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MARCH, 1896.
VOL. IX, No. 12.

# THE OTTAWA NATURALIST.

Published by the Ottawa Field-Naturalists' Club.

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# THE OTTAWA NATURALIST.

VOL. IX. OTTAWA, MARCH, 1896. NO. 12.

## NOTES ON THE STUDY OF BOTANY.

By T. J. W. BURGESS, M. D., F. R. S. C. &c. (Montreal, Que.)

Read before the Ottawa Field-Naturalists' Club, Ottawa, 6th February, 1896.

*Mr. President, Ladies and Gentlemen:—*

The highest and most important object of all human science should be mental improvement, and the study of natural history, in particular field-work, when properly pursued, is assuredly adapted to strengthen, discipline, and develop the mental powers. It robs the mind of contracted ideas, induces us to take close as well as comprehensive views of objects, and teaches us to argue from facts, not from fancies. Though the study of nature in any of her forms is calculated to bring about these results, none of the natural sciences is as good for beginners as botany, the materials being everywhere abundant and inexpensive. To the average student, plants, possessing life, are more interesting than minerals, while animals, though affording the most striking marks of designing wisdom, cannot be dissected and examined without painful emotions.

One of the most apparent of the many advantages to be gained by the study of botany is that it systematizes the mind, by imprinting on it and establishing habits of order and exactness. It thus gives all the benefits of mathematics or logic without the drudgery which debars so many from pursuing the study of these sciences. System is essential not only in science, but in conducting any kind of business and in the most trivial affairs of every-day life; thus, the very logical and systematic arrangement prevailing in botanical science cannot but induce in the mind a habit and love of order, which, when once established, will operate in even the minutest concerns. The methodical habits of

thought, by which alone plants can be properly examined, must necessarily be inculcated, and will prove invaluable in any vocation of life. Nor is it essential that the study (to be of use as a training for the mind) should be carried to any great length—we cannot all hope to be Darwins, Grays or Macouns—the elements of the science alone are sufficient as a means for the practice of this training to habits of methodical thought.

The taking of notes in a neat and systematic way, by which alone the results of examinations and discoveries can be recorded in a manner ready for reference, begets a concise style and an accurate use of exact words; while in the very collecting of material to form an herbarium, the faculty of observation is cultivated and developed, and the power to discriminate between species, thus to appreciate minute differences is obtained. Most important of all things to the botanist are these faculties of observation and comparison. Many persons have a natural acuteness in perceiving details of structure and in generalizing results, while others are very obtuse in such respects. Yet, in all, these powers can be cultivated and strengthened, and herein lies one of the great educational uses of botany, that it trains us to see and to think.

But in addition to the direct benefits to be gained by the study of botany, there are others of a more general nature, and man's great aim in life being the pursuit of happiness, I would place first the added pleasure it gives to life. To one not trained to an inquisitive appreciation of Dame Nature how comparatively few are the beauties she displays.

> "A primrose by the river's brim
> A yellow primrose is to him,
> And it is nothing more."

Very different is it when he has the slightest knowledge of botany Then, in even the humblest of the vegetable creation, he can note the structure, take cognizance of the relationship borne by the several parts to each other, see the marvellous way in which each organ is adapted to serve a certain end, and in all admire and do homage to that All Wise Being at whose creative fiat all things first were made.

Last but by no means least of the advantages to be mentioned is, that the pursuit of the science, leading to exercise in the open air, is

conducive to health and cheerfulness. Botany is not a sedentary study, which can be followed in the house, but one the love of which compels its devotees to seek their amusement out of doors, thus to breathe the pure air where the objects of their search are to be found; in the fields, along the winding brooks, on the mountain side, or in the cool depths of the forest. In every pursuit a certain amount of recreation and exercise is necessary for the maintenance of health, and walking is the means commonly employed to procure this. A walk taken merely as a duty is wearisome, but when indulged in with a definite and pleasant end in view it becomes delightful. As soon as one in his rambles begins to search for and collect any special class of objects he becomes interested, and marvels how he could formerly have been blind to so much that is curious and beautiful. To those who know anything of out-door life what a source of enjoyment it is to wander through the fields and woods. Each step brings some object of interest, or some new discovery; a flower not hitherto noticed, or some familiar one showing variation from the common form; a rare bird flitting from branch to branch; or some brilliantly colored insect pursuing its erratic flight.

During the past thirty years the methods of teaching botany have undergone a radical change. As formerly pursued the study consisted mainly in learning from some book, the names of the different kinds of roots, stems, leaves and flowers. If plants were obtainable the scholar was perhaps made to run superficially over a few of them, and by aid of an artificial key determine their names. The terms used were hard and unfamiliar and there were no specimens to illustrate the lessons. Was it any wonder then that pupils acquired a disgust for the science? Little or no field-work was attempted, and no thought was taken to promote habits of close observation, or to secure a knowledge of the mysteries of plant-life. By the new system of teaching, the special design of which is the training of pupils to fit them for original work, objects are studied before books, and the student is at once set to investigating and experimenting for himself.

