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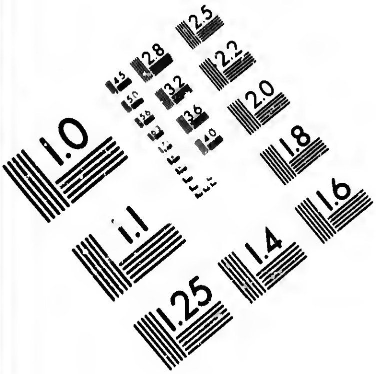

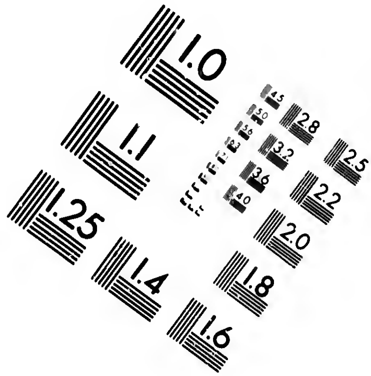

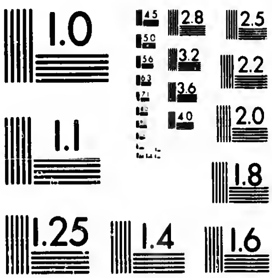

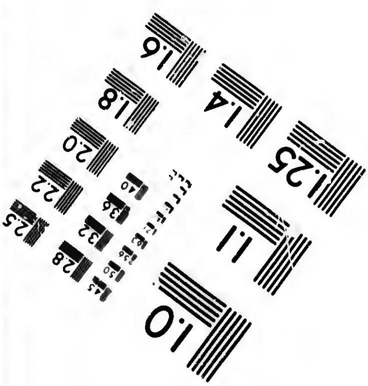

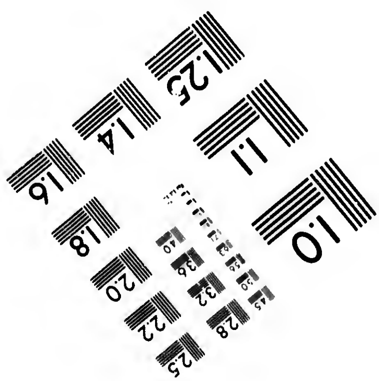

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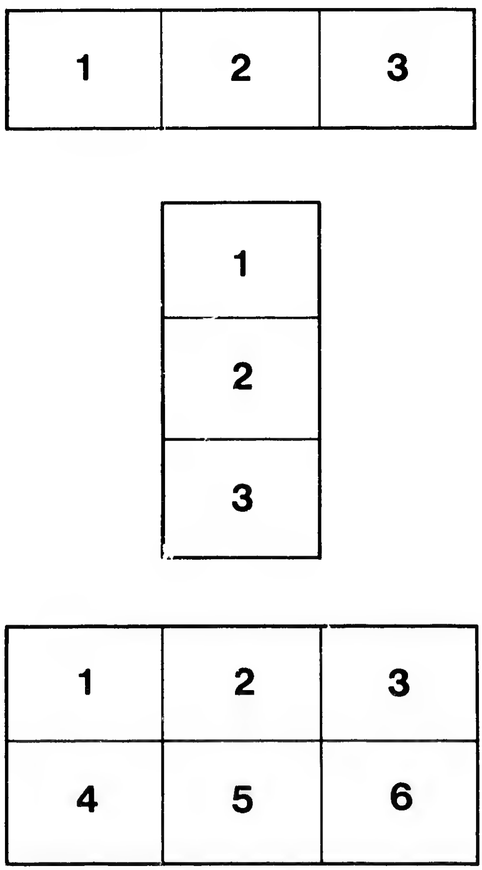
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New Brunswick School Series.
PRESCRIBED BY THE BOARD OF EDUCATION OF NEW BRUNSWICK.

ELEMENTARY Natural History:

AN INTRODUCTION TO THE STUDY OF

MINERALS, PLANTS, AND ANIMALS,

WITH

SPECIAL REFERENCE TO THOSE OF NEW BRUNSWICK.

PREPARED FOR THE USE OF SCHOOLS,

BY

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THE BOARD OF EDUCATION, under the authority of the "Common Schools Act, 1871," has prescribed this edition of ELEMENTARY NATURAL HISTORY as a Text Book for use in the Schools of this Province.

WILLIAM CROCKET,
Chief Superintendent Education.

PREFACE.

This work has been written to meet a special want, and therefore in a special way. The want is this; namely, that while many admirable text books exist which present the facts connected with the nature, structure, and history of minerals, plants, and animals with a considerable degree of scientific fulness and accuracy, there are few in which the mere imparting of information is made subordinate to the direction of the thoughts—more especially of young pupils—towards the consideration of the objects themselves with reference to which such information is given; while such as do exist, besides being too advanced for the lower grades of schools, contain no information whatever as to the natural productions of our own Province. In endeavoring to meet this want the author has had constantly in view the requirements of the course of instruction in the public schools as prescribed by the Board of Education, and trusts that, while enabling the teacher or student, as the case may be, to meet those requirements more readily, he may at the same time succeed in awakening an intelligent and lasting interest in the subjects themselves. To promote this object, and to adapt the work to the comprehension of comparatively young minds, he has avoided, as far as possible, the use of purely scientific terms and phrases, though he has not, he hopes, thereby sacrificed either true scientific method or scientific accuracy. He may also here refer to what is emphasized throughout the volume; namely, the desirability of making the study a thoroughly *practical* one: for in no other way can it be made of real and lasting benefit. Mere descriptions are of very little value unless the pupils have the opportunity of *seeing* the objects described; and even then they should not be told what their characters and relations are, but by judicious guidance be led to deduce them for themselves. This will be found to be especially easy in the case of plants, and, by the aid of these, useful habits of observation and comparison may be awakened and developed even in very young minds. In the case of mineral substances the same method may be pursued, so far as the ordinary metals are concerned, a collection embracing one of each kind being easily made; and though it may not be so easy to obtain specimens of their ores and of the less common minerals, systems of interchange—such as may be originated in connection with the various Teachers' Institutes—will go far to supply even this want. In the case of animals, appeal must be made to the more obvious features of likeness and of difference observable in such familiar forms as come daily under our observation in the woods, in the fields, in the barn-yard, or by the fireside. The work of study, in the case both of plants and animals, will be found to be facilitated by the use of such diagrams and cards as are issued in Prang's Natural History Series, though these should by no means be allowed to take the place of the objects themselves.

The thoughts of young pupils having been directed, by the means here advocated, towards the contemplation of natural objects, and the proper methods of their study, a foundation will, it is thought, have been laid upon which may be successfully based a more ample knowledge in maturer years.

In conclusion, the author desires to return his thanks to the Chief Superintendent of Education for valuable suggestions as to the special needs of certain branches of the school service, as also to Mr. GEORGE U. HAY and Mr. G. F. MATTHEW for the revision of the larger portion of the text, and for aid in the selection of appropriate illustrations. To EDWARD JACK, Esq., C. E., he is also indebted for valuable information regarding the distribution and characteristics of our forest trees.

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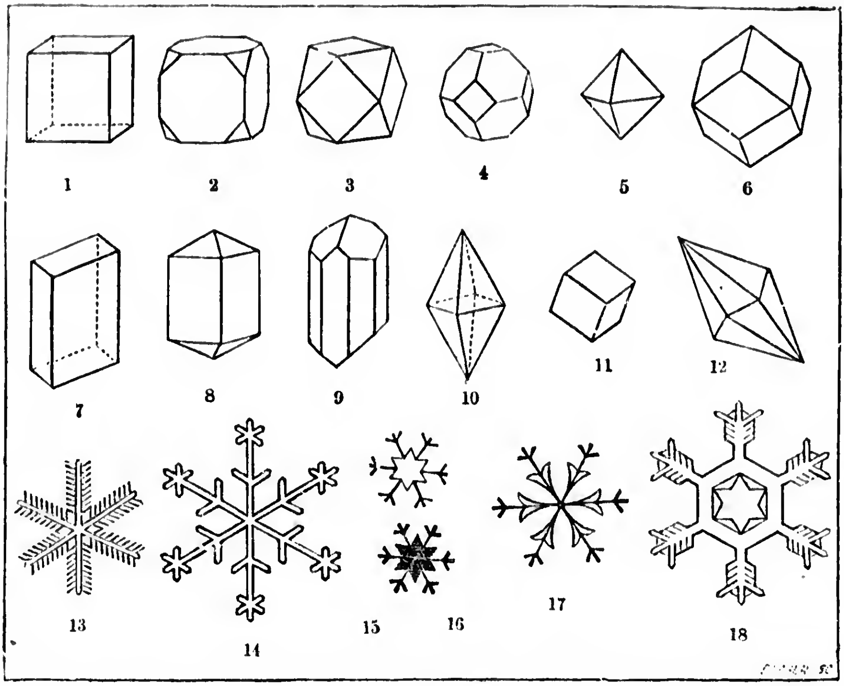
Plate I.—Forms of Minerals.



EXPLANATION OF PLATE I.

FORMS OF MINERALS.

The above figures represent a few among the many shapes assumed by mineral substances, and which are commonly known as *crystals*. All are found in actual minerals, and are the result of purely natural operations. They are also, in many instances, nearly related to each other, and to be obtained, the one from the other, by slight modifications. Thus, from Fig. 1, the *cube* (easily cut by the pupil out of chalk, wax, or soap), it is easy to obtain, by merely cutting off successive slices from angles or edges, or both, all the forms from 2 to 6. In each of these forms, length, breadth, and thickness are alike. In the succeeding figures this is not the case, but the figures still possess their own symmetry, and may be similarly modified. Figs. 13–18 represent some of the forms of snow crystals, the result of the grouping or clustering of many smaller crystals around common centres.

INTRODUCTION.

In looking at the world around us, a process which we begin at a very early period of life, we are unconsciously led to divide the objects which we see into two great groups or classes, viz.: into (1), those which have Life, and (2), those which have not Life.

In the former of these classes we naturally place what we afterwards learn to know as Animals and Plants both being easily recognized as living beings, if not by any visible movements or other signs of life, at least by the fact that sooner or later they all *die*. In the second class, on the other hand, we include such objects as stones, rocks, metals, sulphur, salt, and the like, which are essentially unchangeable, and which have obviously no life to lose. A block of wood, it is true, is also lifeless, as much so as a lump of lead or a bar of iron, and so are the bones and meat which we use as food; but we know that both of these have once formed parts of living beings, and hence we associate them with the latter, even though they now be dead.

If, now, we look further into the differences of things, we shall find that, although both plants and animals are living beings, while minerals are not, there are also between the former so few points of resemblance, and so many features in which they are strongly contrasted, that we would hardly be likely, in any ordinary case at least, to mistake the one for the other. Thus we are led to recognize three great groups or divisions of all natural objects, to which, borrowing a familiar term used in connection with the races of men, we may apply the name of the Kingdoms of Nature, and which are actually known as the Animal Kingdom, the Vegetable Kingdom, and the Mineral Kingdom.

But it is not enough to know, merely in this general way, that there are such things as Animals, Plants and Minerals. An enquiring mind will be led to seek out more exactly the points of resemblance and of difference between them, and by so doing will soon find its knowledge of each vastly increased. The more a person observes, the more he will find to see, and the better will he be able to see it. Thus his powers of observation — his senses of sight, smell, taste, touch, and hearing — will be better developed, his mind will be led to make more careful comparisons, and he will become in every respect a better educated man. Hence some portion of such studies is very properly required to be taught as a part of our ordinary school work. Again, we are brought into relation with many different animals in many different ways, sometimes beneficially and sometimes not; we employ both animals and plants for human food, in the making of clothing, and in many other ways; and, finally, we use various mineral substances in the construction of our dwellings, in machinery, in coinage, in all the arts and industries of life, and the better we know the nature and properties of all these bodies, the better will we be in a position to use them advantageously. Thus the knowledge gained by such studies is *useful* knowledge, capable of being applied in numberless different ways.

It is the wish of the author, in the following pages, to help towards the attainment of this knowledge by pointing out, in the simplest possible way, the distinctive features of animals, plants, and minerals, respectively, with special reference to such as are found within our Province, and which, in one way or another, are capable of serving some useful purpose. His work will be largely that of a guide; but it is his earnest wish that attention should be paid rather to the objects to be described than to the mere descriptions of them, and that the statements made should, as far as practicable, be tested by actual comparison with the subjects of which they treat.

Methods of effecting this result, in connection with each of the three great kingdoms, will be given in subsequent pages, and, if faithfully followed out, will be found to present no difficulty, while they will add greatly to the interest and value of the study.

As the Mineral Kingdom embraces objects of a simpler character than are to be found in the Vegetable and Animal Kingdoms, it is capable of being more readily understood, and will be first considered.

I.

THE MINERAL KINGDOM.

1. Of the Nature of Mineral Substances.

What is a Mineral?

In the Introductory Chapter it has been stated that the various objects on the earth's surface may all be placed in one or the other of three great groups or kingdoms, termed the Animal Kingdom. the Vegetable Kingdom, and the Mineral Kingdom. It will therefore follow that whatever is not an animal or a plant must be a mineral. But such an answer, even if true, would not be satisfactory, for it leaves one entirely in the dark as to what are the real differences between these several groups, and still more as to what characters especially distinguish mineral substances. Again, the terms "minerals," "rocks," and "stones," are of very common occurrence, as are the objects to which they refer, and yet few persons, without previous thought, have any definite idea of the differences between them. Let us then see whether it is not possible to obtain some clearer notions upon the subject.

If we look at any ordinary animal, such as a dog, a cat, a bird, or a fish, we shall find that certain prominent features at once attract attention. It will be seen to move, to take and eat food, to recognize the existence of various objects around it, and in other ways to show that it is an active *living* being. It has, moreover, a variety of instruments or *organs* by means of which it effects these various objects — legs, wings or fins for motion, a mouth, bill, teeth, etc., wherewith to eat, the senses of sight, taste, smell or touch wherewith to seek and select its food, and, we may add, a stomach and other organs wherewith to digest it. It is, in other words, not only a living but an *organized* being, with parts or organs serving different purposes, but all needed for the well being of the animal that possesses them. Each of these animals, moreover, possesses a distinct history. All have had their birth-days; all have attained, by gradual stages, to their full growth; all in turn will die, but not usually until after their own life has become repeated and continued in that of their young.

