow, field and wood, the study of atmospheric phenomena, the changes of the moon, and the movements of the various heavenly bodies are all suitable employments for children under the guiding hand, though not necessarily under the direct supervision, of the teacher.

In dealing with the above and other subjects it is hoped that the teacher will derive many useful hints and much practical aid from our future chapters treating with the school aquaria, vivaria, terraria, garden, and various other appliances for the continuous observation of living and other things either in the school or in the playground.

CHAPTER IV

SPRING STUDIES

1. General Remarks

Spring is the season of the re-awakening of Nature, and is therefore the best time for the commencement of a nature study course in schools.

At the beginning of this season the 'stocks' of the hedgerow plants, that have remained dormant throughout the winter, produce their new leaves, of a fresh green colour; and these, together with the tender seedlings that have grown from the self-sown seeds of the previous summer and autumn, push their way through the old withered herbage, rapidly hiding the latter from view. Similar changes are taking place in pastures and waste places, and the spring foliage is soon relieved by the appearance of the early flowers, most of which develop rapidly from stores of food that were laid up by their plants before the winter set in.

In the woods the winter buds begin to burst, some of them exposing the young foliage leaves of the coming summer, and others giving rise to flowers that either appear before the leaves of the same tree, or expand

in company with them; while beneath the trees we see the early spring flowers that must necessarily bloom before the foliage above is sufficiently dense to shut out the sun, and the multitudes of baby forest trees shooting through the leafy soil in the neighbourhood of their parents.

The animals that have been dormant throughout the long winter are now called forth to new life by the warmth of the spring sun; and others, which have spent the greater portion of the cold season in sheltered holes and corners, now resume a life of activity. Birds are busily engaged in building their nests and tending to the wants of their nestlings, and the feathered friends that left us for warmer climes at the fall of the year now return and make preparations for the accommodation of their offspring. In the fields the lambs are skipping; the ponds and streams are being rapidly restocked with new life; and the rock-pools between the tide-marks on the seashore are being re-peopled with a variety of curious animal forms. In the country, and even in town to a certain extent, human nature responds to this re-awakening of life and activity, and various occupations that were retarded by the winter's frosts are now taken up with renewed vigour.

In the present chapter we shall call attention to the principal objects and events of the spring season, dealing with different departments of Nature in turn, and endeavouring to introduce more particularly those subjects which are suitable for a school nature study scheme.

2. Plant Life

(a) The Winter Condition of Trees and Shrubs

During late winter and early spring we should make a special study of the winter condition of the common forest trees and hedgerow shrubs, while they are still in their dormant winter condition.

As long as the air and the soil are still cold, the roots are inactive. In fact, cell-activity is practically suspended in all parts of the tree or shrub, and the circulation of the sap and all the functions that result therefrom are interrupted.

Figure 2. *Bole of the Oak.*

FIGURE 3. *Bole of the Birch.*

The trees being bare, we have now our most favourable opportunities of studying the various modes of branching—the peculiarities in the disposition of the branches and twigs by which we are able to recognise the different species in the absence of their leaves and flowers. We stand at such a distance from each tree that we can readily command the whole, and endeavour to fix in our mind the general features above referred to; and, passing from one species to another, we note carefully any points of resemblance as well as of contrast.

Those who are not well acquainted with trees and shrubs in all their different phases will often fail to fix the identity of certain trees in their winter condition, even though the same species can be recognised with ease when in flower or in leaf. In such cases considerable help may be obtained by reference to photographs or

other accurate representations of the trees in question; but, failing this, those species which present a difficulty should be watched at intervals as the season advances. This latter method is undoubtedly far preferable to the use of pictures, for it enables us to trace the trees through those interesting stages which mark the return to active life, while our observations are rewarded by the pleasure and satisfaction that we must all feel when a revelation is made—when the thing previously unknown reveals itself as an old and familiar friend.

After observing a tree at a distance, approach it with the object of learning the nature of its bark and the character of its buds.

The former consists of a protecting covering of cork, composed of dead cells—cells which originally contained sap, but now only air. A new layer of cork is formed each year, and this is sometimes added to the accumulation of outer bark produced in previous years, so that, in an old tree, the protective covering is very thick. As a rule, too, a thick bark is very rugged, being divided into patches that are separated by deep, irregular furrows, as in the case of the oak and the elm. This is due to the fact that the bark, being dead, has no power to produce new growth to accommodate itself to the increasing trunk and branches, and is therefore fractured by the outward thrust. Some trees, on the other hand, like the birch and the plane, are almost continually shedding the older and outer layer, which peels off while a new layer is being formed; and thus the bark of these trees is seldom very thick and rugged.