To give you an idea of this modern method of teaching botany, I have made a short resumè of a paper on the subject by Professor Beal.

Before the first lesson each pupil is furnished with, or told where to procure, some specimen for study. If it is winter, and flowers or growing plants are not to be had, each is given a branch of a tree or shrub. The examination of these is made by the pupils themselves during the usual time for preparing lessons, and for the first recitation each tells what he has discovered about his specimen, which is not in sight. If there is time, each member of the class is allowed a chance to mention anything not named by any of the rest. If two members disagree on any point, they are requested to bring in, the next day, after further study, all the proofs they can to sustain their different conclusions. In learning the lesson, books are not used, nor are the pupils told what they can see for themselves. An effort is made to keep them working after something which they have not yet discovered. For a second lesson, the students review the first lesson,—report on a branch of a tree of another species which they have studied as before,—and notice any points of difference or of similarity. In like manner new branches are studied and new comparisons made. Time is not considered wasted in this. No real progress can be made till the pupils begin to learn to see; and to learn to see they must keep trying to form the habit from the very first; and to form the habit the study of specimens is made the main feature in the course of training. The use of technical names is not avoided, nor are these "thrust upon a student." They are learned as they are needed, a few at a time, from the teacher or a text-book. Afterf rom four to ten lessons on small branches, the following points, and many others, are brought out. Is there any definite proportion of active and dormant buds in any year? Where do branches appear? Is there any certain number of leaves in a year's growth, or any definite proportion between the length of the internodes? Is there any order as to what buds grow, and what remain dormant? etc., etc. The pupils are now ready for a book-lesson on buds, branches, and phyllotaxis, and will read it with interest and profit. In like manner any other topic, as roots, seeds, stamens, leaves or petals is first taken up by the study of specimens. Very little stress is placed on investigating a number of chapters in the definite order as given in a text-book. For example, it makes very little difference whether a pupil begins with the study of

petals or stamens, buds or roots, leaves or pistels; but it is desirable after beginning any topic, not to abandon it until many of of the various forms have been thoroughly studied. After a day, two three or more of study of the specimens pertaining to one topic, comes the study of the book. A young man of eighteen begins and pursues the same course as a child of ten, only he will progress faster and go deeper. As students advance, subjects for descriptive compositions are assigned them. Each pupil studies the living plants for himself and makes his own observations, experiments and notes, the only help afforded him being brief hints as to how to set to work intelligently. *For instance,--one studies and writes upon the arrangement and* development of the parts of the flower with reference to its self-fertilization or fertilization by birds, insects, wind or other means; another the climbing of virginia-creeper; another the times of opening and closing of flowers; and so on *ad infinitum.* When completed the theses are read in the class-room. Throughout the academic year full three-fourths of the time is given to object lessons, books serving only for reference. But little time is occupied with lectures, short talks of ten or fifteen minutes being occasionally given. In the whole course there is kept constantly in view how best to prepare students to acquire information for themselves with readiness and accuracy, in other words, they are trained more than they are taught.

This, or some modification of it, is the system of teaching botany now most in repute, and wisely so. I agree fully with Prof. Beal that the great object should be to put students in the way of becoming independent and reliable observers and experimenters, and that the method of study pursued should be primarily objective, and based upon the actual examination of appropriate material. To my mind, however, a certain, though slight, amount of knowledge gained by the old system is necessary before much can be accomplished by the new, and I would prefer, if teaching, to first of all give my pupils some idea of what plants are, how they grow, the nature of their structure, and the number of their parts. This to be done in a short series (three or four) of familiar talks, made as simple as possible, with each point illustrated by drawings, models, dried specimens, or, best of all, freshly gathered plants. With-

out some faint idea of plant life, to plunge a pupil headlong into the depths of the study, were to me like setting him to solve some abstruse mathematical problem prior to his learning the meaning of addition and subtraction. Mr. Beal, too, in his paper, whatever he may do in practice, makes no mention of a point which I deem of vital importance, viz., that every student in botany, from almost his very entry on the subject, should be urged to start and taught how to make an herbarium, or collection of plants, for himself. Field-work is of the greatest importance in promoting familiarity with habitats, and in solving most of the problems of plant life, and to induce pupils to engage actively in field-work there is nothing equal to starting them to form an herbarium, for in no other way can such an interest be excited. In my experience, young people can best be stimulated to take an interest in any branch of study by giving them something to *do* in connection with it.