Plants, again, are living and they are also *organized* beings. They show that they are alive in the fact of *growth*, in being born or produced from seeds, which in turn they again produce, in their power of taking food from without and of converting this into their own substance, as well as in a variety of other ways. They show that they are *organized* by the fact that they also possess parts or *organs* especially designed to meet their various wants. Roots, stems, leaves, flowers, fruit, etc., are all vegetable organs, each serving its own purpose, and together making up the individual herb, shrub or tree. These larger organs also are made up of smaller ones, and these again of still smaller, so that no matter how minute the plant or fragment of a plant we may have occasion to examine, its true nature can at once be recognized.

Now mineral substances have none of the above characteristics. They are neither living nor organized bodies. They are not *born*, they do not *grow*, in any proper sense of the word, they cannot *move*, although they may be *moved*, they do not need, and therefore they do not take, anything of the nature of *food*. They have no *senses*, and are wholly *unconscious*, even of their own existence. One portion is essentially like any other, and each is independent, to a great extent, of all the rest. But these are only negative characters. Have minerals and mineral substances no positive ones? Certainly they have; and their characters, in most instances, are as definite and fixed as are those of any animal or plant, serving as means by which we can at once recognize and distinguish them. Thus, they often have definite *forms*, and these forms, as seen in what we call *crystals*, are almost endless in variety, and often of exquisite beauty. They have, in each case, a definite *weight*, some being heavy and some light, in various degrees. They are variously affected by *heat*, some melting readily, while some can hardly be melted at all. They have various *colours*, which are often rich and beautiful. They may be *transparent*, like glass, or *opaque*, like the various metals. They may sparkle with the brilliancy of the diamond, or they may, so far as appearance goes, be dull and unattractive. In a few instances they possess what are termed *magnetic* properties, as in the lodestone; in other cases again they may possess some peculiar *smell*, *taste* or *odour*.

We may next enquire:

Of What are Minerals Composed?

To answer this question fully would require some knowledge of the science of chemistry—a science which treats of the nature and constitution of bodies,—but it will be enough to say here that minerals are made up of one or more of several distinct and simple substances, which are known as the chemical "elements." Thus Iron, Lead, Zinc, Tin, Gold, Sulphur, Antimony, etc., are simple elements, it not being possible to obtain from either of these anything but itself. But these are often united to form what are called "compound bodies," and these compound bodies may, and generally do, differ entirely in all their properties from the elements which compose them. Thus, water is a compound body, capable of separation into the two elementary gases, Hydrogen and Oxygen. Most of the ores of the metals are compound bodies, and hence special methods have to be resorted to in order to separate them. Coal, Glass, Salt, Alum, Saltpetre, are all compound bodies, and from each, by appropriate means, several different substances can be obtained.

Now, all these bodies are *mineral substances*, that is, they belong to the mineral world, but they are not all *minerals*, as that term is usually employed. So granite, limestone, sandstone, and slate are mineral substances, or of a mineral nature, but are not minerals. In the first place a true mineral is always a natural, and not an artificial product, though many such minerals may be artificially imitated or reproduced. And, secondly, a true mineral must be alike throughout, and not a mere mixture or association of various unlike substances. It is in this respect that a mineral differs from a *rock*. In ordinary granite, which is so commonly used for building or for ornamental purposes, and for tombstones, it is easy to see that the material differs in its various parts, or is made up of different substances. Here and there are hard, glassy grains, which are known as quartz, while side by side are others, usually somewhat larger, and of a pink or reddish color, which are known as felspar, and finally still others, usually nearly black, which may be readily split into scales with a knife, and which are known as mica. Now, the quartz, felspar and mica are minerals, but associated together they form the *rock* termed granite. So sandstone is made up of grains of sand, which may or may not be alike, and the same is true of many clays, of ordinary earth, of slate, and many other substances. Again, water, quicksilver, and petroleum, or rock-oil, are minerals, notwithstanding their ordinary liquid state, for they are all formed by natural causes, are lifeless bodies of similar nature throughout, and possess nothing of the nature of organs.

From what has been stated, it will be evident that the nature of a *rock* will vary with the number and kinds of *minerals* of which it is made up. We shall, therefore, proceed now to show a little more fully how minerals are distinguished and recognized, and will then proceed to enumerate and describe some of those which are of most interest and value.

OF THE RECOGNITION OF MINERALS.

THE following are among the features of minerals which are of most service in distinguishing and identifying them:

(1.) **Hardness.** This is easily tested with the point of a knife, or the edge of a file. Each true mineral has its own degree of hardness. Diamond, for example, will cut glass, quartz will only scratch it, while black lead, which we use in lead pencils, but which is not really lead at all, is so soft as to stain the fingers. A table or scale of hardness, containing a number of well-known minerals, and arranged in a regular series, is of much service in making such comparisons.

Related to hardness, and depending upon like causes, are the properties which minerals possess of allowing or not allowing themselves to be cut, or bent, or hammered out into thin sheets. Gold and lead can be cut (or are *sectile*), while iron cannot; gold, again, is easily hammered out into gold-leaf (*i. e.*, it is *malleable*), and it can be drawn out into wires, as may copper and iron (they are *ductile*), but many others cannot. Mica will bend (or is *flexible*); other minerals are brittle, like glass, and will break if we attempt to bend them. All these characters depend upon the variations in some inward force by which their particles are bound together.

(2.) **Weight.** Every one is familiar with the expression "as heavy as lead." Bodies differ in their relative weight, and these differences, where they are constant, as among minerals, often serve a useful purpose in distinguishing them. Thus not only lead but most of the *metals* are heavy, and so are their ores; but minerals not containing metals are often much lighter. The differences may be measured with great exactness, but the methods of doing so need not be described here.

(3.) **Form.** Minerals often have a definite shape, sometimes exceeding in beauty and perfection of finish the most elaborate works of human art. These regular shapes are commonly known as *crystals*, the name being derived from a Greek word signifying ice. Ice itself is a good example of crystals, as freezing affords a good illustration of what is termed crystallization. Snow, again, is often seen to be composed of exquisitely beautiful crystals, and more (Plate I.) than a hundred different forms of this substance have been observed, though all are mere modifications of a comparatively simple form. So most substances are found, at one time or another, in a crystalline condition, and the form of the crystal being fixed, within certain limits, for each substance, we have merely to notice the form to know what the mineral is. Salt, alum, saltpetre, sugar (rock candy), are other examples of crystalline substances, and they show well the way, or one of the ways, in which many crystals have been formed in Nature. We have only to dissolve either of them in water, and then allow the water to escape again by evaporation, when, if the process is not disturbed, we shall obtain it in the form of crystals, each with its own peculiar shape. In the case of ice, sulphur, and some other substances, the same result has been obtained by the substance first melting, and then, by cooling, becoming solid again. Snow has crystallized from a state of vapour.

(4.) **Cleavage.** This is the property which many minerals possess of splitting or cleaving more or less readily in particular directions. It is similar to what, in the case of wood, we express by saying that it "breaks with the grain." Some minerals, such as quartz, have no cleavage, breaking much like glass; mica, on the other hand, splits indefinitely into thin sheets, often (but inappropriately) known as isinglass. Between these two extremes there is every possible variation, but the feature is constant for each particular substance.

(5.) **Relations to Light.** These are manifested in two ways; first, in the nature and extent of the light which minerals reflect from their surface, and secondly, in the corresponding nature and amount of light which they permit to pass through them. It is through the former power, chiefly, that they acquire their *colour*, varying through almost every possible shade in different species, and often subject to much diversity even in a single one. To the same cause also we are to describe their peculiarities of *lustre*, which may be either brilliant, feeble, dull, or altogether wanting, or on the other hand, may vary in character, sometimes resembling the lustre of the ordinary metals, sometimes that of glass, resin, mother of pearl, wax, or some other familiar substance. To the second cause and its variations are to be ascribed the property possessed by many minerals of being *transparent*, or of allowing objects to be readily visible through them, or of being only *translucent*, merely allowing light to pass, as through ground glass or oiled paper; also the internal colours of gems and precious stones, and in some instances the apparent doubling of objects over which the mineral has been placed. Finally, many minerals intercept light altogether, and are then *opaque*.

(6.) **Relations to Heat.** Some mineral substances, like ice and sulphur, melt very readily; others, like iron, with more difficulty, and others again, like black lead, not at all. Some again, under the influence of heat, may, like water, be readily converted into vapour. For the better appreciation of these differences, a special means of applying heat in the form of what is known as a blow-pipe, is very desirable, but even without its aid the test is often a very valuable one.

(7.) **Relations to Magnetism and Electricity.** The common magnetic toys of the shops illustrate the first of these properties in their power of mutual attraction. It is a property confined under ordinary circumstances to certain ores of iron, and especially to that known as the lode-stone. To the old Latin name of this mineral, viz., *magnes* (derived from the town of Magnesia, in Lydia, whence it was obtained) the words magnet and magnetism owe their origin. Electricity is a related property which is developed in a variety of substances as the result of rubbing and other causes. There are several minerals which become electric and attract light objects when thus treated. From one of these, ordinary amber, of which the Greek name is *electron*, comes the familiar word electricity.

(8.) **Relations to the Senses.** Salt and alum are readily recognized by their taste; sea-water is slightly bitter; many mineral waters have offensive sulphurous odors. Such features are of comparatively rare occurrence, but when found, constitute useful guides in the recognition of the minerals which exhibit them.

A DESCRIPTION OF THE MORE USEFUL MINERALS, WITH SPECIAL REFERENCE TO SUCH AS OCCUR IN NEW BRUNSWICK.

I.

METALS AND THEIR ORES.

IRON.

GENERAL CHARACTER. Every one is familiar with the general appearance and qualities of iron, for among all mineral substances there is none so generally employed, and so generally useful, as this. Hard, firm, and unyielding, and yet capable of being fashioned into almost every conceivable shape; possessed of great strength, and yet in many instances flexible and elastic; not easily affected by heat, and yet capable of being melted and run into moulds; having little tendency to change, unless when long exposed to damp air or moisture, when it is found to rust; and, finally, occurring in enormous quantities, and capable of being obtained at a comparatively trifling cost, it answers far better than any other metal the ordinary requirements of life.

VARIETIES AND USES. Three principal varieties of iron (or, more accurately, of a compound of iron and charcoal), are known in the arts, viz.: *Wrought Iron*, *Cast Iron*, and *Steel*. The first, though hard and tough, is flexible and malleable, *i. e.*, it can be bent without breaking, or rolled out into sheets, as in ordinary sheet iron. It can also be drawn into wire. It cannot, however, be readily melted, its several forms being given to it by various processes of hammering and working. Cast iron, on the other hand, containing much more charcoal, is also more fusible, and hence better adapted for the making of castings. Cast iron stoves afford a good illustration of its character. It possesses little or no flexibility, and, unless thick, is easily shattered by a blow. Steel, again, both in nature and properties, stands between the other two, and further varies in quality, according to the methods of making it and the use for which it is designed. Thus, in razors, knives, chisels, and cutlery of all sorts, it is made, by a process termed *tempering*, extremely hard and brittle, while in swords, saws, and watch springs, by a modification of the same process, it becomes pliant and elastic. Enormous quantities of an inferior variety of steel are now employed in the making of the rails of railways. Some idea of the extent to which iron is at present used, in all its various forms, may be had from the statement that the world's consumption of this metal, in the year 1883, amounted to more than twenty-seven million tons.

SOURCES. The sources from which this vast supply of metal is derived are very numerous. In almost all countries it is found to a greater or less extent, but there are a few which may be especially referred to as the iron producing countries of the world. One of these is Great Britain, where iron ores occur in large beds, and are extensively worked, especially in South Wales, and in the counties of Stafford, York, and Derby. Large quantities are also obtained from Norway and Sweden, and from Germany. The iron mines of Spain have also been worked since a very early period. In America iron ores occur abundantly in various parts of Canada, especially in Nova Scotia and Quebec, and in the United States.

The ores of iron are somewhat various in quality and appearance, but all are essentially compounds of the metal with the gas, oxygen. To obtain the metal they are accordingly heated in large furnaces, called "blast furnaces," with charcoal, which removes the oxygen and sets the iron free, combined, however, with a portion of the charcoal. *Pure iron* is never found as a natural product of the earth (though shooting stars, composed of this metal, sometimes fall upon the earth's surface), and is also never used in a pure state, its various forms, as above stated, being all the result of a combination with charcoal.

In New Brunswick, the chief localities for iron ores are St. John county (in the vicinity of Black River), and Carleton county. In the latter the beds are extensive, and were formerly largely worked in the vicinity of Jacksontown, near Woodstock. Over 40,000 tons of ore were raised and used in the blast furnaces at this place, and for certain purposes the iron produced was of excellent quality, but of late years it has been found impossible to carry on the business profitably, and the works have been abandoned.

The ores of Carleton are of a brownish red colour, and easily recognized by their weight and the colour they exhibit when scratched, this being either reddish or brown. They are mixtures of red iron ore (*hematite*) and brown iron ore (*limonite*). In the rocks of the southern counties veins and crystals of magnetic iron ore are often met with, but they are not in sufficient quantity to be of value.

Another compound of iron, known as Iron Pyrites, should also be mentioned here, not that it is of any value in itself, but because it bears some resemblance to gold, and, being of common occurrence, is frequently met with and mistaken for the more precious metal. It is, in fact, often known as "fool's gold." From true gold it is easily distinguished, by being much harder, not yielding to a knife like gold, and not beating out under a hammer; also by giving, when thrown on hot coals, the well known flame and odor of burning sulphur. It is a very common impurity of ordinary house-coal.

MANGANESE.

This metal, which in its properties bears much resemblance to Iron, is rarely seen in a pure state, and in this form has little or no value. Small quantities of manganese are sometimes associated with iron in the manufacture of certain kinds of steel, or may, as in the Woodstock iron ores, be already present in the proper amount; but the chief value of manganese, or rather of its ore, arises from the indirect use to which it is put in the process of *bleaching*, and for this purpose it is almost solely employed. Small quantities are used in the manufacture of glass, both for giving and removing colour from the latter.

Manganese occurs in large quantities in New Brunswick, and has been successfully mined for many years. The most important deposits are those of Markhamville, about twelve miles south of Sussex, in Kings county. The annual production from these mines varies from 500 to 1,500 tons, being valued, according to quality, from $15 to $50 per ton. Other localities, not now worked, are Shepody Mountain, Quaco, and the Tattagouche River, near Bathurst. The ore, which is of a dark colour, very heavy, and usually crystalline, is chiefly exported to the United States.