The study of the so-called 'winter buds,' which are really formed during the preceding summer, is both interesting and important. Not only may all our forest trees be readily recognised by the form and colour of the buds, but it should be observed how the arrangement and development of these buds determine the general form and mode of branching of the tree.

A bud, it must be remembered, is a young branch. In several trees, including the beech, poplar, willow, and lime, there is a single terminal bud at the tip of each twig, and also lateral buds along the twig, arranged either alternately or in pairs. Imagine these buds to have developed into branches, and these branches in turn to have produced similarly-arranged buds and branches, and so on for several seasons in succession, and you have a picture of the tree as far as the general arrangement of its branches is concerned, but this picture may be more or less modified by the destruction or imperfect development of some of the buds, and by the direction in which the twigs grow. The single terminal bud at the tip of each twig continues, by its growth, the general direction of that twig; and each lateral bud produces a twig resembling the branch from which it grew.

Compare the above condition of things with that which obtains in the case of the oak. Here, at the tip of each twig, there is a cluster of from two to five or six buds, one or more of which are often much more strongly developed than the others. If only one of these buds develops in the spring, the twig formed is seldom in a straight line with the one that gave rise to it; and if two or more grow, they produce new twigs diverging

Figure 4. ***Trees in Winter or Early Spring.*** 1. *Hazel, with catkins.* 2. *Ash.* 3. *Oak.* 4. *Lime, with remains of the last season's fruits.*

Figure 5. ***Trees in Winter or Early Spring.***
5. *Birch, with catkins.* 6. *Poplar.* 7. *Beech.*
8. *Alder, with catkins, and the old fruit 'cones' of the previous season.*

from one another. Thus, by studying the distribution of the buds on the oak tree, we are enabled to explain the crooked and gnarled appearance of the old kings of the forest.

We may take yet another example—that of the sycamore. On the twigs of this tree we note that the terminal buds are frequently in pairs, while the lateral ones are also in opposite pairs. With such an arrangement of terminal buds it is, of course, impossible for the new twigs to continue the direction of the older ones; for if both develop a fork is formed. Also, the two lateral buds of each pair will give rise to two branches diverging from the parent twig. Here, then, we have an explanation of the rather crooked branches of the sycamore, the frequent forking, and the common threefold divergence of the same. The ash also has its lateral buds opposite, but each twig has usually a single terminal bud.

Children should be taught to observe the above and other characteristic features of our common forest trees in winter, and the teacher should encourage and help them to think out the various problems connected with their growth—how it is that some trees have a thin, smooth bark while others are provided with a thick, rugged covering; and how the tree came to be of its present form as regards the arrangement of its branches.

(b) The Bursting of the Buds

The best time to study the buds of trees is the period immediately preceding the commencement of the

expansion. This period will, of course, vary considerably as regards the different species, so that the whole study will extend throughout, perhaps, the whole of March and April.

Let the children observe the times of the appearance of the first leaves of different trees, and enter these times in their nature diaries. Continuing this, year after year, they will see not only that trees of the same species will be earlier or later, in the same season, according to the situation of the individual trees and the soil in which they grow, but also that the season itself varies in different years, sometimes calling forth the young leaves very early, and sometimes retarding their appearance to a much later date. They will also learn that some species are generally earlier than others, and that the order of the bursting of the bud, as regards different species, is not always the same. All these variations are both interesting and instructive, especially as they lead to the consideration of temperature and atmospheric conditions, and help the children to better understand the circumstances most favourable to vegetable growth.

Buds should be examined in their winter or dormant condition previous to the observation of the opening and the expansion of the leaves; and particular attention should be called to the impervious character of the scale-leaves that surround and completely inclose the delicate structures within, and which prevent loss of moisture by evaporation at a time when the tree is deriving but little water from the soil.

Some large buds, such as those of the horse-chestnut, may be cut longitudinally with a sharp knife in order to show the parts of the future branch—stem, leaves and flowers—*in situ;* and transverse sections are equally instructive, and are especially useful in showing the manner in which the young leaves are folded within the bud.

FIGURE 6. *Buds of the Horse Chestnut opening on a cut twig standing in water.*

The examination of such sections, as well as the observations of the opening of the buds, will show that some are destined to produce branches that bear foliage leaves only; that others are to give rise only to floral branches; and that some are to develop into branches bearing both foliage and floral leaves.

If the observations of opening buds are made only out of doors it is possible that some very interesting stages may be missed on account of breaks that occur through unfavourable weather and other circumstances; but a good many buds of forest trees and shrubs open very readily if the twigs bearing them are placed in a vessel of water in the schoolroom, and these give very favourable opportunities for a continued series of observations and for the drawing of series of sketches.