But it is not alone in the excitement of an interest in the study of botany that the value of an herbarium lies. The ultimate end of any scientific study being the mastery of all that can be learned concerning it, the formation of a collection of plants in a manner most convenient for reference is a necessary part of the science of botany.

But enough has been said to give you an idea of the general principles on which botany is now usually taught in colleges and schools. Let me next devote myself to telling you what *I* consider the best way for *you* to enter on the study. The first step is to procure a text-book on structural botany. For choice I would name Gray's "Lessons in Botany." It is not too complicated and yet is extensive enough, except for advanced students who wish to devote themselves specially to the study. A work on systematic botany is also essential, and I know of none better than the "Manual of the Botany of the Northern United States," which covers our Canadian flora in great measure. I would advise any one purchasing to get the "Lessons" and "Manual" bound together. In this shape, the books are not only cheaper but more handy. We have in combination excellent works on both departments of Botany, Structural and Systematic, no small desideratum to the beginner, who, in naming plants by the latter, will

from time to time meet with unfamiliar terms, for the meaning of which he will require to refer to the former.

A text-book secured, comes what is generally looked upon as a rather dry part of the study, viz, the reading of it. Many words are met with which are strange and difficult to remember, but let me tell you that the labor of learning technical terms is usually much over-estimated. With practice they soon become familiar, while the discipline taught the mind in learning them is worth all it costs. There is no royal road to solving the problems of nature any more than there is to deciphering the mysteries of mathematics or metaphysics, but at each step the way becomes easier till at last what was a wearisome task becomes a pleasant and absorbing recreation. The so-called drudgery is greatly lessened if the reading be pursued in a proper manner, and especially if the reader has before him the proper material to illustrate the more important points in each topic as it is taken up. He who has some older botanical head to advise him what material to provide beforehand for each chapter, is greatly blessed; but, whether he has specimens to examine or only the plates in his text-book to guide him, I would strenuously advise him to make no effort to commit all the terms he meets to memory. Let him try to read slowly and understandingly, but let him bear in mind that the object of this primary reading, is only to get a general notion of plants and their parts, and to learn the meaning of a few of the most material technial terms, so as to be able to start collecting and naming plants for himself. Thus, in the first reading, he will gain an idea of the life-history of a plant, and discover that as a rule a miniature plantlet, the embryo, exists ready formed in the seed. If now this seed, say that of the maple, be placed in the ground and allowed to germinate, the miniature plantlet will soon be seen to develop in two opposite directions; downward into a root or descending axis, and upward into a stem or ascending axis. The stem as it reaches the surface of the ground will be seen to bear a pair of narrow green leaves, the seed-leaves or cotyledons. Soon between these seed-leaves will appear a little bud, which shoots upward into a second joint bearing another pair of leaves, which, however, differ in shape

from the first pair and resemble those of the maple as usually seen. Later, a third joint shoots up from the summit of the second, bearing a third pair of leaves, and so on until the plant likeness of the seed becomes a fully developed tree. The three organs, root, stem, and leaves, which exist in the embryo in a rudimentary state, are called the fundamental organs or organs of vegetation, because they have for their object the development and nutrition of the plant; while all the parts which succeed the leaves, such as the flower and its organs, are only modifications of them designed for a special purpose, and are called the organs of reproduction, since on them depends the increase of the plant in numbers, or the continuance of the species.

Proceeding onward with his reading the student will obtain some general knowledge of the various sorts and forms of these two sets of organs, and afterward will get an insight into the life of plants, and the mode in which they do the work of vegetation. He will discover that all plants possessing leaf-green (Chlorophyll) as the pigment which gives the green color to the leaves is called, possess also the power of assimilation, that is of making starch and similar organic compounds out of inorganic elements, such as water and carbonic acid: which transformation, briefly speaking, is thus effected. The plant through its roots, by the process known as osmose, takes in, dissolved in water, various compounds containing carbon, oxygen, hydrogen, nitrogen and other materials. The pressure exerted by the liquid as it comes into the roots, together with the attraction exerted by a constant process of evaporation from the leaves, causes the "sap," which is the plant food, to rise, and gives us what is known as the plant circulation. When, by this osmotic action, the sap finally reaches the leaves, it, in conjunction with carbonic acid derived from the air, is converted, in the chlorophyll grains under the influence of sunlight, into organic materials, which pass into a whitish granular liquid called protoplasm, and are used in "growth," that is in the building of new cells to form plant tissue. Assimilation takes place only in sunlight, but growth goes on most rapidly at night. In the former process oxygen is set free and given off through the leaf-pores, or stomata, but in the latter, air is taken in through the stomata, and, as its oxygen is used up, carbonic acid gas is

given off. It will thus be seen, as tersely put by Mr. L. H. Bailey, Jr.—"*If the leaves are the lungs of the plant because they breathe, they are more emphatically the stomachs of the plant because they assimilate and digest.*"

It is now in order for the student to learn something of classification, as it is by this means he is enabled to analyze and recognize by name the plants with which he meets, thus to avail himself of all that has been recorded concerning them by botanists before him.