Beds of very impure manganese ore, known as "*wad*," occur in various parts of the Province, and may usually be readily recognized by their very black colour. One such bed, of considerable extent, may be seen on the bank of the St. John River, just above Government House, in Fredericton. They are of no value.

Of foreign localities, those yielding the chief supplies of manganese are Spain and Portugal. It is also obtained from various localities in the United States and from Nova Scotia.

COPPER.

GENERAL PROPERTIES AND USES. Several of the more important qualities of this metal, such as its peculiar reddish colour, metallic lustre, hardness and durability, are familiar as seen in the smaller denominations of ordinary coins. In addition to these properties, copper is in a high degree malleable and ductile; that is, it can be readily rolled into thin sheets or drawn out into long wires, which are at once strong and flexible. It is not easily melted, while at the same time it gives easy passage both to heat and electricity. Lastly, it unites readily with other metals to form what are known as alloys, such as brass, bronze, bell metal, and the like. As a result of these qualities, it is largely used in the manufacture of utensils, in the sheathing of ships, for electrical purposes, in engraving and electro-plating, as well as in coinage. Even ordinary gold and silver coins contain a certain proportion of copper in order to add to their hardness and durability. Copper also gives rise, by chemical means, to several important compounds, such as Blue Vitriol, Verdigris, Paris Green, etc. Introduced into the human body in any form it is highly poisonous.

SOURCES. Copper is a very widely distributed metal, and is found in nature in several different forms. In some instances it is found quite pure, and large masses of such pure or native copper occur about the shores of Lake Superior, where they have been mined from a very early period. More commonly the copper is united with more or less sulphur, forming either a rich brass yellow mineral (Copper Pyrites), or one of darker and somewhat variable colours, known as Variegated Copper ore. A bright green variety of copper ore, known as *Malachite*, in addition to being used as a source of the metal, is also valuable for ornamental purposes, being readily polished and somewhat largely used in jewelry.

The chief foreign sources of supply for copper are the districts of Cornwall and Devonshire, in England, portions of Russia, France, Hungary, and Spain, the Cape of Good Hope, Australia, and New South Wales. In America, in addition to the Lake Superior region, there are very rich mines in Colorado, Arizona, and other parts of the Rocky Mountain region, with some, of more limited extent, in the Province of Quebec.

In New Brunswick copper ores occur at many localities along the southern seaboard, in Charlotte, St. John, Albert, and Westmorland Counties, as well as near Woodstock, in Carleton County, and near Bathurst, in Gloucester County, and attempts have been made at many different points to remove the ore, but as yet none of them have resulted profitably. All the varieties of ore above named are occasionally met with.

LEAD.

CHARACTER AND USES. Lead is a metal remarkable chiefly for its great weight, for its whitish colour, bearing some resemblance to silver, and for its great softness, which admits of its being readily cut, bent, or hammered. It is also very easily melted. When freshly cut it is bright and silver-like, but soon tarnishes by exposure to the air. Its effects on the human system are highly injurious.

The principal uses of lead as a metal are in the making of pipes for the conveyance of water, in the lining of cisterns, in shot, in plummets, and, by union with tin, in the making of alloys, such as plumbers' solder, and pewter. Combined chemically with other substances it is the basis of several important paints, such as White Lead, Red Lead, Chrome Yellow, and others, and, as "Sugar of Lead," is employed in medicine. Several of these substances are dangerous poisons.

SOURCES. In the old world, lead is chiefly obtained from England (especially Derbyshire), Spain, and Prussia. In the United States, large and valuable deposits of the ore exist in Missouri and Wisconsin, but the most remarkable mines are those of Colorado and Nevada. From a single locality, that of Leadville, in Colorado, there were obtained, in 1884, over 35,000 tons of lead. It is not mined to any extent in Canada. In New Brunswick, lead occurs at a number of points, among which may be mentioned the island of Campobello, in Charlotte county; Musquash, in St. John county; Norton, in King's county; and the neighborhood of Bathurst, in Gloucester county. But from none of these localities has it yet been removed in profitable quantities.

The principal ore of lead is a brilliantly lustrous, very heavy mineral, looking much like lead itself, and often breaking readily into little cubes. It is a compound of lead and sulphur, and is known as *galena* or *galenite.*

ZINC.

PROPERTIES AND USES. Zinc is a metal of bluish-white colour, rather brilliant when quite clean, and not very liable to tarnish, easily melted, and when made very hot, taking fire and burning readily, with a peculiar bluish flame. Owing to the slight change produced upon it by air or water, it is very largely used for roofing purposes, as well as for the covering and protection of other metals which are more easily changed. Thus what is known as "galvanized iron" is simply sheet iron which has been covered over with a thin protecting coating of zinc.

The metal is also very largely used in the production of electricity. It may be readily united with other metals, and one of these compounds (or alloys), a mixture of zinc and copper, is familiar as ordinary *brass.* Bronze, so largely used in early times, before the general introduction of iron, is a compound of zinc, copper and tin. German silver is brass, to which a small quantity of nickel has been added.

Some of the compounds of zinc are of service as paints, and others as medicines.

SOURCES. Zinc is never met with, in nature, in the pure state, but combined, most commonly, with sulphur. It then forms the mineral known as *blende,* which the miners, from its dark colour, sometimes call "black jack." It has a peculiar lustre, recalling that of resin, and, like true resin, will become electric by rubbing.

Zinc ores are found and profitably worked in many parts of Europe (especially Belgium), and America. In the United States, the most productive works are those of New Jersey, Illinois and

Missouri. In Canada, deposits occur in the vicinity of Lake Superior.

In New Brunswick, zinc ore (blende) is found associated with lead ore (galena) at several points (chiefly on Campobello Island) along the southern coast, but the quantity is too small to be of much value.

TIN.

GENERAL PROPERTIES AND USES. Tin is one of the oldest metals used by man, and possesses many valuable qualities. It is a whitish metal, having some resemblance to silver, but with a less brilliant lustre, and becoming somewhat dulled through long exposure. It is quite soft, and possesses but little strength, but may be beaten out into very thin sheets, then known as tin-foil. It is readily melted, and much of what goes under the name of tin is merely thin sheet iron which has been covered with tin by dipping it into the latter when in the melted state. By proper treatment, the surface of this tinned iron may, owing to the highly crystalline character of the tin, be made to assume a very beautiful frost-like appearance. Tin unites readily with other metals, and a certain amount of it is contained in bell-metal, bronze, Brittania-metal, plumbers' solder, pewter, etc.

SOURCES. Tin is rarely, if ever, found pure in nature, but rather combined with oxygen, to form what is known as tin-stone. This mineral occurs abundantly in the district of Cornwall, in England, where it has been mined from the earliest ages. The British islands were indeed known to the ancient Romans as the Tin Islands, and it was partly with a view to obtain this metal that England was invaded and conquered by that people. A certain amount of tin is also obtained from Asia, and from Australia. It is of rare occurrence in the eastern United States and Canada, but is more abundant in some parts of the Rocky Mountain region. It has been mined, to a limited extent, in the state of Maine.

In New Brunswick, tin ore was reported many years ago as occurring about the Pokiok River, in York County, but the quantity was small, and no similar discovery has since been made.

ANTIMONY.

GENERAL PROPERTIES AND USES. Antimony is a substance of decidedly metallic aspect, having a bright, somewhat silver-like, colour and lustre, which does not readily change. It is a very brittle metal, which, by hammering, is easily reduced to powder. It also melts very readily. Owing to its brittleness, it cannot well be used for many of the purposes to which the ordinary metals are applied, but certain quantities of it are often added to other metals to make them melt more readily, or for other purposes. It is thus found in the metal of which *type* is made, as well as in Britannia metal, Babbit metal, etc. An interesting application is in the manufacture of rubber goods. A certain quantity is also used in medicine, as the "wine of antimony," and "tartar emetic." Its action on the human system, like that of arsenic, is highly injurious.

SOURCES. Antimony is found both in the pure state (Native Antimony), and combined with sulphur (Antimony Glance). The chief foreign localities from which the metal is obtained are the Island of Borneo and New South Wales. In the Dominion of Canada antimony ores occur in New Brunswick, Nova Scotia, and Ontario.

Of the New Brunswick localities yielding antimony the most important is that of Lake George, in the parish of Prince William, York County. The first mines in this vicinity were opened in the year 1862, since which, at various periods, considerable quantities of ore have been removed. The latter is partly pure or "native" antimony, and partly a compound of sulphur. Expensive works for the separation of the metal from the latter were erected near the mines, but they have recently been destroyed by fire. When in full operation they yielded about fifteen tons of metal every six weeks. More recently the ore has been exported unchanged, and used chiefly in the manufacture of rubber goods. It is said that not less than $400,000 have been expended at the locality since the first commencement of mining operations.

GOLD.

PROPERTIES AND USES. Gold is the most precious of all the metals, its value depending partly upon its rarity and partly upon its well-known qualities. Of a beautiful yellow colour, it is soft, malleable and ductile, receiving readily a high degree of polish, and retaining its lustre unchanged under all conditions of temperature and exposure. A very high heat is required to melt it, and the only substances which will readily dissolve it are quicksilver or mercury, and a combination of the stronger acids. Its chief uses are in the making of coin, in gilding, in dentistry, and in the manufacture of gold plate. In coinage it is associated with a certain proportion of copper to render it less soft, and therefore more durable. As gold leaf, the metal may be beaten out so thin that 280,000 leaves, placed one upon another, would not exceed an inch in thickness. Some of the compounds of gold are employed by photographers in giving a more desirable colour or "tone" to photographic pictures.

SOURCES. Though somewhat widely distributed, and found in many different countries, the larger part of the gold of commerce comes from California, from Australia, and from Russia. From the United States, in the year 1881, there was obtained an amount valued at over $34,000,000, and an amount nearly as large from Australia. In the same year Canada furnished gold to the value of between one and two millions of dollars, most of which was obtained in Nova Scotia and British Columbia.

In New Brunswick gold has, as yet, been found only in very small quantities, usually in the bed of streams. No veins of the metal are known to exist, and all search for profitable quantities have so far proved unsuccessful. Reports of its discovery are, indeed, frequently made, but it is seldom that these reports can be traced to any reliable source, and in most instances they originate from other and worthless minerals being mistaken for gold. The two minerals most likely to deceive in this respect are mica and iron pyrites (or fool's gold), but the former is easily distinguished by splitting readily into thin sheets, and the latter by being hard and brittle.

SILVER.

PROPERTIES AND USES. Silver, like gold, is a *precious* metal, valued alike for its comparative rarity, its beauty of color and lustre, especially when polished, and its fitness for the manufacture of jewelry, plate, coins and the like. Like gold, it is also malleable and ductile, quite soft, but readily hardened by the addition of a little copper, not easily melted, and unaffected by exposure to air or water. Dissolved in Nitric Acid, it forms the substance known as Nitrate of Silver, so largely used in the taking of photographic pictures. Its extensive application in the arts is well shown by the statement that the quantity thus used, in 1884, and not employed for coinage, amounted in value to five and a half millions of dollars.

SOURCES. The chief silver-producing countries are the United States, Mexico, and South America. In the United States the richest mines are those of Lake Superior, Nevada, Montana and Colorado. In Canada, considerable quantities have been obtained in British Columbia.

In New Brunswick, some of the ores of lead have been found to contain silver, but the proportion is usually small, and attempts to obtain it have not as yet given satisfactory results.

MERCURY.

PROPERTIES AND USES. This singular substance stands alone among the metals in being a perfect liquid at ordinary temperatures, a fact which, in connection with its beautiful colour and lustre, resembling those of silver, led early writers to mistake it for that body. Hence its common name of quicksilver.

Owing to its fluidity, in connection with the fact that it freezes only at very low and boils only at rather high temperatures, it is admirably adapted for measuring various degrees of heat, and is thus employed in ordinary thermometers. Its weight, again, is so great that a comparatively small amount of it (a column of about 30 inches) is sufficient to balance the weight of the air, and it is thus used in the construction of barometers. Owing to its power of dissolving gold and silver, it is used in large quantities as a means of separating these latter from their ores. Finally, one of its compounds, vermillion, is a valuable paint, and others, like calomel, as well as the metal itself, are employed as medicines.

SOURCES. Mercury is found to a slight extent in a pure state, but chiefly combined with sulphur, forming a bright red mineral (cinnabar) resembling vermillion. The chief mines are found in Spain, Austria and California. It has not been found in New Brunswick or other parts of Canada.

RARER METALS.

The following are a few additional metals, which are either of comparatively rare occurrence, or not often seen in the metallic state, but which find more or less extensive applications for useful purposes.

Platinum. A metal bearing some resemblance to silver, but of inferior lustre, is used chiefly in the making of vessels for chemical purposes. It is obtained from nearly the same sources as gold.

Nickel. This metal, of whitish colour and rather brilliant lustre, is but little affected by the air or water, and is often spread over other metals to protect them. It is familiar in American coinage and in nickel-plated goods. It is also a constituent of German silver. It comes chiefly from Germany.

Cobalt. This metal accompanies nickel in Germany and elsewhere, and is chiefly valuable from the power possessed by some of its compounds of imparting a deep blue colour to glass and china.

Arsenic. The name of this substance is most familiar as that of a deadly poison. What is commonly so called, however, is not really the metal arsenic, but a white compound obtained by roasting the ores of the metal. It comes mainly from England and Germany. Considerable quantities are also obtained from a mine in Ontario. In New Brunswick it is of rare occurrence.

Bismuth. This metal is used, to a limited extent, in making soft solder and other easily fusible compounds; also to some degree in medicine. The supply comes chiefly from Hungary, England (Cornwall), and Australia. Small quantities have been found in Canada and in New Brunswick.

Chromium. This metal is used only in the form of certain compounds, which are valued for their colours. The most common of these is the bright yellow paint known as chrome yellow. They are obtained from certain ores of iron found in the United States, in Turkey, and in Russia.

Aluminum. This metal can only be described as rare in the sense that in the pure metallic form it is comparatively unfamiliar. In reality it is one of the most wide-spread and abundant of all metals, as indicated by the fact of its entering largely into the composition of many minerals and nearly all rocks. It is especially abundant in common clay, and fully one-twelfth of the solid crust of the globe is believed to be composed of it. As a metal it possesses many valuable qualities, especially those of strength and lightness, but its separation is difficult and expensive. Its more important compounds will be again referred to.