We have already referred to the dissection of buds with the object of studying the manner in which the leaves are folded within; but this folding can be seen remarkably well in most buds just as they begin to expose the leaves, and may, therefore, be studied from the specimens kept in water. Yet it will be wise to extend these observations out of doors when this can be conveniently done, not only because we may thus have the opportunity of seeing a greater variety, but also because the expansion of the buds may be observed to later stages and under more natural conditions than would be the case with indoor specimens.

Particular attention should be called to the folding of the young leaves as they make their first appearance, the method of folding being, of course, the same as that which obtained while the leaves were entirely enclosed within the bud, and revealed at this earlier stage by transverse sections only. It must be observed, too, that most leaves retain their folds for a period after they have freed themselves from the cover of the protecting scale-leaves that formerly enclosed them, this being a matter of considerable importance; for,

since the epidermis of the tender leaves is as yet very thin, and readily permeable to water, the sap within would rapidly pass out and evaporate, especially when the air is dry, thus causing the young leaves to shrivel and die. The retention of the folds, however, prevents a free exposure to air-currents, and consequently retards loss by evaporation.

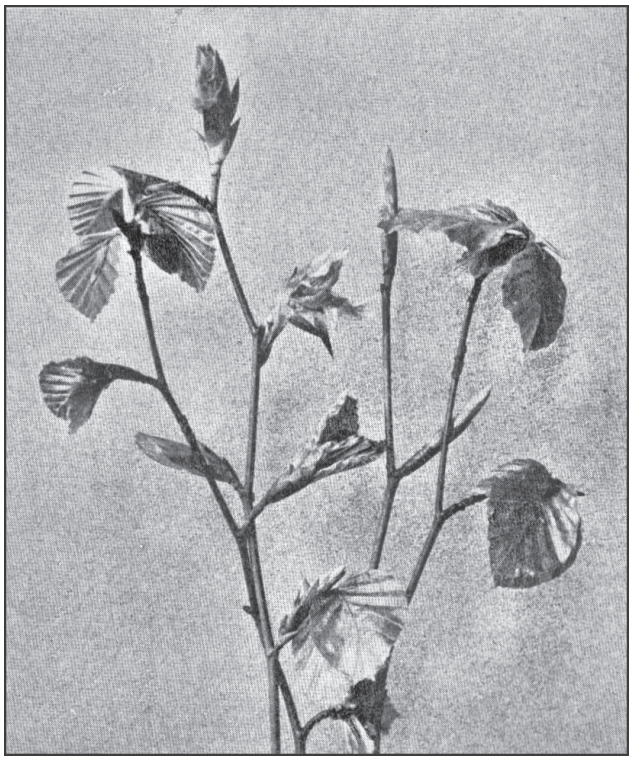

FIGURE 7. *Opening Buds of the Beech.*

Again, it will be observed that many young leaves are further protected from the drying influence of air currents by a covering of downy or silky hairs. Note, for example, the young leaves of the horse-chestnut and the beech. The leaf of this latter tree is characterised

by strongly marked parallel veins branching off from the midrib on either side; and, when very young, it is folded in such a manner that the only parts exposed are these veins and the margin. But there is a line of silky hairs on each vein and on the margin, so that the folded leaf is completely surrounded by a hairy covering. As the leaf grows and expands, the lines of

FIGURE 8. *Young Leaves of the Horse Chestnut.*

hairs are separated and the leaf becomes more exposed; but the epidermis is now less permeable to moisture, and the former protection is no longer necessary; and,

the function of the hairs having been duly performed, they are gradually shed, so that the old leaf of late summer bears hardly a trace of them.

Evaporation of moisture is also greatly accelerated by full exposure to the rays of the sun, but the retention of the folds in young leaves prevents such exposure. In this connection it is also interesting to note how some young leaves, quite apart from their folding, dispose themselves in such a manner that they are more or less protected from the direct rays of the sun. The leaves of the horse-chestnut are at first densely folded, and covered with a mass of woolly hair; but, when they expand, they are still in danger of suffering a serious loss of moisture on a sunny day, or even on a windy day when there is no sun; and so they hang vertically from the tips of the branches, thus affording themselves and one another a certain amount of protection from both sun and breeze.

As a rule, those parts of a plant that have only a temporary function to perform are shed as soon as their work has been completed. This is certainly the case with the scale-leaves which protect the buds during the winter and early spring, and with the stipules that are required for the protection of leaves only during their early stages.

Children should be taught to note such phenomena and, on seeing, for example, the shower of deciduous stipules falling from lime trees and covering the ground beneath during April, to inquire, What is this falling?