To the ordinary observer plants differ so much from one another that he can see no points of resemblance which could connect them naturally. For example, what likeness is there between the common strawberry and the mountain ash? Yet both belong to the rose family. Notwithstanding this great external dissimilarity, the botanist can readily point out in both, characters which at once stamp them as closely akin. The points which determine the relationship of plants are not confined to any one part of them; they may exist in the roots, leaves, flowers or fruits, but the natural system now in use aims to bring together those which most closely resemble each other in all these particulars, laying especial stress on the flowers and fruit. In this respect it differs from the Linnæan and all other artifical systems, which took up a certain set of organs and based kindredship on those alone.

The means by which a plant reproduces itself and is prevented from becoming extinct is evidently its most important and essential part, and it is upon this the fruit, that the vegetable kingdom is primarily divided, viz, into flowerless plants, such as ferns, mosses and fungi, and flowering plants, such as herbs, shrubs and trees. The former reproduce themselves by spores, which are commonly simple, minute cells and contain no embyro; the latter by seeds, which are embyro plantlets enclosed in an integument. Among flowering plants; increase in the diameter of the stem forms the first basis of division. There are two general methods in which this increase takes place. In the one case the woody tissue is scattered as separate threads throughout the whole stem, and the increase in diameter is by the interposition of new woody threads which stretch its surface; while in the other case,

the woody tissue is all collected so as to form a layer between a central cellular part, the pith, and an outer cellular part, the bark, the increase in diameter being by the addition of new layers of wood beneath the bark. The former class of plants, which includes our grasses, sedges and lilies, is called endogenous or "inside-growing;" while the latter, which includes all our northern trees and shrubs and most of our herbs, is known as exogenous or "outside-growing." In Canada, the endogens are all herbs with the single exception of Smilax, but in warm climates they are largely represented by the palms. It is not, however, only the manner of growth that separates these two great divisions of flowering plants; marked distinctions exist in the seeds, flowers and leaves. But I shall not weary you with these distinctions, nor by describing the principles upon which the exogens are again subdivided into polypetalæ, gamopetalæ, and apetalæ; neither will I inflict upon you the method of applying the system of classification to the naming of plants. All these you will find laid down in your structural botany under the heading "How to study plants." This I will say, however, that the analysis or naming of plants, tedious and difficult as it may at first seem, soon becomes very easy. After a few analyses the primary steps can be rapidly passed over, and I will guarantee that any one who will conscientiously study out twenty to twenty-five good examples will afterwards experience little difficulty in naming most of our flowering plants. Be not discouraged at the slow progress you will at first make; each successful analysis will facilitate the next, and very soon it will become so that when you have worked out one species of a genus you will be likely to know others when you see them, and even when plants of a different genus of the same family are met with, you will, ere long, generally be able to recognize their order at a glance from the family likeness. A capital practice for the beginner is to work out a few plants with whose names he is already familiar. Success in these attempts will naturally inspire confidence in the determination of plants previously unknown.

By his initial reading over of his text book the student has got some knowledge of plants and plant-life, as well as an insight into the manner in which their names are determined. He is like the race-horse to

which the jockey has just given a preliminary canter that he may "feel his legs" preparatory for his true task, the race, which lies before him. The knowledge he has gained is slight I grant you, but he is not quite in the dark. A foundation has been laid upon which it now becomes his duty to raise a creditable superstructure; a superstructure, the first step towards which should be the commencement of an herbarium which, however, should be subservient to, or a co-partner with, the highest aim in botancial science, the elucidation of the mysteries of plant-life. Laying such stress as I do on the formation of a collection as an aid to further study, let me for a little call your attention to the advantages to be derived from having one, and the best appliances and methods for accomplishing this.

The use of an herbarium is, in general terms, to have constantly on hand material for study in any class of plants, for, by soaking them in water, dried specimens can be studied almost as easily as fresh. In no other way can we see simultaneously specimens of neighboring species, different states of the same species, and specimens of a species from different localities; and some of the brightest theories on the distribution of plants have been worked out by the aid of the "hortus siccus" or herbarium. The nomenclature and classification of objects can be best acquired by the constant handling of them, and the price of a good herbarium is incessant vigilance in warding of the attacks of insect pests. But in this vigilance what a throng of pleasant memories is perpetually being called up; the time and the locality, the surroundings, and, if you were not alone when gathered, your companions. Each specimen represents so much information, and the very mention of its name will recall to mind associations connected with its study. These results from the possession of an herbarium have been so beautifully set forth by Professor Bailey of Brown University that I cannot refrain from quoting his words on the subject.