II.
MINERALS NOT METALLIC.

1. MINERALS APPLICABLE TO ORNAMENTAL PURPOSES.

Quartz. This is one of the most common, and, though exhibiting much variety, one of the most easily recognized minerals. In its simplest form it is clear and colourless, like glass. It is then known as Rock Crystal, and under various titles, such as Rhinestone, etc., is largely used in jewelry. Not unfrequently it is coloured of a rich purple tint, from the presence of a small amount of manganese, and is then known as Amethyst. This, also, is highly prized in jewelry, being especially suitable for brooches. Other varieties are Chalcedony, Carnelian, Agate, Bloodstone, and Jasper. All of the above, except Bloodstone, are occasionally found in New Brunswick, but much finer specimens are obtained from Nova Scotia (North Mountains) and from Lake Superior. All varieties of quartz are *too hard to be scratched* with a knife, and are also destitute of cleavage.

Quartz is an abundant constituent of rocks, such as granite and the like, in which it is easily recognized by its hard glassy grains. Owing to this hardness, and the fact that quartz is unaffected by air or water, it remains unchanged when these rocks decay, and thus originates the grains of sand found in ordinary sandstones and soils. Quartz, alone, is also essentially infusible, but when heated with certain other substances may be readily melted. Ordinary *glass* is thus made by heating and melting together clean sand with either soda, potash, lime, or lead, or mixtures of these latter. At a certain temperature the material becomes soft or waxy, and may then be blown or pressed into any desired forms. Quartz is also the most common filling matter of mineral veins, and hence the most frequent associate of metallic ores.

Felspar. This very common mineral, a compound of Aluminum, is chiefly interesting from the fact of its entering so largely into the composition of ordinary rocks, and its relations to the soils which result from the wear and decay of the latter. It is the pink or reddish constituent of ordinary granite. It is, like quartz, very hard, but, unlike that mineral, splits or cleaves in two directions, nearly at right angles, and thus forms bright, lustrous surfaces. By the action of air and water it "weathers," or decomposes, and thus originates the different varieties of clay, which, besides forming an important part of ordinary soils, are used extensively in the making of bricks, tiles, earthenware, pottery, china, and porcelain.

It is found in all the granites of the Province, associated with quartz and mica, and often forms also the larger part of many prominent hills, especially around Passamaquoddy Bay.

Mica. This mineral, also an aluminous compound, is most readily recognized by its power of splitting almost indefinitely into thin, flexible and elastic sheets. When these are sufficiently large, as they are found in some parts of Quebec, they may be profitably mined and used for the windows of stoves and similar purposes, but in general they are too small to be thus employed. As one of the elements of common granite it is of frequent occurrence in New Brunswick, and is also found in other rocks and in soils. Owing to its brightness and silvery lustre it is frequently mistaken for gold, another instance of the fact that "all is not gold that glitters."

Garnet. This mineral, in its finer forms, has a rich cinnamon-red color, and a high lustre, and is used in jewelry, both under its proper name and that of carbuncle.

In New Brunswick, small garnets are found in some of the rocks near Moore's Mills, in Charlotte county, and in the parish of Canterbury, York county, but they are too small to be of value.

Tourmaline. This mineral is also occasionally found in clear transparent crystals, of green or red colours, but is more commonly black and opaque. The latter variety is sometimes found accompanying garnet, in the localities given for this mineral.

Fluor. This mineral exhibits rich shades of colour, including green, yellow, and purple varieties, and, being rather soft, is often used in England for the making of articles of ornament. In New Brunswick, it is found somewhat abundantly in Harvey Settlement, in York county, also on Frye's Island, in Charlotte county, and in Westmorland. The mineral, however, as occurring at these points, has little or no value.

Hornblende. This mineral deserves mention chiefly as one of very frequent occurrence, being often found taking the place of mica in many granite-like rocks, and sometimes making up the larger part of the latter. It differs from mica in not splitting into thin sheets as that mineral does, as well as in being much harder and heavier, features which it imparts to the rocks of which it forms a portion. It presents many varieties of form and colour, one of them being the mineral *asbestos*, valued on account of its long, flexible fibres, and its power of withstanding heat, in the manufacture of fire-proof fabrics, the lining of safes, and for roofing purposes. It has been found at a few localities along the southern coast.

Serpentine. This name is given to a compact and massive mineral, of pale yellowish green or dark green colours, and which is so soft as to be readily cut by a knife. In its finer forms, and when mixed with limestone, it often forms a rock of considerable beauty, known as verde antique marble, and is thus found at a number of points in St. John county, including Musquash, Pisarinco, and Portland. Specimens of large size are, however, difficult to obtain. A dark green variety occurs in rocks in the vicinity of St. Stephen.

Gems. A few of the minerals already mentioned, such as garnets, tourmalines, and some varieties of quartz, may properly be included under this head. In addition to these, the following are the gems most highly valued, viz.: Diamonds, Rubies, Turquois, Sapphires, Emeralds, and Topaz. Excepting diamonds, which are varieties of carbon, they are all more or less nearly related to Felspar. Their value and use depend upon their beauty and brilliancy of colour, in connection with their rarity. None of them are known to occur, in available forms, within the limits of the Dominion.

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2. MINERALS USED AS SOURCES OF HEAT AND LIGHT.

PEAT.

This name is given to the masses of half decomposed vegetable matter, consisting largely of branching mosses, often found bordering the shores of ponds or lakes, and sometimes covering extensive tracts. It is especially abundant in Ireland, where, after drying, it is largely used as fuel. It has also been so employed in Canada. In New Brunswick, it is not uncommon in the southern counties, and sometimes — as in parts of Charlotte county, near the line of the

New Brunswick Railway—covers large tracts. No use has here been made of it. Many small streams originate in peat bogs, deriving therefrom a dark colour and swampy taste. At the same time these bogs, by their spongy character, tend to retain the water, and to prevent its too rapid removal.

COAL.

NATURE. Coal is, like peat, of vegetable origin, but, unlike peat, is not now to be seen in process of formation, and differs further in many important particulars. It has been shown to be the product of a far distant period of the earth's history, when not only did vegetation of a widely different kind flourish on the earth's surface, but with a luxuriance which has not since been equalled, and yet under such peculiar circumstances as led, from time to time, to its general overthrow and burial beneath vast quantities of sand and clay, now hardened into rock. As a result of this burial and the enormous pressure thereby produced, the vegetable matter has been greatly changed, and in this changed form, hardened, compacted, and darkened in colour, it constitutes our ordinary coal.

VARIETIES. There are two principal varieties of coal in common use, viz.: Bituminous, or Soft Coal, and Anthracite, or Hard Coal. The former, as indicated by its name, is rather soft, easily broken, takes fire rather readily, and burns with a bright but somewhat smoky flame. The latter, on the contrary, is hard, brilliantly lustrous, difficult to ignite, and, in burning, produces great heat, with little or no smoke. In this respect it is like coke, such as is formed in gas works from the heating of bituminous coal, and it is altogether probable that it has been similarly formed from such coal by the heating of the latter, through natural causes, while still within the earth.

USES. In addition to its employment as fuel, soft coal is the direct source of illuminating gas and of various burning oils, such as Paraffine, Kerosene, etc. Indirectly, it is also the source from which are obtained the rich and varied Aniline dyes.

SOURCES. The chief coal-producing countries are Great Britain, the United States, Belgium, and Canada. In each of these countries coal-bearing rocks cover extensive areas, and enormous quantities are annually removed. In Great Britain alone there were raised in the year 1884 nearly one hundred and seventy million tons of this substance, while the amount raised in the United States was bı less. This quantity is about one-fourth that of the total proc of the world. Hard Coal, or Anthracite, is almost solely tl duct of the Pennsylvania mines, and from the latter the qı removed in 1883 amounted to over thirty-one million tons. A a rate is the mineral fuel of the earth being consumed!

The coal fields of Canada are confined to the Maritime Pro chiefly Nova Scotia, and to some portions of the Northwest. Iı Scotia the coal beds are numerous and thick, and are largely w especially about Picton, Spring Hill, and Sydney. Single coa occurring here are sometimes as much as thirty feet in thickn

In New Brunswick the coal-bearing rocks cover a very ext area, embracing large portions of the counties of Queens, Su York, Kent, Westmorland, and Northumberland, in all abou third of the entire Province. But though seams of coal been observed at many different points over this great tract are for the most part very small, the only ones which have ı capable of profitable working being those found in Queens C about the head of Grand Lake and the streams connected w Even in this last-named region the seam is thin, not exce twenty-two inches, and were it not for its nearness to the sı and the consequent ease with which it can be obtained, it wou of comparatively little value. As it is, considerable quantiti removed every year, and sent to the Fredericton and St. John kets, where it is especially valued for blacksmiths' use. The amount of coal originally present in this coal field has bee mated at 150,000,000 tons, of which probably not over 100,00 have as yet been removed.

Beds of impure anthracite occur at Lepreaux, in western St county, but have not repaid the cost of working.

ALBERTITE.

This name has been given to a peculiar mineral first fou Albert county, New Brunswick, and which was there mined for years with great profit. Though often called by the name of Coal, it is not in reality a true coal, being rather of the natur mineral pitch, and probably resulting from the chemical alte of mineral oil or petroleum. It does not occur, like coal, ir but in the form of irregular and branching veins, of whic largest, when first discovered, had a thickness of eighteen feet. Between the years 1863 and 1874 over 154,000 tons were removed, having a value varying from $15 to $20 a ton, but in descending the vein was found to diminish greatly in size, and after reaching a depth of over 1,500 feet it was found necessary to abandon the mine. Numerous attempts have been made to discover other veins, but so far as known to the author none of workable size have yet been found.

The Albertite, a black, highly lustrous, pitch-like substance, was never used as an ordinary fuel. Its great value resulted from its employment in the manufacture of oil (Albertine) and gas.

BITUMINOUS SHALE.

This is the material in which the veins of Albertite occur, and from which the Albertite itself was probably derived. It is a rock rather than a mineral, and is found in thick beds extending through a large part of Albert county (from Elgin to Hillsboro'), and portions of Westmorland (about Memramcook). It is of a dark grey colour, very tough, with a strong bituminous odour, and in some places contains so much oily matter as to yield oil in considerable quantities when heated. Works for its separation were at one time established near Baltimore, in Albert county, but the discovery of the great petroleum wells of Pennsylvania prevented the work from being profitable, and it was soon abandoned. Portions of the shales contain large quantities of fossil fishes, and the oily matter contained in the rock has probably, in great part, been derived from this source.

PETROLEUM, OR ROCK OIL.

In addition to the oily matter spread through the Bituminous shales last described, fluid oil, or Petroleum, is sometimes found oozing from these shales in small quantities. It has been thus observed in the Albert Mines, and at several places about Memramcook, where it is accompanied by inflammable gas. All attempts, however, to obtain it in profitable quantities have so far failed.

Petroleum, in large quantities, is found in Pennsylvania, the Russian provinces on the Caspian Sea, in British Burmah, and also in Ontario. After being refined, it is employed chiefly as a burning oil, but has also many other applications. Single wells in Pennsylvania have in some instances yielded 6,000 barrels of oil a day, while the value of the yield in the United States for the year 1884 was upwards of twenty millions of dollars.

SULPHUR.

The appearance and some of the properties of this substance are made familiar by its use in connection with ordinary friction matches. The first ignition of the latter is due to a small quantity of phosphorus with which the match is tipped, but behind this is a quantity of sulphur, which, taking fire from the phosphorus, in turn ignites the wood. The sulphur is a bright yellow substance, very brittle, and very inflammable, producing, when burning, dense, suffocating fumes. In addition to its employment in match-making, sulphur is used in enormous quantities in the manufacture of gunpowder and fire-works, as well as in the making of sulphuric acid, in medicine, in bleaching straw goods, and for many other purposes. The supply for these uses comes chiefly from Sicily and other volcanic countries, where it is found in a nearly pure state. No such pure sulphur is to be found in New Brunswick or Eastern America, but many ores of the metals are compounds of sulphur, and from some of these the sulphur may, if desired, be profitably extracted.

A compound of sulphur and hydrogen is sometimes found disolved in the water of mineral springs, which are accordingly known as "sulphur springs." They are readily recognized by their offensive taste and smell, but are often considered as serviceable in the cure of certain diseases.

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3. MATERIALS CAPABLE OF RESISTING HEAT.

GRAPHITE, OR BLACK LEAD.

Graphite is probably vegetable matter greatly altered by intense heat. It is therefore now but little affected by the latter, and may be usefully employed where the effects of heat are to be resisted. It is thus used for "facing" the moulds in which stoves and similar articles are cast, as well as for giving to iron a bright, glossy surface. But its most important application is in the manufacture of lead pencils, for which it is especially adapted both by its softness and its black colour. It has not, as its name would seem to indicate, any relation to ordinary metallic lead.

Graphite is obtained from many different localities in Great Britain and the United States, as also in Canada. In New Brunswick the mineral is found at several points in St. John county, and has been mined to some extent in the vicinity of the Suspension Bridge, in Portland.. As here found it is somewhat impure, and has been chiefly used for foundry purposes.

BRICK AND FIRE CLAYS.

The different varieties of Clays are not properly *minerals*, but result from the decomposition of the latter, especially from felspar and mica. They are most commonly found in the valleys of the larger streams and rivers, but are also to be met with in other situations. Their most important quality is that of their *plasticity*, or power of being moulded into any desired form. In consequence of this property and the power which they acquire, when baked, of retaining their form and of resisting heat, they are largely employed in the manufacture of all kinds of bricks and tiles. They also constitute the basis of the manufacture of all varieties of earthenware.

Brickyards are of common occurrence in the Province, but the two of most importance are those at St. John and at Marysville, in York County. From the latter there were produced, in the year 1884, not less than 8,000,000 bricks.

Fire brick differs from ordinary brick in being made of a purer clay, and one better adapted to withstand high temperatures. It is generally of a whitish colour. Clays suitable for such use are frequently found beneath seams of coal, as at Grand Lake and elsewhere.

MICA, SOAPSTONE, AND ASBESTUS.

The first of the above minerals has already been referred to as being frequently employed in the making of the windows of stoves, being adapted to this use by its transparency, by its splitting readily into thin sheets, and by not being acted upon by heat.