Where does it come from? Where did it grow? What was its use? Why is it now shed?

The trees and hedgerows in spring afford abundant opportunities of studying an enormous variety of opening buds and the interesting phenomena associated with their expansion, but it is hoped that the few instances quoted will be sufficient to show the teacher something of the nature of the work that may be accomplished.

During the winter months, long before even the earliest of the buds begin to burst out of doors, very interesting and instructive observations may be made on growing bulbs, such as those of daffodils, bluebells, tulips, onions, etc.; and afterwards, or even at the same time, while the structure of the buds of various trees and plants is being studied, comparisons should be made with the object of showing that a bulb is really a bud. Longitudinal sections of bulbs should be exhibited side by side with similar sections of the buds of a tree, such as the horse-chestnut; and it should be shown that the former are buds with thick, fleshy leaves, all

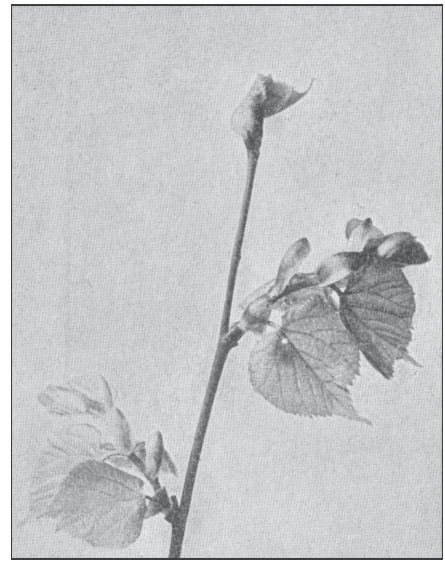

FIGURE 9. *Twig of the Lime in Spring, showing the deciduous, scaly stipules.*

attached to a mass of hard substance beneath which is really a shortened stem.

These bulbs should be grown under varying circumstances in order that the children may become acquainted with the conditions necessary for healthy development. The following notes give an outline of some of the more instructive experiments:

1. Bulb grown in a good soil and under favourable conditions as regards warmth, light and moisture. The plant commences to grow at the expense of food material stored in the thick, fleshy leaves. Roots are soon formed, and these absorb water and dissolved mineral food from the soil. The leaves appear, absorb carbonic acid gas from the atmosphere, and manufacture new material from the elements of the food obtained from both air and soil, thus assisting the growth of the plant. The plant then reaches its flowering stage, and the flowers give rise to fruit and seed. After the flowering and fruiting stages are over, the leaves continue to manufacture mineral food, which is stored in the bulb, or used in the formation of new bulbs, thus providing for a new plant or plants in the following season.

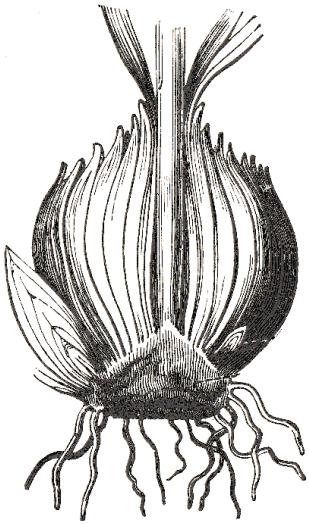

FIGURE 10. *Section of an Onion.*

2. Bulb in good soil, with the same amount of heat

and light, but no moisture.

3. Bulb grown in the same soil, with sufficient moisture and warmth, but kept in the dark. The unhealthy, straggling, white plant produced will clearly demonstrate the necessity of light for this kind of vegetable growth.

4. Bulb grown in the same soil, with light and moisture, but kept in a cool, exposed situation. The result—a much slower growth—will show how heat affects the development of the plant.

5. Bulb grown in water only (or in wet sand, sawdust, or fibre). The plant flourishes to the flowering stage, but not sufficient food is obtained to produce strong bulbs for the following season.

6. Bulb grown in water (or wet sand, sawdust, or fibre), and supplied with a proper amount of mineral food or 'fertiliser.' A strong plant produced, and sufficient food stored up in the bulb (or new bulbs) for new plants in the following spring—the result as good as when the same kind of bulb is grown in a good soil.

Other experiments, equally valuable as a means of education, will suggest themselves to the teacher.

It will be well to let the children themselves plant the bulbs for the intended experiments, and to attend to them throughout. Children take a greater interest in what they do themselves than in what is done for them. All the class should also take a part in making and keeping the records of the results; and each child should be called upon to give his opinions and conclusions as

regards the results obtained.

(c) The Movements of the Sap in Plants and Trees

Various simple experiments should be performed by the children with the object of learning how water is absorbed by roots and transpired by the leaves; and also how the sap flows in a living plant. For full descriptions of such experiments the reader should refer to suitable botanical works, for we can do no more here than briefly refer to them.