"In looking them over one sees not alone the specimens themselves, but the locality in which they were gathered. Many an incident of his life, the memory of which has long since become dormant will be re-awakened as by an enchanter's wand. He will thread the forest paths gay with flowers; he will pause in imagina-

tion for the nooning by some fern-laced spring; he will climb the mountain ravine where the blood-root and orchis bloom; or wander, full of speechless yearning, by the ocean shore. Not only do the natural scenes return thus vividly, but the faces of friends who enjoyed the occasion with him. He is once more seated, may be, by a little lake on the mountain, in a garden of alpine flowers. Cool streams flow by him, and he picks the tart fruit of the cowberry. The world lies mapped at his feet, and the infinite heaven is above him. He hears the merry jest and ringing laughter, and his heart becomes gay with the thought of those old-time rambles."

A collector's outfit, which will answer all ordinary purposes, is cheap and most of it can be got or made at home. It consists of a botanical box or vasculum; a plant press; a pocket lens; a trowel; a sharp pocket knife; and a note-book. The clothing worn in collecting should be strong, as one often has to make his way through a tangle of thorny bushes, and old, so that no nervousness at fear of spoiling it may be excited. For foot-wear, stout shoes are generally recommended, but I prefer the oldest and easiest pair I have. A pair with plenty of holes in them. One has occasionally to wade through a swamp where the water comes above the tops of any ordinary boots, and it is much better that it should run out freely as fast as it enters, than to have to sit down, take off and empty one's shoes,or continue to walk with the water sogging about in them.

With the vasculum you are all doubtless familiar. Any easily portable box will answer the purpose. Of late years, however, I have entirely abandoned its use, putting my specimens directly into the press, and carrying in my pocket an old newspaper or two, in which, previously dampening it, I loosely wrap up any plant that I wish to make special examination of.

Plant presses are of various kinds. The one that I commonly use, and which has stood me in good stead from Cape Breton to British Columbia, was given me by our mutual friend Dr. George Dawson when we were in the North-West together, away back in 1871. Though battered, as you see, it is useful as ever, and that after twenty-five years of honest service. It is made of quarter inch basswood strengthened by four cleats, and is 18 inches long by 11½ inches wide. The straps are provided with a cross piece, like a shawl strap, which prevents them becoming separated when the press is open, and also serves for a

handle to carry it by. Wire presses and those of lattice woodwork are highly recommended by some, the advantages claimed being lightness and a free escape of moisture. In wet weather, however, the ordinary form has the great merit of keeping one's paper dry. For an excursion the press should contain a good supply of specimen sheets and driers with one or two pieces of mill-board or thin deal, all of them a little smaller than the press. Any thin, cheap paper will answer for specimen sheets. What is known as printing paper is the kind I ordinarily use. For driers a special paper is manufactured, but it is expensive, and I substitute "filter paper" which is obtainable at most druggists. Blotting paper of any kind will do, and, if economy be an object, old newspapers can be made to serve. Some of the finest and most beautiful specimens I have ever seen were turned out from newspapers alone. The object is to have a medium that will quickly absorb moisture and as quickly part with it again. The mill-boards or deals are to keep apart the damp papers containing the plants and the dry unused ones. I also usually carry in my press a few sheets of cotton-batting to lay over ripe fruits, such as strawberries or raspberries, to prevent their receiving too much pressure and so getting crushed out of shape.

A pocket lens should always accompany the collector, and should not be of too high power, (an inch to an inch and a half focal distance.) A very powerful lens while magnifying greatly, inconveniently narrows the field of vision.

A stout table knife answers the purpose of a trowel, which is used for taking up plants by the root.

The note book is an object of prime importance, and should be of such a shape that it can be easily carried in the pocket. In this book are to be jotted down any observations one cannot trust to memory, e.g. the color of flowers, the height of plants, the character of the soil in which they grow, etc. Unless the collector takes field-notes he will run the risk of letting important observations escape him, and he cannot too soon learn to make them in a concise, systematic and legible way, never mixing up conjectures with actually observed facts. Everyone is

prone to get into a hurried way of making notes, under the idea that they are for his own use only, and that he will readily recollect any facts omitted at the time. This is a great mistake. Notes are not often required immediately, because every circumstance connected with the subject is fresh in the memory. But it sometimes happens that weeks, months or years after, in pursuing some branch of study, the exact facts then observed are required; and I know nothing more disappointing than, on turning to one's note-book, to find that at the time, trusting to memory, some of the details had been omitted.