SOAPSTONE is, as its name indicates, a stone of a peculiarly soft, soapy feeling, and is sometimes used in the making of stoves, mantels, etc. It does not occur in any available form in New Brunswick.

ASBESTUS. This substance is a variety of the mineral Hornblende, or sometimes of Serpentine. It is remarkable chiefly for its fine fibrous character, resembling cotton or flax, and its power of resisting heat. In consequence of these properties, it is largely used for roofing purposes, for packing fire-proof safes, in making fire-proof garments, and for kindred purposes. The mineral is of rare occurrence in New Brunswick, but has been found in some parts of St. John County. It is much more abundant in the Province of Quebec

MINERAL PAINTS.

1. OCHRES.

Ochres are clays variously coloured with compounds of iron. By their colour and softness they are adapted to the manufacture of certain kinds of paint, and in some parts of the United States are largely so used. They are found in New Brunswick, both as yellow and red ochre, at a number of localities, especially in Albert county, but little has as yet been done with them.

2. BARYTES.

This is a white and very heavy mineral, sometimes known as Heavy Spar, and used somewhat largely, both alone and in connection with White Lead, in the making of paints. It is found in many parts of the United States, in Canada, and in England.

In New Brunswick it is found chiefly on Frye's Island, in Charlotte county, and near Memramcook Station, in Westmorland.

3. CHALK.

This is the familiar material employed for writing purposes. It is a variety of limestone, and consists largely of the remains of very minute animals, at one time living in the sea, at the bottom of which similar material is now believed to be accumulating. Chalk is widely spread, and in large deposits, over the continent of Europe (especially in England and France), but in America is confined to some small beds in the Rocky Mountain region.

MINERAL MANURES.

1. GYPSUM.

This mineral occurs in very large beds both in New Brunswick and Nova Scotia. In New Brunswick the chief localities are in Kings county (in Sussex and Upham), in Westmorland county (near Petitcodiac station), in Albert county (near Hillsboro and Hopewell), and in Victoria county (on the Tobique River). Near Hillsboro it has been very extensively quarried for a number of years, and large works have been erected for grinding and burning it. When simply ground, Gypsum is found to be of much service in adding to the fertility of certain soils, and from several of the localities above mentioned it is removed in large quantities to be so employed. On the other hand, when heated, it loses water, and becomes converted into Plaster of Paris, a material largely used in the making of cements, in the interior finishing of houses, in the stereotyping of books, and for many other purposes. From the Hillsboro beds the total amount removed during the last year (1886) was 29,921 tons, of which the larger part was exported to the United States.

As a mineral, Gypsum presents several varieties, being sometimes white and opaque or slightly translucent, being then known as Alabaster, sometimes granular, sometimes fibrous, and sometimes crystallizing in large, flat, transparent slabs. It also varies much in colour, that of Hillsboro being pure white, while that of the Tobique is of reddish and chocolate colours.

2. APATITE.

This mineral is not known to occur in New Brunswick, but is mentioned here as being one of the important mineral products of Canada. It is often known as "Canadian Phosphate," being in reality a Phosphate of Lime, and, like bone-earth, which has nearly the same constitution, is highly valued as a fertilizer. Immense quantities are annually removed from mines in different parts of the Ottawa valley.

SALT AND MINERAL WATERS.

1. SALT.

The Salt of commerce is obtained from three sources; viz., from sea water, from beds of solid ro k-salt, and from salt-springs. The two last may occur together or separately, and are thus found in many parts of the world, notably in England, France, Spain, Austria and Hungary; also in the United States and in Canada (Ontario).

In New Brunswick no beds of rock-salt have as yet been discovered, but salt springs or brines issue from the rocks at several points, as near Sussex (Dutch Valley), Upham (Salt Spring Brook), and the Tobique Valley. Near Sussex the brine has been employed as a source of salt, and from sixty to seventy bushels per week have been at times manufactured—an amount which might easily be largely increased.

2. MINERAL SPRINGS.

These are springs containing mineral substances in solution. In addition to those containing salt, already noticed, there are springs containing compounds of sulphur, iron, magnesium, and the various alkalies. Owing to the presence of these dissolved bodies, they acquire more or less of a medicinal character, and are often resorted to for curative purposes. In America the best known are those of Saratoga, in New York, and the Sulphur Springs of the Southern States.

Sulphur springs, so called, have been observed at a number of places in New Brunswick, especially in Carleton county, and have acquired some local celebrity, but none of any great value are known. Where waters contain iron it is usually indicated by the formation of colored films upon the surface, and, eventually, of a reddish brown sediment in the brooks which they originate. An alkaline spring occurring near Apohaqui Station in King's county, has been recently brought to notice as possessing valuable curative properties.

USEFUL ROCKS.

The relations of rocks to minerals have been pointed out on a previous page. Among the substances already noticed there are some, such as rock-salt and gypsum, which, though true minerals, occur in rock-like masses, often of great extent, and others, such as coal and iron ores, which are rather rocks than minerals; but we have now to notice a number of substances, largely employed for useful purposes, about whose rock nature there can be no question.

1. GRANITE.

On page 5 this substance was referred to and described as affording the best illustration of what a true rock is—an association of two or more minerals in considerable masses. These minerals are quartz, felspar, and mica, each distinguishable by its own peculiar features, but distributed very regularly and in nearly equal quantity through the granite formed by their union, and hence giving to the latter, in any particular instance, corresponding uniformity. One granite, however, compared with another, may differ in the proportion of these parts as well as in their size and colour; and hence different varieties of granite originate, adapted and used for a variety of purposes.

Owing to its hardness, firmness and durability, granite of almost any kind is well suited to the making of the foundations of buildings, and is largely so employed. In many instances, also, it is favorably employed in the construction of entire edifices. Granite for such purposes is very abundant in New Brunswick, especially in Queens county, in Charlotte, in York, and Gloucester, in each of which it covers large areas and rises into prominent hills. At many points, also, it is suitable for ornamental and decorative purposes, taking readily a high polish, and possessing shades of colour which are highly valued. The principal quarries are those of Long Island, or Hampstead, in Queens county, and the neighborhood of St. George, in Charlotte county. At the former locality the rock is mostly gray, and is chiefly employed in the rough state for ordinary construction. That of St. George, on the contrary, has a rich, warm reddish colour, derived from the felspar which it contains, and is largely polished both at St. George and at Carleton, St. John.

2. SANDSTONES.

In a sandstone the particles of which the rock is made are not, as in granite, crystalline particles, but simply, as the name indicates, cemented grains of sand. The grains may be large or small, and either firmly or loosely compacted. They may also vary in colour. Thus sandstones also present many differences, and become fitted for a variety of uses.

Sandstones which are rather fine, and at the same time not too hard, and having an even texture throughout, are commonly known as *freestones*. Such stones are highly prized for building purposes, and they have been very largely employed in the construction of all the Atlantic cities. They are commonly known as Nova Scotia stone, but a very large part has really come from New Brunswick. The most important quarries in the Province are those about the head of the Bay of Fundy, near Hopewell and Harvey, in Albert County, and Dorchester and Westmorland; also on the North Shore, at Newcastle. Stone from the last-named locality is now being used in the construction of one of the large public buildings at Ottawa. It is readily cut into ornamental forms, and is quite durable. The colours vary from olive gray to purple.

Sandstones which are of a very uniform texture, and which possess a clear sharp grit, are adapted to the manufacture of millstones and grindstones. Such rocks are found with ordinary freestones at the localities above named, and are often removed for such uses. Grindstone Island, off the coast of Albert County, derives its name from the occurrence here of rocks of this character.

3. SLATES.

As sandstone is composed of cemented grains of sand, so slate is only a hardened bed of clay. It is thus much finer than sandstone, of more uniform texture, and, owing to the pressure which it has undergone, exhibits a tendency to split or cleave into thin slabs. It also does not allow water to pass through it readily. Owing to these properties it is largely employed for roofing purposes, as well as in the manufacture of writing slates, slate pencils, etc.

The best slates in America come from quarries in Maine, Pennsylvania, and Vermont. In New Brunswick slate rocks are common, covering a large proportion of the entire area of the Province, but little has been done to test their quality. The area which affords most promise in this particular is that of northern Charlotte County and southern Queens.

4. LIMESTONE.

Limestone is the rock from which ordinary lime is derived. It is found in beds, often of great thickness, and extending over considerable tracts of country. It varies much in colour, though usually tending to pale grey, bluish, and whitish tints, and may readily be recognized by its softness, and usually by the facility with which it effervesces or froths up upon the addition of an acid. It not unfrequently contains shells, the relics of former life, and much limestone is almost wholly thus constituted.

In New Brunswick limestones are found in beds of great extent and purity along either side of the St. John river, in the county of the same name, and large quantities of stone have been thence removed and burned for the making of lime. Quite recently this business has assumed very large proportions, and in the last year (1886) over 150,000 casks of lime were manufactured here. Limestone is also found, and has been to some extent burned, at Musquash, in St. John county, and at L'Etang, in Charlotte county. Smaller beds occur along the valley of the Becaguimic river, and at Windsor, in Carleton county; near Hillsboro, in Albert, and elsewhere; and from some of these beds considerable quantities of lime have been manufactured, but only for local use.

5. MARBLE.

Marble is of the same nature as limestone, but is harder and more crystalline. It occurs in the same way, and exhibits similar differences of texture and colour, but owing to its firmness, durability, and capability of being worked and polished, it is better adapted for ornamental purposes. It is hence largely employed in the manufacture of tombstones, monuments, mantels, statues, and the like, and at times for the construction of large public buildings. The best foreign marble comes from Italy, but some varieties of American rock are also extensively employed.

In New Brunswick portions of the limestones of St. John county are true marbles, and in small specimens are often quite handsome, exhibiting, in addition to pure white varieties, shades of blue, pink, green, and dark grey. It has, however, been found difficult to obtain rock sufficiently free from cracks and flaws, and as yet has been but little used. At present there are no marble quarries in operation in the Province.

OF THE RELATIONS OF ROCKS TO THE EARTH'S SURFACE.

IN the description of rocks and minerals in the preceding pages, and of the uses to which they are applied, they have in all cases been supposed to be removed from their natural places, and often subjected to various artificial operations. But even in their original positions, rocks at least often affect our well-being, and that not less than the ores, gems, ornamental or architectural materials which we may obtain from them. A few of the rocks already noticed will enable us easily to understand this point, while they may also serve to convey some idea of *how rocks are made*, *when* they were made, and in what way they throw light on the earth's history.

(1.) **How Rocks Crumble and Decay.** We commonly look upon rocks and stones as unchangeable and everlasting; but one has only to go into some old church-yard to find proof of the fact that this is not the case—that these, like everything else in nature, are liable to change and decay. While some newly erected tombstone will present a surface which is clear and bright, others by its side, and which have been longer exposed, will be found to be far more dull, while in still others, evidently the oldest of all, the inscriptions which they once bore have become well nigh illegible. These changes result from the action of the air, which, partly by variations of heat and cold, partly by frost and moisture, and partly in other ways, tend sooner or later to alter the character of the surface and to hasten its decay. Ordinary building stones are liable to similar changes, and many beautiful buildings in various parts of the world, erected at enormous cost, have had their beauty sadly marred by this cause, or have fallen into utter ruin. So in general all rocks exposed to the action of air and water, whether in large or small masses, whether on mountain sides or in the more level plains, and whatever their nature, tend eventually to break up, crumble, and to fall to pieces. The power which water has of *dissolving* many rocks and minerals, especially those containing lime, aids in this process, as does also the constant *wear* produced by the flow of this water in streams and rivers. We have next to enquire "*What becomes of all the material thus set free?*"

(2.) **How Rocks are Formed.** Rocks, as we have seen, by "weathering" crumble and decay. But in so doing the materials composing them are not lost; they are only changed in character or, it may be, removed to some new position, and thus they are made to contribute to another important result; viz., the *formation of new rock*. In some instances the material is merely added to the soil, and there is reason to believe that all soils have to a large extent been produced by similar agencies. Some of the varieties of these will be noticed presently. In other instances the loosened materials are taken up by flowing waters and borne away, it may be only for a few feet or yards, but not unfrequently for scores or hundreds of miles. But, whatever the distance, sooner or later the material must find a resting place, and there heaped up it in time becomes rock again. If the material transported be sand, a bed or beds of sand will be deposited; if mud, a clay; if pebbles, a bed of gravel. Moreover, as quickly moving waters have more power to hold up and carry along solid matter than those which flow more gently, and as differences of this kind are found along the whole length of streams and rivers as well as upon the sea coast, pebbles will accumulate at one place while sands are forming at another, or mud-beds at still another. Or, by changes in the condition of the stream at various seasons, as in times of drought or freshet, very different kinds of materials may be deposited in the same place, one above another, in successive beds.

Now it is true that the materials thus deposited differ from our ordinary ideas of rocks in being loose and uncompacted, rather than hard and solid. But we must not attach too much weight to the difference. Hardness is a very variable characteristic, and comparatively slight changes are sufficient to determine it. Snow, by mere pressure, becomes as hard as ice, and so clays and sands, by the mere pressure of their own weight, tend to become more compact and solid. So sand and lime become compacted into mortar, in time becoming as hard as many rocks, and as lime is often present in the waters which penetrate sandy and clayey beds, these in similar manner may, by its agency, also become cemented, and thus acquire firmness and solidity. And thus it is that a large part of the rocks of the earth have been produced. A sandstone, as has been described, is only a hardened bed of sand, and so a shale or a slate is but a hardened bed of mud; or where the material is coarser, consisting of rounded and various pebbles, we have what geologists call a *conglomerate*. Such rocks, as their nature at once shows, have all been formed by the action of running water, and for this reason are often called Aqueous or Water-formed Rocks. Again, such rocks successively laid down in moving waters are usually in layers or beds, and are sometimes known as Bedded or Stratified Rocks. Finally, as most waters contain or may receive different forms of vegetable and animal life — tree-trunks, leaves, insects, shells, etc. — portions of these often become imbedded in the forming deposits, and there entombed and preserved constitute what are known as *fossils*. In the rocks accompanying coal beds, such as those of Grand Lake, fossils in the form of leaves and trunks of trees are exceedingly abundant, though they have probably been entombed for thousands of centuries, and so at the Albert mines many of the shales were found to contain myriads of fossil fishes, wholly unlike anything now living, while in the northern part of the province (and similarly over much of America and Europe) we have large tracts, and even mountain masses, almost wholly made up of shells, corals, and other forms of marine life. But while water has thus been the great agency both in the destruction and building up of rocks, there is also another, that of heat, which may also operate in the same direction. Thus enormous quantities of *melted* rock are at times poured out from volcanoes, and overflow extensive tracts, carrying destruction with them. Or they may be thrown from volcanic *craters* high into the air, and, falling, build up a high cone or volcanic mountain around the point of their discharge. Such rocks, of course, will not be *stratified* in the same way that we have seen water-formed rocks to be, nor will they, in general, contain remains of living beings. They are what are known as Fire-formed or Igneous Rocks. Lastly, igneous rocks, on their way to the surface from the bowels of the earth, may bake or alter the rocks through which they pass; or the heat from the earth's interior, spreading through a great mass of rock without actually melting it, may greatly alter its character, either simply hardening it, or, it may be, giving it a crystalline character. This is probably the way in which granite and many related rocks have been produced. Originally formed by the action of water, as the stratified structure in some of them clearly shows, they have since been acted on by subterranean heat, and thus made to assume their present form. Such rocks are accordingly known as Altered or Metamorphic Rocks.