1. Remove a plant from the soil without injury to the root. Wash the soil from the root, stand the plant in a graduated jar or bottle of water so that the root is quite submerged, and then close the neck of the jar with some impermeable material (such as a good cork cut longitudinally and grooved to grasp the stem) to prevent evaporation. Note the rate at which the water disappears from the bottle, and how this rate varies with different atmospheric conditions and with the amount of light.

2. Cover this plant with a bell-jar, and observe the condensation of water that has been transpired as vapour from the leaves.

3. Cut away a complete ring of the outer bark from the branch of a tree or bush. The branch still thrives, thus proving that the function of the outer bark is protection only.

4. Cut a deeper ring round a second branch, dividing both the outer and the inner bark (bast), but not penetrating to the wood, and note that while the

branch still thrives and grows thicker above the ring, there is no increase in thickness below it.

5. In the case of a third branch, preferably an old one, cut a ring through both outer and inner bark, and also through the outer rings of wood. This branch dies.

From experiments 4 and 5 the children will (perhaps aided by the teacher) come to the conclusion that the sap rises from the roots through the outer or sap wood, that new material is manufactured in the leaves, and that this new material is carried downward through the vessels of the inner bark to add to the growth of the tree.

Other suitable experiments may suggest themselves to the teacher, and in all cases the children should, with as little assistance as possible, work out their own conclusions from the results.

(d) Observations and Experiments Connected with Food Storage

Many plants prepare and store considerable quantities of food material for use at a future period. Some of these are biennials—plants which do not, as a rule, produce their flowers and seeds during their first season, but lay by a quantity of food that enables them to reach maturity early in the following year. As familiar examples we may mention the turnip, parsley, parsnip, carrot, wild lettuce, and the spear thistle, all of which store food in their large, fleshy roots. Other plants which store food are perennials, and these usually lay

up their supplies for future use in thick, fleshy roots, or in thick, underground stems.

The plants referred to above may be employed for various interesting experiments. Thus, if the tops of carrots, turnips, parsnips, etc., be cut off horizontally and placed in saucers of water, they will produce beautiful tufts of leaves; and potatoes (modified underground stems) that have been stored through the winter will develop stems and leaves from their buds (the 'eyes') in the spring. In all these instances a certain amount of growth will take place even without the aid of added water, since the parts contain large supplies of moisture in addition to solid food; but the development may be carried much further if water is used in the experiments.

Some of the above may be grown in a dark box or cupboard, in order to demonstrate the value of light to a growing plant. The comparison of a potato grown in the dark with another that has been exposed to a good light is particularly interesting and instructive.

(e) Study of the Germination of Seeds

The study of the germination of seeds should be preceded, in early spring, by the examination of the seeds themselves. Procure several suitable kinds of seeds, such as beans, peas, mustard seeds, maize, and oats, soak them in water for about twenty-four hours, and then distribute them among the children for examination. After the exterior has been observed, cause the skin to be removed, and direct attention to the young root, the bud, the seed-leaves or cotyledons,

and to special food, stores extraneous to these parts, if such exist. It should be made clear that the seed is really an embryo plant, awaiting favourable conditions for its development.

Having observed the general structure of the seeds, a moderate number should be sown under varying conditions, the growth of the young plants carefully watched, and records kept. The children should take the active part in all this. They will sow the seeds, tend the young plants, keep written records of the growth, and make dated sketches of the natural size, under the guidance of the teacher.

It will be necessary to have a number of seedlings that may be removed from their bed at intervals for the examination of the roots. These may be grown in wet sawdust, from which they can be readily removed without injury.

In cases where the earlier stages only are required, plain water only is necessary; but if the plants are to reach a mature stage, the seeds must be grown in a good soil, or watered with a nutrient fluid such as that given below.

It is important that the children become practically acquainted with the conditions essential to the healthy development of a plant, and to this end it is necessary to give the seeds and seedlings various modes of treatment. In this connection the following hints may be of some service:—

1. Count the seeds sown in some instances, in order to ascertain the proportion that grow.

2. Sow some in sawdust, sand, or soil, and keep them quite dry, to demonstrate the necessity of water.

3. Sow others in sawdust or sand, and keep them moist with pure water only.

4. Place seeds of the same kind in a similar bed, but water them with a nutritive solution made as follows:—

1 part	Common salt (sodium chloride)
2 parts	Nitro or saltpetre (potassium nitrate)
1 part	Calcium sulphate
1 part	Calcium phosphate
1 part	Epsom salts (magnesium sulphate)

Dissolve about a quarter of an ounce of the above mixture in a gallon of water, and add one or two drops of a weak solution of iron perchloride.