In collecting, when a number of plants of a desired species are discovered, the first thing is to make a judicious selection. To be really valuable the specimens in a collection should be as perfect and characteristic as possible, so that anyone referring to it can learn full particulars about each species. A perfect specimen comprises all that is necessary for complete botanical investigation; leaves (both mature and immature, cauline and radical) flowers and fruit. Specimens can often be secured showing both flowers and fruit on the same plant, or fruit may be found on more advanced plants at the same time. If not in fruit, it must be collected in this condition later in the season. The same rule applies to the obtaining of specimens with different leaves, or leaves in different stages, and it may require several seasons to make a complete specimen. The plant should be so arranged as to be no larger when dried than can be readily mounted on the herbarium paper.

Of small herbs, the whole plant, root and all, should be taken, but in any case enough of the root should be collected to show whether the plant is annual, biennial or perennial. Large plants may be doubled into a V or N shape, and thick stems, roots or bulbs can be thinned down. In the case of very delicate plants, as many ferns, thin sheets of paper should be placed on both sides of the specimen, in which sheets it remains until perfectly dry. By this means the delicate leaves are prevented from doubling up in changing the driers.

Care should be taken to display the specimens neatly, showing, if possible, both sides of the leaves. In some cases it is easier to spread out the leaves and remove creases after a night's pressure has somewhat subdued their elasticity. Morning is the best time to collect most flowering plants, as many close their blossoms by noon, but those that open in the evening, vespertine flowers, should be gathered at that time.

The actual pressing and drying of specimens is done at home, either in the ordinary field press in which they were collected, or between a couple of pieces of inch board of the same size as the press. Weights make the best pressure, and a good weight is made of half a dozen bricks tied together with a cord strong enough to lift them by. Specimens should be put into the drying press as soon as possible after gathering, but often in returning from an excursion one is too tired to care for more labour, and I commonly leave mine in the field-press until next morning, nor do I find them suffer any harm from so doing. Herein lies one of the great advantages of collecting directly into the field-press instead of a vasculum. In drying, the thin sheets (specimen sheets) containing the plants are transferred into fresh driers, heated in the sunlight or by a stove, and remember always, *the hotter they are the better*. Be careful to place the specimens in such a way that one part of the bundle is not materially thicker than the other, by placing them on alternate sides, or putting in wads of paper if necessary. Plants dry best in small piles, and for dividing up a package if too large, or for separating the lots put into the drying press on different days, use thin deals like those taken out in collecting. Some very succulent plants, and others with rigid leaves, such as stone crops and pines, dry better if plunged for a moment into boiling water, ere being put into the drying press. Every day, or at first even twice a day, the plants in their specimen sheets are to be shifted into fresh hot driers, the moist ones taken off being spread out to dry in the sun or by a fire, that they may take their turn again at the next shifting. The more frequently the plants are changed the better will they retain their color. After the first three or four days the changes need only be made every other

day until the specimens are thoroughly dry and no longer moist or cold to the touch. The drying usually occupies from a week to ten days, but varies according to the succulency of the plants, the state of the weather, the frequency of the changes, and the degree of heat of the driers. The most convenient place for changing plants, if it can be managed, is a table beside a good hot range or stove, the top of which is free for use. If a damp drier be laid flat on the hot metal, steam at once begins to rise from it, and the moment it ceases to do so the paper is dry; leave it for a second until it becomes so hot as to be barely touchable with the naked hand, then lay it quickly on a specimen previously moved from the damp pile, and continue thus until the whole lot is changed. This plan is invaluable when driers are scarce, as sometimes happens on a botanizing trip, for by it the same driers, no matter how wet, can be used again immediately. A plan adopted by myself and Professor Macoun a few years ago, while collecting in Nova Scotia, might be mentioned as worthy of remembrance should any of you ever be placed in similar circumstances. Though not to be recommended for common use, as the specimens fall short of those obtained by the ordinary method, yet, if so situated that an abundance of driers is not obtainable, or if the weather be so foggy and wet that they cannot be properly dried, it will be found of great practical value. On the trip referred to, a large number of specimens had been collected, but so bad was the weather from rain and sea fogs that there was great danger of losing them all. Under these circumstances the thought occured to take advantage of occasional glimpses of sunshine in the following way; each sheet of specimens was placed between two driers, which were spread in a single layer on the floor of an open balcony exposed to the sun. Pieces of board, logs, or bark placed in the sun would of course answer the same purpose as did the balcony. Small stones placed on the corners of the sheets prevented the wind disturbing them, and no pressure was used except the weight of the single drier them covering. An hour of good sunshine served to fully cure most plants. The plan, is only applicable to specimens previously somewhat wilted in the pressas, the leaves of fresh or insufficiently wilted ones curled up in the absence of pressure.