(3.) **How Rocks Tell the History of the Earth.** From what has been stated, it will be evident that in the various features which rocks present we have not only an indication of the special circumstances under which each was formed, but also of the various changes which at different times have affected the regions in which they were formed. They enable us to tell the former sites of lakes and rivers, the former different distribution of land and sea, the former frequent changes in the surface level of the continents, and the depths of the ocean, and — most interesting of all — the former existence of whole tribes of plants and animals which have at various times peopled the earth, but of which we would have no knowledge whatever were it not for their remains which the rocks reveal. Thus the earth becomes a great historical record, the events of which are to be unfolded and read through the careful study of the rock formations which constitute its successive leaves. This study is the work of the science of Geology.

(4). **How Rocks Determine the History of Man.** Besides constituting the solid foundation on which all human structures rest, rocks have a most important bearing on the welfare and development of man in many other ways as well.

FIRST, *They Originate and Determine the Character of All Soils.*—These are directly the result of the breaking up and decay of rocks, as previously noticed, and their character and productiveness are directly dependent upon the nature of the source from which they are derived. If the materials required for the healthy growth of plants are not contained in a particular rock, the soil resulting therefrom cannot contain them, and will be correspondingly sterile; if it is rich in such materials, the soil will be fertile and productive. Thus some rocks weather easily and others scarcely at all, so that the one will be covered with a deep soil, the other with little, if any. Soils resulting from the breaking up of sandstones are themselves sandy, and therefore generally poor, lacking firmness, and not readily keeping the moisture which plants require; while those resulting from the decay of clayey rocks are apt to remain cold and wet. By ploughing, and various other agricultural operations, the natural conditions of soils may be greatly altered and improved, or, by bad agriculture, they may become impoverished; but the general character of all soils is originally and chiefly determined by the rocks on which they rest, and from which thy have been derived.

SECONDLY, *Rocks Determine all the Distinctive Features of the Land.*—Some rocks are hard and some are soft. The latter accordingly are readily washed away, while the former are but little affected. Thus, in part, originate hills and valleys, highlands and lowlands, and with them the general aspect of the country and all the details of its scenery. The course and length of rivers, the position and depth of lakes, the place and character of water-falls, and, upon the coast, the occurrence of bays and headlands, of rock-bound shores and sandy beaches, of islands and harbors, are other features, all of which are largely determined through like differences. And these, in turn, determine the origination of commerce, the sites of cities, the construction of railways and canals: in general, all those factors upon which the character and growth of nations depend.

LASTLY. Rocks and their contents afford or produce a large part of the wealth of nations. From them we derive the greater portion of the materials employed in the construction of our dwellings, much of the material of which all our tools and machinery are constructed, a large part of our fuel, the substance of our coinage and plate, and all of our gems and precious stones.

Being thus intimately connected alike with the present and the past condition of our earth and the beings which inhabit it, the study of rocks in their various relations must ever be a source of profit as well as pleasure. It is hoped that the few simple explanations and statements contained in the preceding pages may contribute to this result.

EXPLANATION OF PLATE II.

PLANT LIFE.

FIGS. 1–5.—STAGES OF GROWTH. 1. The Seed; 2. The Seedling; 3–4. The same more advanced; 5. The Plant with fully formed Leaves.

FIGS. 6–10.—THE BRANCHING PLANT. 6. Showing position of Buds (Linden); 7. Nature of Buds as undeveloped Branches; 8, 9, 10. Forms of Trees.

FIGS. 11–20.—FORMS OF THE STEM AND BRANCHES. 11. Prostrate Stem or Runner (Strawberry); 12. Underground Stem, forming tubers (Potato); 13. Stem with Branch forming a tendril for climbing (Vine); 14. Section of "Exogenous" Stem, showing bark, pith, and rings of wood. Figs. 15–20. "Endogenous" Stems; 15. Grain of Corn germinating; 16. Same more advanced; 17. Leafy Stem; 18. Underground Stem or "Root-stock" of Iris; 19. Grass; 20. Section of Endogenous Stem.

FIGS. 21–26.—FORMS OF ROOTS. 21. Young Seedling forming root and rootlets; 22. Roots branching for absorption; 23–26. Roots thickened by deposited food: Carrot (23); Turnip (24); Radish (25); Dahlia (26).

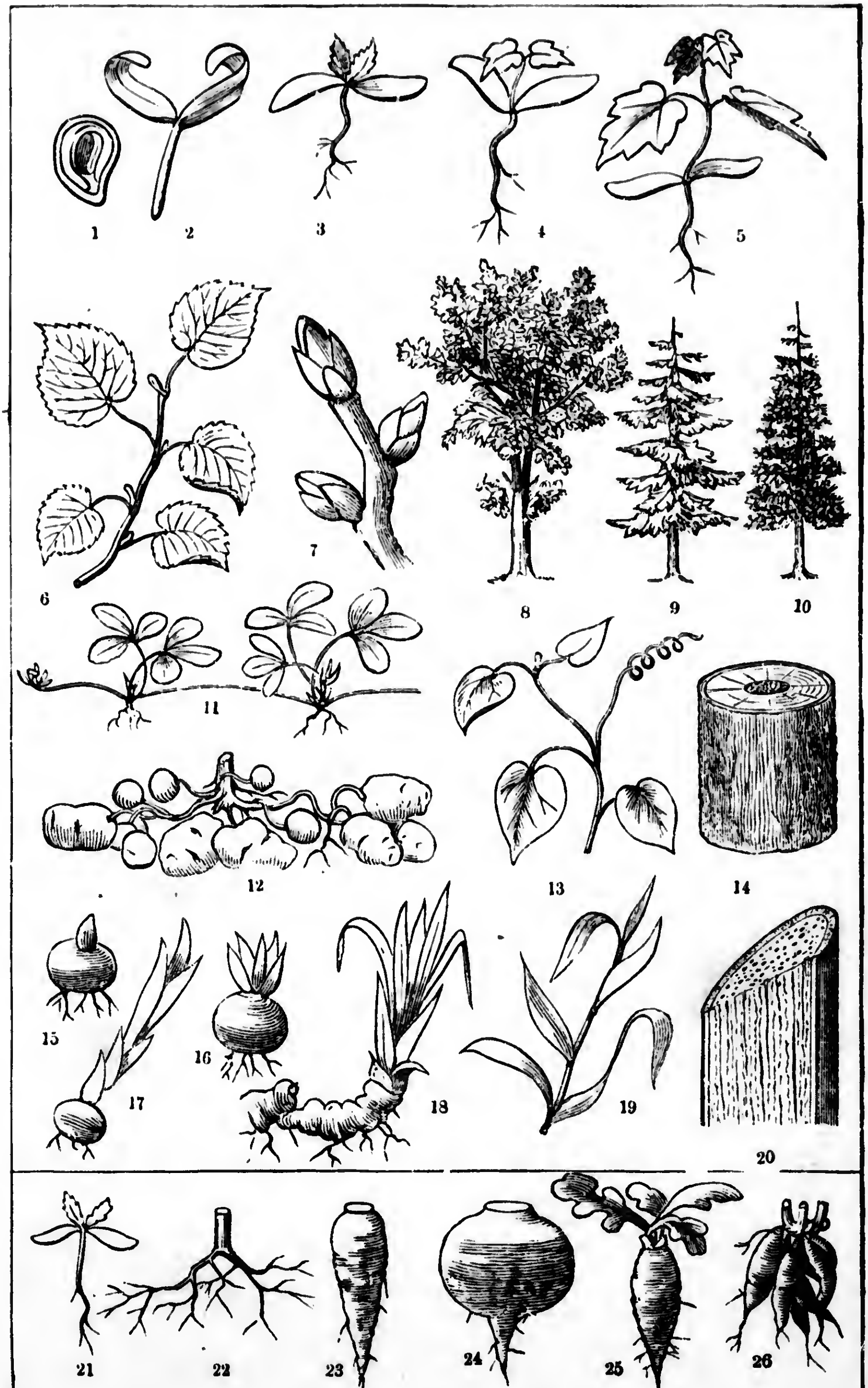

PLATE II. PLANT LIFE.

EXPLANATION OF PLATE III.

PLANT LIFE.

FIGS. 1–10.—FORMS OF LEAVES. 1. A simple and complete Leaf; 2. Leaf with cleft margins; 3. Leaf with three-lobed margin; 4. Three-cleft Leaf; 5. Three-divided Leaf; 6. Compound Leaf, with seven Leaflets. The above are Leaves of "Exogenous" Plants. Figs. 7, 8, 9. Leaves of Endogenous Plants. Fig. 10. Leaf of Fern.

FIGS. 11–21.—FORMS AND GROUPS OF FLOWERS. 11. Solitary Flower (Bluets); 12. Flower-cluster of Lily of the Valley; 13. Umbrella-like clusters (or Umbels) of Caraway; 14. Heads, or "Compound Flowers"; 15. Harebell, showing Calyx and Corolla; 16. Flower of Stone-Crop, showing Sepals, Petals, Stamens, and Pistils; 17. Flax-blossom cut through, and showing—in addition to Calyx, Corolla and Stamens—the Ovary or interior of the Pistil, with contained Ovules. (The above are Flowers of Exogenous Plants.) 18. Adder's Tongue; 19. Trillium; 20. Indian Turnip—a form of flower cluster in which the small and imperfect flowers are near the base of a central fleshy "spike," and concealed by an enveloping flower-like leaf; 21. Flower-clusters of Grass. The above are Flowers of Endogenous Plants.

FIGS. 22–28.—FORMS OF FRUITS. 22. Stony Fruit of Plum; 23. Fleshy Fruit of Cranberry; 24. Nut or Acorn; 25. Strawberry—the true Fruits being minute and buried in the thickened stem; 26. Winged Fruit of Maple; 27. Pear, divided to show the core, or ripened ovary; 28. A Pea-Pod.

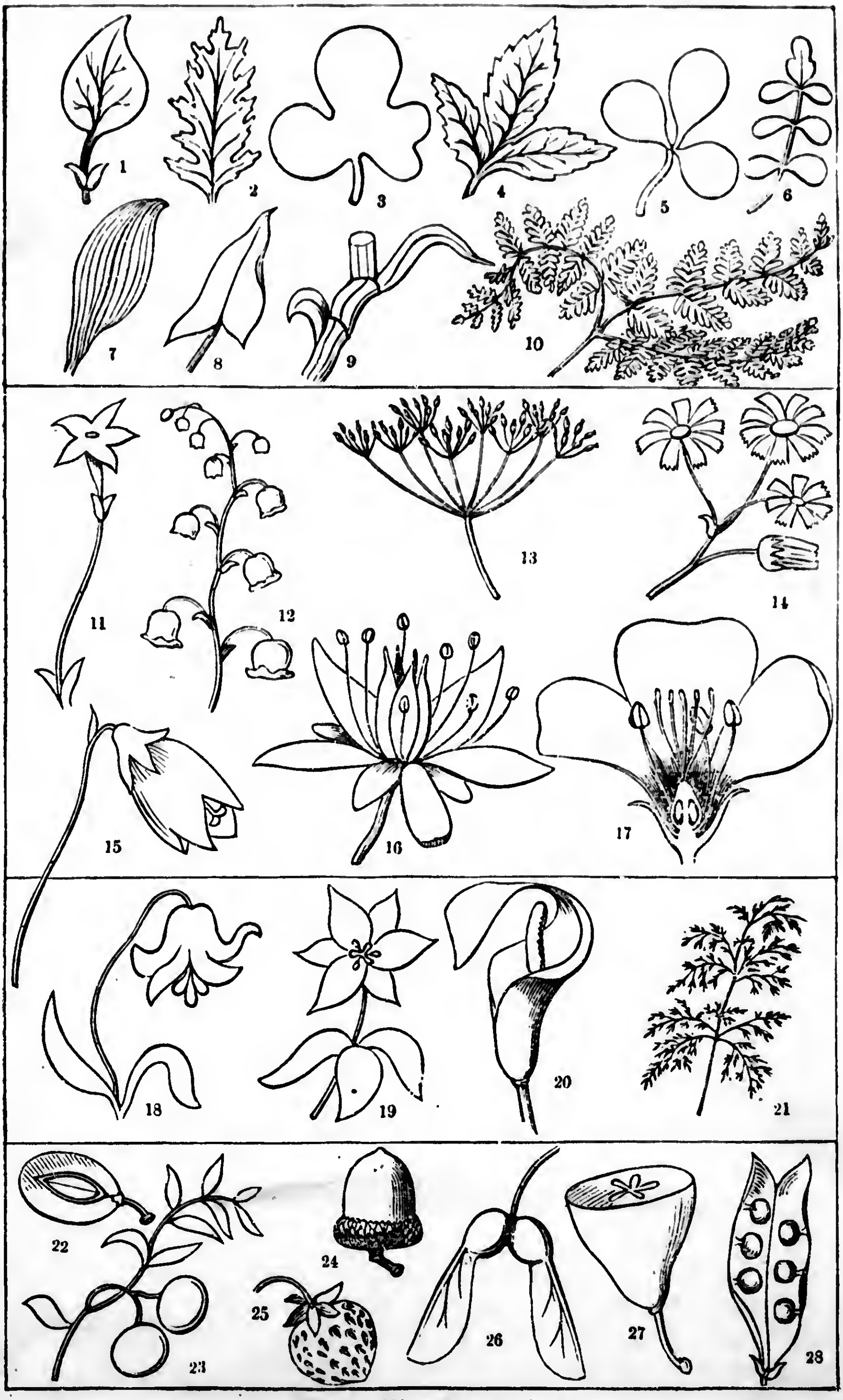

PLATE III. PLANT LIFE.