5. Sow some in a good soil, and give them the normal treatment for plants in general.

6. Sow seeds in a good soil, or in sand or sawdust kept moist with the nutritive solution, but keep them always in a dark box or cupboard.

Perform the above experiments with seeds of the same species, and let the children enter the date in their nature diaries, and make complete records of the results as recommended above.

In the case of experiments 4 and 5, if the seeds selected are those of a forest tree or of some other perennial plant, the growth and the observations

thereof may be continued season after season for years in succession; and very great interest will be aroused by the re-awakening, each spring, of the tree that was dormant and apparently dead during the preceding winter. If you would have your children interested in the nature and growth of forest trees, probably nothing will secure that end better than the formation of a little nursery in which trees are reared from seeds that have been gathered, planted and tended by the children themselves.

The results of experiment 6 should be very carefully compared with those of 4 or 5, the seeds being of the same species, and treated in exactly the same manner except as regards light. Here the children should not only make comparisons of the general characters of the seedlings produced, but also make measurements of the plants at regular intervals, and compare the average growth of the plants in one set with that of the plants in the other.

If suitable balances and weights are available, they may also take the average weight of the seedlings in the two sets at corresponding intervals, with the object of noting the amount of solid matter built up; in which case the plants must, of course, be thoroughly dried in a slow oven previous to the weighing.

We have already referred to the seed as a plant in embryo, containing the parts of the future plant distinctly visible though, as yet, imperfectly formed. In this respect the seed of a flowering plant differs from the spores which give rise to ferns, mosses and other

flowerless vegetation. These latter are very minute cells that contain not the slightest trace of the structure of the plant which produced them; but the plants are often easily reared from the cells, and their life-histories are particularly interesting. A method of propagating ferns from the spores will be found in the next chapter.

(f) Spring Wild Flowers

The study of the spring wild flowers will, of course, form a most interesting part of the work of this season, but we must be careful here not to adopt the practice, far too common, of confining our attention to observations of the form and colour of cut or gathered flowers.

FIGURE 11. *The Wood Anemone—Slightly Reduced.*

Flowers are certainly very beautiful, and present a marvellous variety of form and colour, and we should

FIGURE 12. *The Lesser Celandine—About Half Natural Size.*

by all means make use of them in the cultivation of an æsthetic appreciation of all that is beautiful; but we need not trouble about those details of structure by means of which the systematic botanist distinguishes between genera and species. A flower may have four sepals or five, its petals may be united or distinct, its stamens below the pistil or above it, and the pistil superior or inferior. The observation of these features will arouse but little interest, and, if the observance of them is accompanied by the use of the technical terms with which botanists are so familiar, the effect will probably be to make the flower-study a distasteful drudgery. Rather deal with plants as living things with wonderful habits and marvellous life-histories. Let our questions be: Where does it live? How does it grow? Why does it

climb? How does it climb? How is it protected? What is the advantage of this or that particular form, colour, or habit? etc. It is far better to encourage the continuous, thoughtful observation of the commonest weed in a neglected corner of a garden or on a wayside bank, than to make a study of the most conspicuous flower apart from its accompanying growth and its natural surroundings.

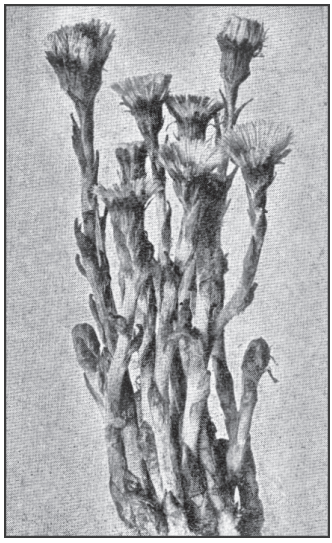

FIGURE 13. *The Colt's Foot in Early Spring—Half Natural Size.*

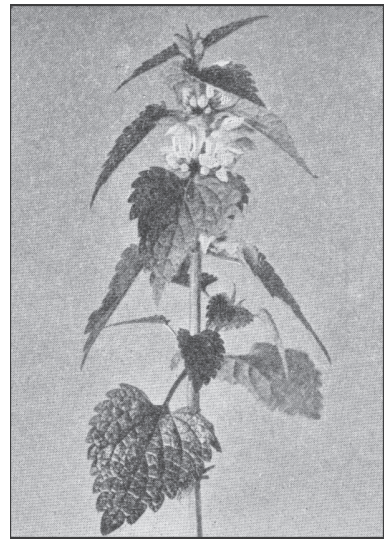

FIGURE 14. *The White Dead-Nettle—One-Third Natural Size.*

It follows, from what has been said, that the study of flowers should be conducted, as far as possible, out of doors. The note-book should now be in constant use for the purpose of recording the habits and habitats of the plants observed. If a nature diary has not been previously in use, the early spring is the best time of the year in which to encourage the children to start one.