A collector's work does not cease when his specimens are dried. Plants are subject to the attacks of insects and it is therefore necessary to poison them in some way. The best protection is corrosive sublimate dissolved in alchol, which is applied lightly to the specimens with a soft brush. It should be done as soon as the plants are dried, care being taken afterwards to leave them spread out until the alcohol has evaporated. The formula I used is :

| | |
|---|---|
| Corrosive sublimate . . . . . | 1½ drachms. |
| Carbolic acid . . . . . | 1½ " |
| Alchol . . . . . | 12 ounces. |

All the work hitherto done, the collecting, drying and poisoning, is but the preparation for the formation of an herbarium, the specimens in which should be fastened on half sheets of stiff white paper, either by slips of gummed paper or by glue applied to the backs of the specimens themselves. For a few cents a supply of white gummed paper, sufficient to last for years, can be purchased at any printing establishment. A narrow slip of this is cut off, moistened with the tongue, and placed over the part of the plant to be fixed down. The advantage of this process over actually glueing the specimens to the paper is that, in case the plant has to be removed for examination or any other purpose, these slips can be easily lifted.

In mounting plants care must be exercised to keep the pile forming each genus as nearly level as possible, by scattering the specimens over the sheets instead of placing them all in the centre. If the plants are small put some at the top of a sheet, some at the bottom, some on the right side and some on the left ; occasionally, in the case of large specimens, reversing them so as to have the thick stems and roots at the top. In no case should more than one species be put on the same sheet,but if small, two or more specimens of the same species may be so placed. The best size for mounting paper is what is known as the standard size, from its being the one used in the public herbaria of the United States. This size, 16½ x 11½ inches, experience has determined to be the best. My own sheets, I am sorry to say, are smaller, being only 15½x 10 inches, but my collection was started and had grown to such a size before the standard was adopted, that to change it all would

have entailed great labour and expense. I have therefore considered it advisable to continue as I began. The Linnæan herbarium is on paper of the common fools-cap type, but this is much too small.

The labels to be attached to the sheets vary according to taste, the points desirable of observance being clear type, neatness and simplicity. They should not be to large nor yet too small. When a specimen is given you the accompanying label should always be mounted with it. Some collectors attach their labels permanently with paste or by having them printed on gummed paper, but I prefer to merely fasten them lightly at the sides thus allowing their removal should it ever become necessary to transfer the specimen to another sheet. All the sheets containing plants of the same genus are placed in genus covers, which are full sheets of stout, colored paper. They should measure about a quarter of an inch more in width than the mounting sheets. The name of the genus is written at the bottom of the genus cover, or sets of genus labels can be purchased cheaply and one of these pasted on instead. The various genera are arranged under the order to which they belong and laid flat in large pigeon-hole compartments in a closed cabinet, or else placed in portfolios, which stand upright like books in a book-case. The herbarium is made complete by a list or catalogue of the plants it contains.

Having thus described the method of collecting and preserving specimens, let us briefly consider the next step in the study of botany, viz. excursions. The object of collecting excursions should be threefold:

1st. To cultivate habits of observation and secure knowledge of habitats and the growing appearances of plants.

2nd. To gather specimens for the herbarium.

3rd. To secure material to work on during the study of structural botany.

Even in the winter season excursions should not be entirely abandoned. The true naturalist can always find something to admire, and much useful work can be done in observing the trunks, branches and buds of trees and shrubs. Winter is, however, the time pre-eminently fitted for herbarium work, preserving, mounting, labelling,

cataloguing, and, if the necessary appliances are obtainable, laboratory work with the microscope.

The best place to begin collecting is where you live. Be your abode where it may there are surely some plant rarities near it, and the first goal to struggle for is a through knowledge of the resources of your own vicinity. When you have made a special study of the plants there you may easily extend your researches. If on your excursions you can have the company of some older botanist so much the better, since from him you can get the names of the plants you gather and the prominent characters on which the naming is founded. I would, however, strongly advise you always to take home one or two unnamed specimens, on which to practice analysis, for it is only by such practice you can ever become so familiar with the orders as to be able to, at least pretty nearly, locate strange ones at a glance. The accumulation of a mass of unnamed plants is to be avoided, lest a pleasant task becomes a wearisome labour, inspiring only disgust. Make it a rule to get your specimens named as soon as possible. If you have no one near to whom you can show them, enter into correspondence with some botanist and arrange with him to name the packets you may send him from time to time. You need not fear that your letter asking the favor will be unanswered. The wonderful spirit of fellowship, comradeship if I may call it so, existing among scientists, and evinced by their willingness to lend a helping hand to even the humblest votary, is to me one of the greatest charms in scientific pursuits. But here a word of warning,—never send scraps of plants to be named, for though a good botanist can often identify them, it is unfair to ask him. His time is too valuable to be spent in guessing riddles. Courtesy also demands that in all correspondence the seeker after information should enclose stamps for return postage. In collecting a specimen for yourself, if it be at all rare, always, if possible, gather duplicates to be used in exchange. Under no consideration, however, obliterate a rare species from any locality, and do not even make its whereabouts known to any except true lovers of the science. There are vandals, who, through mere vanity, would not hesitate to destroy the last survivor of a species; nor would they do it only unthinkingly. From the duplicates