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II.

THE VEGETABLE KINGDOM.

1. OF LIFE IN GENERAL.

In the first portion of this work the attention of the student has been directed, almost exclusively, to what may be termed *dead* Nature. The various rocks which constitute the substance of the earth, together with the minerals of which they are composed, or which are contained within them, however liable they may be to certain kinds of change, never manifest in any way the possession of what we term *Life*. Plants and Animals, on the other hand, are *living beings*. They are produced, they grow, they move, they take and digest nourishment, and finally they die, their life having, however, in the meantime, been transmitted to their young. Now if we reflect upon these characteristics of living things, as compared with those of rocks and minerals, we shall see that the difference lies in this one thing; viz., that the former are capable of *doing* something, while the latter are not. Mineral substances may be used in a variety of ways; they may be made the implements wherewith to do something, but they can do nothing of themselves. Plants and animals, on the other hand, are always doing [illegible]hing by powers of their own, and as soon as they cease to [illegible] die, and return to the earth from which they sprung.

What we have to study, then, in the case of Plants and Animals, is, What They Do, and How They Do It. As the work of Plants is far simpler than that of Animals, and as the agents or organs by which it is effected are also much simpler, we shall find it most convenient to take up their study first.

2. PLANT LIFE.

It seems somewhat odd at first that we should look upon a plant as a living thing, and should attempt to describe its life. In an ordinary herb, shrub, or tree, there seems at any one time but little to suggest vitality. The trunk of the tree apparently differs but little from the boards into which it may be sawn; the leaves fluttering in the breeze seem no more alive than when, detached by the same breeze, they are scattered over the ground. We see no motion, except such as the wind provokes. The tree has apparently no organs wherewith to take food, or to digest it when taken. It seems neither to eat, nor drink, nor sleep, nor breathe, nor climb; and though we know that it grows, it is far from being obvious at first how this growth is effected, or by what agents it is carried on. And yet a plant does all these things and a great deal more, after its own peculiar fashion; and so it is a real living thing, as much so as we ourselves are, having a regularly allotted term of life, having a definite work to do, and definite instruments or organs wherewith to do it.

The study of this peculiar life of Plants, systematically pursued and in all its varied relations, constitutes the science of Botany. It is both an interesting and a valuable study for many reasons, of which a few only can here be stated:

(1.) Plants supply us directly or indirectly with all our food. A knowledge of vegetable growth and structure therefore assists us in obtaining from the earth the greatest possible supply of such food and of using it to the best advantage. The whole science of agriculture has for its immediate object the promotion of the growth of plants, and its successful prosecution may be very largely affected by our knowledge or ignorance of the laws of Plant life.

(2.) Plants furnish us with much of the materials wherewith we clothe our bodies and build our houses. Their suitability for these purposes depends upon peculiarities of structure and growth which it is the part of the botanist to work out and understand.

(3.) Plants supply us with many important drugs and medicines, with valuable perfumes and dyes, with the materials for tanning, and with much of our fuel. Their capability of being so used or not can in many instances be directly inferred from a knowledge of their botanical character and relations.

(4.) A knowledge of plant-life—of "What Plants Do, and How They Do It"—adds a ten-fold interest to the contemplation of the plants themselves. With such knowledge they cease to be merely the pretty things they were before, valued only for their beauty of form, or colour, or perfume; they become things in which we can take an intelligent interest, as being constructed according to some plan; as having everything about them with a meaning and a purpose; in short, as being so many manifestations of Creative Wisdom.

To understand fully all that is embraced in the life of plants would, of course, require a very lengthy course of study, even on the part of those of mature years, and with all the modern aids to assist investigation. But much may be learned from the mere observation of the most familiar plants, and we shall now proceed to show, in a very simple way, some of the facts which these are capable of teaching us.

4. THE BIRTH OF PLANTS.

The farmer, in order that he may obtain his crop, sows his seed. The dandelion and the thistle by the wayside, despite the farmer's wish, scatter *their* seeds broadcast by entrusting them to the winds, and again a crop is sure to follow. In all our woods, seeds in large numbers fall at certain seasons to the ground, and from them again, sooner or later, springs up a lot of young seedlings, some to grow again into trees, but a larger number to perish. So all ordinary plants spring from seeds, and this springing from the seed (commonly called *germination*) is the first obvious act in the plant's history.

Obtain now a number of seeds, as many as can readily be procured, and compare them one with another. Probably some will be large, others small; some heavy and others light; some of one colour and some of another; some smooth and others wrinkled or having various appendages attached to portions of their surface. But these are only outside differences. Amid them all this one fact remains, that each one, provided the seed is good, contains in the interior a living plant, which is at least capable of growth, and which will grow as soon as it is placed under suitable conditions. Even within the seed this little plantlet can generally be discovered, with its little stem and leaf or pair of leaves, but, from want of room and other causes, generally so crumpled up or otherwise mis-shapen that we are apt to overlook its true nature. Thus, even from the inspection of a few seeds, if attentively considered, we are led to recognize this important principle, that amid all the apparent variety of nature there is unity and harmony of design—one general plan which may be recognized amid an infinite diversity of detail.

These statements will find other and more interesting illustrations as we now trace the development of our seeds into full-grown plants.

5. THE GROWTH OF PLANTS.

Let the pupil take a number of such seeds as have been above named—those of the Bean, Pea, or Morning Glory will answer well—and sow them, a few of each kind, half an inch deep or more in clean sand placed in a small flower-pot or saucer, and to which a little water has been added. After an interval of two or three days let him repeat this process with other seeds of the same kind in other jars, and yet again a third time, after a similar interval. If in the meantime all the pots or saucers have been kept in a moderately warm place, and also kept moist, it will be found that by the time the seeds last planted begin to peep above the sand, those which were planted first will have attained a considerably greater growth, and thus, by comparison with the former, will enable us to ascertain in what that growth consists. To make the comparison more complete it will be well to have, in addition to the growing plants, a few actual seeds which have simply been soaked in water in order to soften them.

Now, if the pupil will take one plant from each of the jars which have thus been successively started, and place them side by side in the order of their growth, adding finally the unaltered seed as the starting point of the series, he will be in a position to recognize a number of things which, if he were to confine his attention to any one period, he would probably fail to see. Thus, in addition to the *fact* of growth, he may, if he cares to do so, form something like an estimate of How Long it Takes to Grow. He may see more clearly the *direction* of the growth. He may, by a few trials, see also what circumstances may promote and what may retard their growth. He will see, for example, how they turn to the light (that portion, at least, which is above the ground), and if he allow them, by carelessness, to get dry or to become chilled, he will be led to recognize their need of warmth and moisture. Finally—and this is a point to which he should pay especial attention—he ought to be able to see wherein, if at all, his more advanced seedlings differ from those which have but just sprouted, or even from the plantlet in the seed which has not yet sprouted at all. The growth of the same plants in gardens affords admirable opportunities for further profitable comparison. The culture of beans, acorns, or grains of corn, allowed to sprout and then suspended in tumblers or glass vases filled with water, also affords good illustrations of the subject.

Having now become familiar with the facts of growth in any one of the several kinds of seeds with which he started, if the pupil will further take the rows or series of specimens illustrating that growth, and place them side by side, he will be in a position to make further comparisons, and to see wherein one plant in its growth resembles or differs from another. By so doing he will again find, as he did in the comparison of seeds, that amid many apparent differences, there is one common plan; that, however unlike various plants may be in the rapidity of their growth, in their form or colour, they are composed of essentially the same parts, having the same relations to each other, and doing the same kind of work.

We have next to consider what these parts are.

6. THE PARTS OF A PLANT WHICH ARE CONCERNED IN GROWTH.

It will not be possible, nor is it desirable, within the limits of this little work, to describe in detail all the various parts of which a Plant consists, with their more minute structure and mode of operation. If, however, the practical experiments which have been above recommended have been faithfully performed, and the comparisons suggested by them have been carefully thought over, the pupil will probably have already learned for himself all the main facts of the case. He will, for example, have recognized in each of the plants examined an obvious distinction between that portion which remains beneath the ground and that which rises above it into the light and air. In the former he sees the Root, in the latter the Stem and Leaves; and though he may find when he begins to compare, as he should do, one stem and its leaves with another, or one root with another, very considerable differences, he will again find that among these seeming differences the main idea is never lost, and that Stem and Root respectively have certain constant features by which they may always be distinguished.

In the case of the Root or Roots (for even on the same plant there may be one or many) the first common feature is that of their downward growth. They seem to be attracted towards the earth and to avoid the light. In the second place they have no apparent regularity of growth, turning here and there without any obvious reason, and, though branching freely, having the branches also disposed on the root without order or symmetry. Finally they are wholly destitute of leaves. A little reflection will probably suggest that this, after all, is what might be expected; for, buried in the soil, a root is obliged to take its chance, and grow this way or that as circumstances may determine. Again, the roots being (as will presently be shown) the parts concerned in drawing up moisture from the soil, they will naturally turn or form branches wherever such moisture happens to be most abundant. But they have no leaves, for, even if they had, they would, underground, be of no service whatever.

In the Stem, on the other hand, we have, in most of our plants, at the beginning at least, a single upright shoot looking towards the sun and sky.

Along the sides of this shoot, and upon its summit, it is clothed with leaves, but these are found to be disposed with great regularity, either in pairs or one after another up the stem, so as to give to the latter the appearance (and it is more than mere appearance) of being composed of a succession of joints. If, now, we further compare together any one of our series of experimental seedlings, we shall see that the whole growth of the stem, from the beginning, consists merely of the successive formation of new joints, each one growing, as it were, out of the preceding one, and each having at its top a leaf or pair of leaves, which are necessarily left on the sides as new joints are formed above them. It would seem as though it were the object of the joints to *increase the number of the leaves*, and at the same time to place each of the latter where it shall have the greatest possible amount of light and air. And this is indeed the case; for it is the main purpose of leaves to digest the plant's food, and this they can only do when freely exposed to the warmth and light of the sun.

It may here be added that even if we extend our observations to plants of longer and larger growth, we shall find no different parts or organs concerned in that growth. A seedling Maple may, in time, become a tall forest tree; but whatever its size or age, its growth is merely a repetition of the same process, and is effected through the same organs — roots below and stem above, the latter bearing leaves on its newly-formed joints or twigs. It is true that in this and similar cases the original stem naturally sub-divides at quite an early period into what we call the branches, but these are evidently mere repetitions of the main stem, consisting of the same parts and growing in the same way. They may produce flowers also, but (as will be shown farther on) these are in no way concerned in ordinary growth, *their* purpose being the formation of seed, by which the plant is to reproduce itself.

Root, Stem, and Leaf, then, are the agents or organs of Vegetable Growth, and each has its own peculiar part to fulfil, — the root that of binding the plant to the soil, and of absorbing therefrom a portion of its food; the stem and branches serving to carry up this food to the leaves, which are at the same time spread to the light and air, and the leaves serving, under the influence of the sun's rays, to so change or digest this food as to fit it for the nourishment of plants and animals.

But Root, Stem, and Leaf are subject to numerous modifications, and are made to serve many other than their ordinary purposes, becoming, as a consequence, so disguised that we may at times have difficulty in recognizing them. As some of these modifications play a most important part in the life-history of the plant, a few of the more prominent may now be noticed.

7. VARIETIES OF ROOTS.

Let a pupil or a school devote a half holiday to the collection of Roots — entire ones in the case of the smaller plants, and portions of the extremities in the case of the larger. The specimens having been collected, place them side by side and compare them one with another. Such comparisons are very suggestive, and the student should endeavor, *for himself*, to find a meaning for all the differences which he sees. A few examples only can here be given.

(1.) **Roots Designed Mainly for Absorption.** These are usually thin and fibrous, branching freely, as they thus increase the number of points as well as the extent of ground available in the taking of food. They are especially common in annual plants, which have to do all their work in a single season.

(2.) **Roots Serving as Depots of Food.** Many plants do not become sufficiently mature to flower and form seed in a single year, but require two or more for the purpose. In these the root is often made a receptacle in which a portion of the food prepared in the first season is stored away under ground to be drawn upon for a second season's growth. Turnips and carrots are examples. What is food for the plant is food for man and beast as well. Hence the value of such root-crops in ordinary farming and gardening.

(3.) **Roots Serving as Holdfasts.** This is to some extent the case with all roots, but besides those which grow directly downward from the seed, other roots are often seen higher on the stem which would seem to have this as a more special office. It is to some extent the case with the roots developed from the second or higher joints of the stem in common Indian corn, when earth is heaped up around the latter, and so it is in many vines and trailing plants; but there are other cases, like that of the English Ivy, in which this would seem to be the sole purpose, the whole stem being thickly covered with little rootlets by which the plant is enabled to cling for support to various objects, and thus to reach heights which would otherwise be unattainable

8. VARIETIES OF STEMS.

The Stem, as might be expected, presents a much greater number of varieties than does the Root. They may be studied in the same way by the collection of as many different kinds as can conveniently be got, and then, remembering what has been said of the proper nature of the stem and its mode of growth, endeavoring to recognize that nature amid all the possible variations. These all have their purpose, and to seek it out in each special case is a most entertaining study, but our space will only allow us to mention a few of the more striking examples.

Stems, then, differ in *length*, from that of the tiny seedling to that of the tall forest tree, and with increase of length there is generally, but not always, increase of breadth, thus giving the necessary strength. Stems differ in firmness and solidity; some, like our ordinary herbs, being soft, juicy, and easily injured or destroyed, while others, like our shrubs and trees, are *woody* and not so readily affected by outside influences. Even among woody plants great differences exist, as seen in the contrast between our hard and soft woods, and the uses to which they are applied. Again, stems differ in *duration*, those of herbs either dying altogether at the end of the summer, after the seed is ripened, the plant being then an *annual;* or dying down to the surface of the ground, as in many ***biennials*** and ***perennials***. They may differ also in the method and extent of their branching, some (like our Spruces) sending off only small side branches, while the main trunk continues to grow upward like a spire, or (as in Elms and Willows and Maples) the main stem may, at no great distance from the ground, lose itself in the branches. Stems, again, differ in *position* and *direction of growth*, some being wholly above ground and standing erect, or nearly so, while others, like those of Mayflowers and Strawberries, recline or lie prostrate on the ground. They may even lie below the ground, in which case they are apt to be mistaken for roots, as in the subterranean stems of Couch Grass, Mint, etc. In the latter instance they are often used, as was the case with some true roots, to serve as depots of food, and become greatly thickened as the latter is deposited in them. Some varieties of *bulbs*, and what are known as *tubers*, as in the case of the common Potato, are thickened stems of this sort. In the case of underground stems, the leaves borne by them are generally only in the form of small and useless scales, but the presence of the latter, with their arrangement on the stem, and the occurrence of buds developing into leafy branches, usually remove all difficulty in recognizing their true character.