Although we do not recommend any attempt at the classification of flowers on the part of young children, all striking resemblances between different species should be observed and noted; and the observations made will result in a store of knowledge which, in future years, may form the basis of a very elementary classification, confined exclusively to the plants that have been examined. Thus, the common buttercups may be compared with the water crowfoot and the lesser celandine; the stem, leaves and flowers of the dead nettles with the corresponding parts of the bugle and the ground ivy; the cuckoo-flower with the wallflower and the garlic mustard; and the bluebell with the daffodil.

FIGURE 15. *The Ground Ivy—Half Natural Size.*

During early spring we meet with a large number of flowering plants that are well in leaf, but which, as yet, show no trace of the future flowers. Many of these are probably unknown in their present condition, even

FIGURE 16. *The Dog's Mercury—Half Natural Size.*

FIGURE 17. *The Elm in Flower—Half Natural Size.*

though they are easily recognised when in flower. Encourage the children to note the soil and situation in which they grow, and then to take the plants home and set them in a garden, preserving, as well as possible, the conditions natural to them, so that their progress and development may be watched up to the fruiting stage.

At first, while the weather is still rather cold, but few flowers are to be seen, but the few that appear are all the more conspicuous and interesting on that account, and will therefore receive their full share of attention.

Some of the very early spring flowers are hardy species that bloom practically all the year round, such as the shepherd's purse, chickweed, groundsel, and the red dead-nettle; and these are followed by, or accompanied

by, the furze or gorse, the hazel, and the pretty little barren strawberry which is so often confused with the edible wild strawberry. But all the above flowers may be regarded as winter, rather than as spring, blossoms, inasmuch as they commence to bloom before the former season is at an end; and for this reason we give illustrations of a few of them, for purposes of recognition, in Chapter VII, dealing with winter studies.

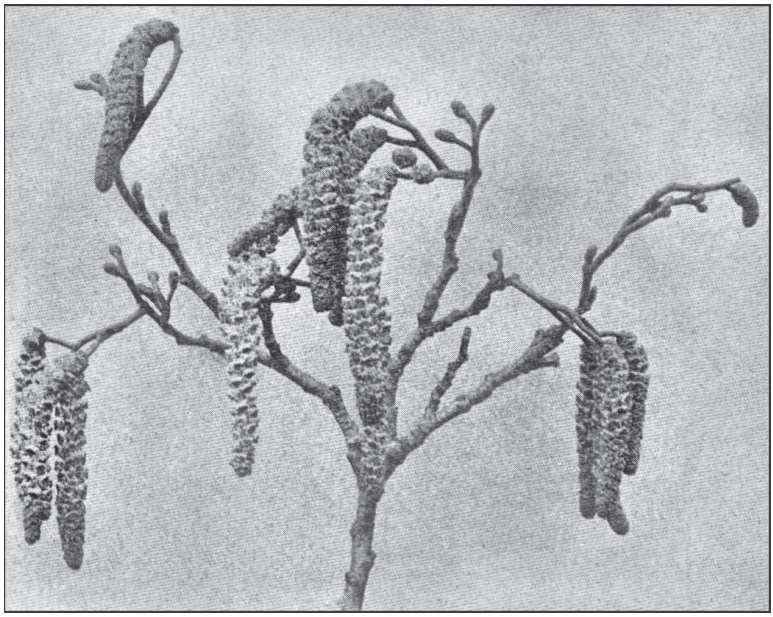

FIGURE 18. *The Alder in Flower—Slightly Reduced.*

With the advent of spring we renew our acquaintance with the wood anemone, lesser celandine, violet, colt's-foot, primrose, daffodil, the yew blossom, and the annual meadow grass. In the case of the colt's-foot special attention should be drawn to the fact that the flowers appear before the leaves; and the exact position of the clusters of flower-heads should be noted so that,

in the following month, a second visit may be made to the spot in order to see the globular, hairy 'clocks,' and also the leaves, which are now commencing to cover a large patch of ground.