of the best things around you a large variety of plants can be got by exchange. and the pleasure and profit in making a collection is largely due to the intercourse thus brought about with those of kindred tastes. Nor is this confined to those in your own country; it is often necessary to have certain specimens from other regions, and you are thus brought into correspondence with scientists in all parts of the world. Let your specimens be well made, and never send away a poor one unless it be of something very rare. A man soon becomes known by his exchanges, and if his specimens are poor he is made the subject of much unpleasant criticism and will in time be avoided by all good collectors. Always preserve the choicest specimen collected for your own herbarium, but after this send the best you have to the first correspondent who asks for it. Keep even a fragment of any species not represented in your collection until you get a better, but of your duplicates destroy any too poor to send away. Do not hoard up duplicates. The man who studies science for science sake would sooner give away every specimen for nothing than allow them to remain buried like a miser's gold. Make sure that all plants you send are correctly named, and notify your correspondent whether they are poisoned or not. Never promise a plant unless you actually have it or are positively certain of being able to get it, and keep a catalogue of your duplicates that you may be prepared at all times to answer a brother collector who applies for anything.

The last stage in botanical study, and the one to which all the others should be stepping-stones, is the working out of some of the many unsolved problems of plant life by independent and intelligent observation and experiment. The breadth of the field for exploration by original observation is immense, as comparatively little is known of the laws governing many of the phenomena of plants. For example, little is known of the hosts of some of our parasitic plants, and in some cases it is even disputed whether certain plants, commonly considered such, are parasites at all; though all plants move more or less, we possess scanty knowledge of the nature of this movement in many of them, and still less of its object; we know that cross-fertilization is generally necessary for the production of perfect seed, but in many cases we do not know

the particular agents that perform the work; we are aware that cleistogene flowers produce pods far more fruitful than the ordinary blossoms, but we know almost nothing about the proportion of the kinds, or why a plant should be provided with two sets of blossoms. There are many other points just as vague, hints to which may be found in such works as Darwin's "*Climbing Plants*," Bailey's "*Talks Afield*," Prentiss' "*Mode of Distribution of Plants*," and Kerner's "*Flowers and their Unbidden Guests*": enough, however, has been said to show that the way to discoveries new to science is open to even the humblest votary. There is practically no limit to the papers that could be prepared by many of you for this or similar societies: papers both interesting and useful; papers of value to science:—papers that I feel sure the "OTTAWA NATURALIST" would gladly find room for. In conclusion, I would say, that if within his means, and they are very cheap, no student of botany should neglect to take at least one of the periodicals devoted to the science. The "*Bulletin of the Torrey Botanical Club*," the "*Botanical Gazette*," and the "*American Naturalist*" are among the best. The first two are devoted entirely to botany, the last takes up other sciences as well. I take it for granted of course that all of you are already subscribers to your excellent local Natural History monthly.

If I have trespassed too much on your time, or wearied you with my effort to make plain to you some points on the study of botany, I pray you pardon me. Each of you who takes up this charming science will, I have no doubt, see modifications that you think might be advantageously made in the methods suggested. Should it be so, by all means adopt them. The method employed is of little importance provided only it brings about the great aim and end of the study, which is to learn to observe and compare. Do this honestly and you cannot fail to become lovers of nature, and, as lovers of nature, better and happier men and women, men and women in some degree approaching the illustrious scientist of whom was sung:—

"And Nature, the old nurse, took
The child upon her knee,
Saying: 'Here is a story-book
Thy Father has written for thee.'

'Come, wander with me,' she said,
'Into regions yet untrod;
And read what is still unread
In the manuscripts of God.'

And he wandered away and away
With Nature, the dear old nurse,
Who sang to him night and day
The rhymes of the universe.

And whenever the way seemed long,
Or his heart began to fail,
She would sing a more wonderful song,
Or tell a more marvellous tale."

# GENERAL INDEX

TO THE

# OTTAWA NATURALIST, VOL. IX., 1895-'96.

AND

# Transactions of the Ottawa Field-Naturalists' Club, Vol. XI.

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ERRATA :

| | | | | | | |
|---|---|---|---|---|---|---|
| Page 23, | line | 2 : | for | *Americana*, | read : | *Aucuparia*. |
| " 175, | " | 13 ; | " | *Bulimus*, | " | *Bulinus*. |
| " 175, | " | 32 : | " | 451, | " | 351. |
| " 175, | " | 32 ; | " | 1884, | " | 1885. |
| " 176, | " | 4 : | " | 95, | " | 65. |
| " 215, | " | 19 : | " | 1893. | " | 1883. |

" 178, Heading of column 5, for Wheeler, read Willing.

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