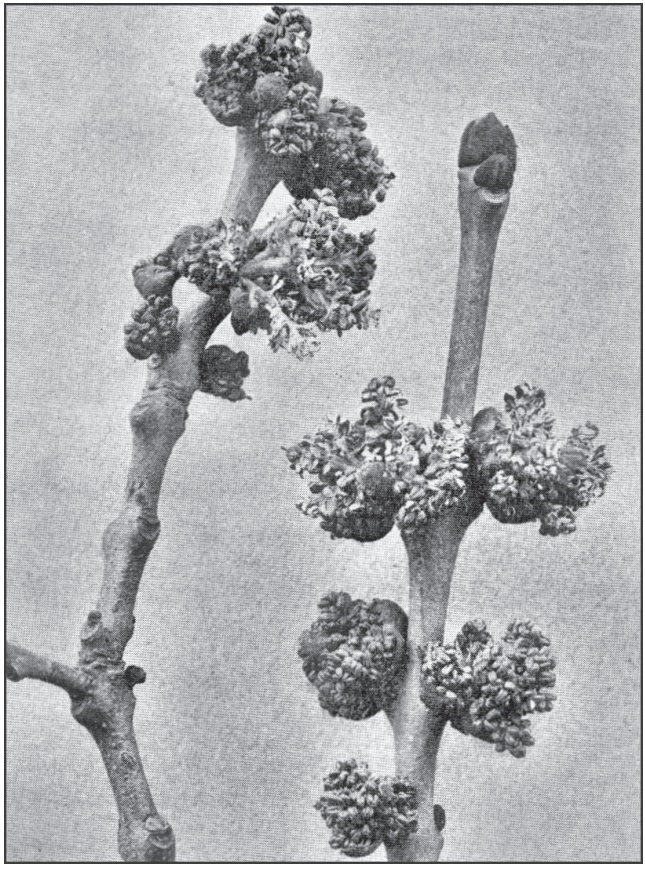

FIGURE. 19. *The Ash in Flower—Natural Size.*

During April quite a large number of common flowers will make their appearance, and the note-book and diary will be brought into constant use. The wayside is now brightened by the garlic mustard or Jack-by-the-hedge, dove's-foot crane's-bill, dandelion,

white dead-nettle, ground ivy, and the dog's mercury. In meadows we find the common daisy, cowslip, the pretty little field woodrush and the fox-tail grass; and, on banks, the early forget-me-not.

This same month is still further interesting as being the period during which a number of our common trees and shrubs are in bloom. The willows, poplars, and alder are rendered conspicuous by the appearance of their catkins while the leaves are still hidden within their buds. The tops of the elms have a somewhat fluffy appearance, due to their clusters of small flowers, which are often absent on the lower branches. The flowers of the ash form dark purple clusters on the yet leafless branches. The oak, birch and hornbeam display their drooping catkins among the developing leaves which appear at the same time. The leafless sloe or blackthorn is thickly covered with its pretty, white flowers; and the yew still bears its little blossoms beneath its dark, narrow leaves.

From April onward the succession of new wild flowers is so rapid that we forbear even to mention their names. The teacher who has not spent some years in the study of the wild flowers and trees will, of course, frequently meet with those which he cannot name; and during his school rambles he will often find some, even common species, which he has not noticed previously. This need not discourage him, for the object of school nature study is to become acquainted with things rather than with names, and it is possible for one to know much of the interesting habits of flowers without even knowing what these flowers are called. It

is a pleasure, however, to be acquainted with the names of the natural objects we meet with, and these may be gradually acquired by frequent reference to good books in which the descriptions and representations of the flowers are given.

As the various flowering plants and trees progress, they should be observed till they reach their fruiting stages, in order that the nature of the fruits and the modes of dispersion of the seeds may be studied. But few plants reach this stage before the season is well advanced, and consequently this portion of the work will be continued into the summer and autumn, and will be considered in its proper place.

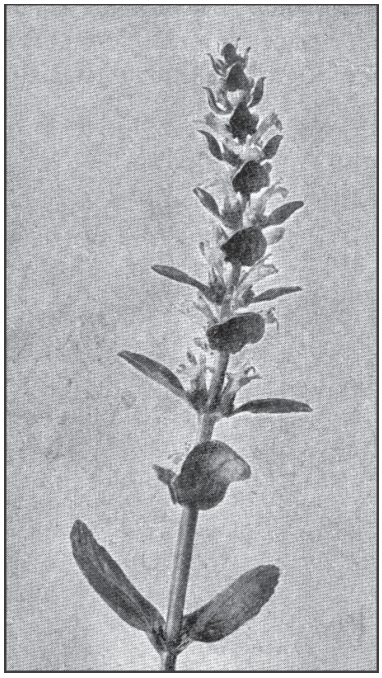

FIGURE 20. *The Bugle—Half Natural Size.*

The photographs of some of the commonest spring flowers interspersed in this section will serve for the identification of species that are not already familiar to the reader.