The only other kind of difference presented by stems which can be here referred to is one connected with their interior structure, and which results from their different modes of growth. To understand the difference, cut with a sharp knife a slice from off a stem of Indian corn, a Lily, or a Grass, and then a second similar slice from a young Beech, Maple, Willow, Grape Vine, or Elder. In the latter case, as every one knows, there will be revealed to view a separable *bark* on the outside, enclosing one or more layers of wood, and, it may be, a quantity of soft *pith* in the centre. The cut end of a cord-wood stick exhibits similar rings still more strikingly, and in very old trees they may be very numerous. In the plants first named, on the contrary, there is no distinct bark, nor is there any very distinct wood; for, though the latter is really present, it is so scattered in irregular bundles, here and there, that some search is required to find it. Now it has been found that plants possessing these two different kinds of stems differ quite as markedly in the character of their leaves, in the nature of their seeds, and in the peculiarities of their flowers, and hence the distinction is of much importance in the grouping or classifying of plants. The figures and explanations of Plates II. and III. will serve to make these differences more intelligible.

It may be well in this place to observe, further, that if our ordinary powers of vision be assisted by the aid of a strong magnifying glass, or, still better, by a good microscope, such a view may be obtained of wood, pith, and bark (as well as of other parts of the plant), as will serve to show more clearly their real nature and relations, as well as to give a better understanding of the processes by which vegetable life is carried on. Whatever be the part taken, such an examination, by means of a thin slice sufficiently enlarged, will show that it is not, as we might suppose, absolutely dense and solid, but is really made up of a vast multitude of little cavities, each bounded by its own proper walls, and which are variously associated together, as they also present many differences of form and size. These cavities are known as *cells*, and the masses formed by their association as *Cellular Tissue.* In the case of pith the cells are either round or, by mutual pressure, many-sided, looking much like honey-comb, while they are at the same time thin and easily destroyed. Similar tissue forms also the edible portion of ordinary fruits. In wood, on the other hand, many of the cells are found to have been lengthened into tubes, and these being arranged side by side, spliced together, as it were, as well as thickened, help to give strength to the rising stem, as they also serve to form the fibrous framework of the leaf. It is from differences of this kind that we have the familiar distinctions of "Hard" and "Soft" Woods, of Sap Wood and Heart Wood, etc., as well as the adaptation of each kind of wood for some particular use. Finally, cellular tissue may, in certain cases, become so dense and thick as to acquire almost the solidity of stone. This occurs in the so-called Stone Fruits, as the Cherry and Plum, and again in the outer portion of nuts.

9. VARIETIES OF LEAVES.

Let the student again collect as many different varieties of leaves as he can conveniently find. The mere search for such varieties can hardly fail to suggest many instructive comparisons. The leaves having been collected and arranged before him, let him then endeavour to see what they have in common, and wherein they differ. One part, the Blade, he will be pretty sure to find in all, it being the most important part of the leaf, and, as evident from its form, so constructed as to expose to the sun's rays the greatest possible extent of surface. In many he will find a second part, the leaf-stalk, by which the Blade is attached to the stem, and he *may* find a third in the form of two little appendages, often resembling miniature blades, and attached at the base of the leaf-stalk on either side. These are the parts of which a complete or pattern leaf consists; but now for some variations of the pattern.

In the first place there may be variations due to *incompleteness.* The leaf-stalk, for example, not being absolutely necessary, may be very small or (with the appendages at its base) may be wanting altogether. Secondly, in the blade itself there may be an endless variety of *form* and *size.* Thirdly, there may be great variety of *colour.* The prevailing tint is, of course, green; but, as seen in many foliage plants, and again in our autumnal woods, leaves often assume colours almost as rich and varied as those of flowers. Fourthly, they may differ in their *veining; i. e.*, in the way in which the delicate little tubes or *veins* of the leaf, forming its more solid framework, and serving to carry through it the sap which it digests, are spread through the blade. In those plants which possess a true bark and rings of growth, these veins generally branch irregularly through the blade, much like the veins of our own bodies, while in grasses, corn, lilies, and similar plants not possessing a bark, they commonly run parallel from one end of the leaf to the other. Finally, leaves differ through being employed for various and unlike purposes. Their ordinary purpose, that of assisting the plant in the processes of digestion and breathing, is best effected by having the leaves broad, thin, and delicate; but leaves, like roots and stems, may be thickened by having nourishment temporarily deposited in them, as in ordinary Onions and most bulbs; or they may become thin, narrow, and flexible, as in some *tendrils*, then enabling the plant to *climb;* or they may become hard and woody, as in the outer leaves or *scales* of buds, when they serve to protect the more delicate leaves within.

It will be of service to the pupil at this point to look again at his series of experimental plants, and, beginning with those which have attained the largest growth, to trace the parts of which they are composed backward through the different members of the series to the earliest seedling. If he does this carefully, and notes how the parts, without altering their essential character, become reduced in size and number, he will probably have no difficulty in tracing the succession even into the seed itself, and of thus proving what has been before stated, that a true plant with stem and leaf (or leaves) actually exists in the latter, even before it begins to germinate and grow.

So, also, he may with advantage compare one of the leafy twigs formed early in the spring on many of our common shrubs and trees with some of the still unfolded buds on other parts of the same plant. He will thus see that a Bud is nothing but an undeveloped stem or branch, thickly clothed with leaves, which, as the branch grows, simply separate from each other by the lengthening of the joints, at the same time that the leaves expand to their full size. So the seed may be regarded merely as the first bud, compacted and protected by external coatings, so that it may remain uninjured until its life is awakened by suitable conditions.

10. THE PARTS OF PLANTS WHICH ARE CONCERNED IN MULTIPLICATION.

The Root, Stem, and Leaf, which have so far engaged our attention, have been described as concerned in *growth* only, and as being the only parts or organs actually needed for this purpose. But sooner or later in the life of all ordinary plants* these are found to produce what seem to be new parts in the form of *Flowers*, which by a process of ripening become converted into *Fruits*, within which again are contained the *Seeds*. As the seed contains a new plant which may grow independently of that which produced it, we may regard such Seed, with the Fruit which holds it, and the Flower, out of which the seed was formed, as *Organs of Multiplication or Reproduction.*

Before considering these organs further, it will be well here to draw the attention of the pupil to the fact that the ordinary stems and branches may and often do serve the purpose of multiplication. For example, nothing is more common than to multiply such plants as common Geraniums by slips or cuttings; *i. e.*, by portions of stem, bearing leaves, and which, when placed in water or damp earth, grow into new plants. So strawberry plants, by sending out long slender branches or runners bearing a bud at the end, and there

*No account is here taken of certain forms of plants, such as Ferns, Mosses, Lichens, Sea-Weed, Mushrooms, etc., which never form true flowers. The beginner will do well not to attempt their consideration until more familiar with higher forms.

striking root, soon spread over large areas, and sooner or later become independent plants. Finally, the great difficulty met with in exterminating such weeds as couch grass from our gardens arises from the fact that their underground stems, full of abundant nourishment, branch in all directions, and each being largely independent of all others, each will grow into a new plant and throw out more branches, even if all the other parts shall have been destroyed. The sowing of potatoes, in which the so-called *eyes* are nothing but little buds on a greatly thickened piece of stem, is another illustration of similar facts. But it would seem as though plants could not indefinitely multiply in this way. By doing so they are likely to become weakened and would eventually be destroyed, so that, sooner or later, we have to come back to the other method, through the formation of Flower, Fruit, and Seed.

11. THE FLOWER AND ITS VARIETIES.

Flowers may be studied in the same way as roots, stems, and leaves. Let some comparatively simple flower—that of a Geranium (so called), the Flax Plant, the Rose, or the Apple will answer well—be first taken and carefully examined as to the parts of which it consists. These will be found to be, (1) on the outside a circle of green leaves, smaller, it is true, than the ordinary leaves of the plant, but not unlike them in colour and appearance. These are known under the name of *Sepals*, and together they form a sort of cup around the rest of the flower, which is known as the *Calyx*. Next within them is another circle, also composed of parts which are somewhat leaf-like, but much more delicate than any ordinary leaves, and either pure white or, like the leaves of many foliage plants already referred to, possessed of some gay and brilliant colour. These are the *Petals*, and together they make up the showy part of the blossom, called by botanists the *Corolla*. If these be in turn removed, we find, standing just inside of them, a number of curious organs, which seldom bear much resemblance to leaves (though the botanist still regards them as representing the latter), and which are more especially concerned in the formation of seeds. Of these the outer ones, known as *Stamens*, consist of a long narrow stalk (*filament*), bearing upon the top a sort of sac or case (the *anther*), from which, if the flower is ripe, there will fall, when shaken, a yellowish powder, known as *Pollen*. The inner ones, on the contrary, which are known as *Pistils*, and which occupy the very centre of the flower, are usually largest below, forming a second sort of sac (the *Ovary*), usually larger than the anthers, and having within it what appear to be small seeds, and which will really become so if in any way the pollen shed from the anthers can reach and act upon them. To facilitate this the upper part of the pistil is usually lengthened out, and either on its top or side is left bare and moist, so that the pollen grains (either falling by their weight, blown by winds, or carried by insects), if they happen to touch it, readily cling, and thus gain access to the interior. As soon as the ovules have been acted upon by the pollen, the office of the flower has been accomplished, and soon after all parts of it, except such as are needed for the protection of the seed, fall away and perish. Those which remain, however, become greatly changed, and these changed portions, with the seed which they enclose, eventually become the Fruit.

The varieties of flowers are almost endless, and no more interesting or delightful study can be engaged in than that of tracing out the one common plan amid this infinite diversity of detail. The total number of flowering plants now known to botanists will not fall far short of 120,000, yet in every one of these the only parts present will be one or the other (or all) of those which have been referred to above, and which, by sufficiently careful study, may be recognized and distinguished. The variations are due to a number of causes, a few only of which can here be mentioned.

Differences may arise, (1) from unequal growth in the several parts of any one circle, producing corresponding *irregularity* of size and shape, as in Violets and Pansies; (2) they may arise from the total failure of certain parts to grow, thus interfering more or less with the *symmetry* of the blossom; (3) they may arise from the disappearance or *suppression* of entire circles, three, two, or only one, being sometimes left, as in some Maples and in Indian Corn; (4) they may be due to the growing together or *union* of the different members of any one set or circle, as in the calyx of Fuchsias or the corolla of Bluebells; or (5 those of different circles, as the petals with the stamens (Morning Glory), or the calyx with all the parts within it, as in the Apple or the Hawthorn; (6) they may differ in the interior structure of the ovary, and in the number and arrangement of the seed-like bodies (ovules) which it contains, but for the examination of these a good magnifying glass is required; lastly (7)

flowers differ in their mode of attachment and distribution
stem, sometimes occurring singly, sometimes in numbers; so
wide apart, but more commonly clustered; sometimes wi
sometimes without little stalklets of their own. All of th
features are pretty constant, not only in individual plants, b
in whole groups of plants, and are among the means by wl
recognize their family relationships.

12. FRUITS AND THEIR VARIETIES.

The parts of a flower which are commonly lost in the F
the Corolla and the Stamens, these having served their purp
perished. The Calyx may also disappear, but it commonly r
giving a degree of protection to the parts within, and is su
so where, as in the Apple, it has grown into union with th
The latter, however, is the essential part of the Fruit, a
ripening, becomes a seed vessel, in which the seeds are matu
this process various changes take place, determining as man
ent varieties of fruits, but only a few of the more common c
be indicated.

In ordinary berries (such as currants and cranberries) we
seed vessel or ripened pistil, which is soft and fleshy throug
is also the case with tomatoes and grapes. Oranges and le
similar, only here the outer portion forms a thick and leathe
which becomes still harder in cucumbers, pumpkins, and
In stone fruits, on the contrary, such as the cherry, plum, and
it is the inner part which becomes hard or "stony," while t
portion becomes soft and edible. In our common *grains*
rye, Indian corn, etc.) the whole fruit becomes dry, the seed
here also clinging closely to the seed. It is much the san
nuts, only here, as in chestnuts, beechnuts and the like, the
free within. The seeds are also free in ordinary pea-pods, or
the seed vessel, when ripe, splits down one side, and thu
something like the leaf of which it is really only an alter
In the scales of a pine-cone, which are also ripened pistils,
quite numerous and crowded together, this resemblance to o
leaves is still more evident. Where the calyx remains as a
of the fruit, it may also form the larger part of it, as in th
portion of apples, pears and quinces, where it surrounds a
core within, containing the seeds. Finally, much of what

the fruit (though it is not properly so called) may be only thickened stem, with the true fruits resting upon or imbedded in it. The strawberry furnishes the best illustration of the latter kind.

13. SEEDS.

The general nature of seeds, and some of their differences, have already been pointed out. (See page 44.) It only remains to say a few words here as to the means of their dispersion, and the conditions which determine their growth, or otherwise, when once spread abroad. Their escape from the seed vessel may be effected either by the splitting of the latter or by its decay, and sometimes the very act of thus opening, if sudden, may serve to jerk the seed to considerable distances. More commonly this is effected by the agency of the winds, and to facilitate it many seeds are furnished with tufts of hairs, as in Milk-weed, or long woolly hairs, as in Cotton-plant, or by various other contrivances. In many cases, however, as in Dandelions, Thistles, and similar plants, these appendages are attached to the fruit, *i. e.*, the ripened pistil, rather than to the seed.

The subsequent growth of the seeds will depend upon a variety of causes, as, first, upon the length of time they have been kept. Good seeds will, in some instances, retain their vitality for many years, but the period is usually quite limited. Even when good, their growth will usually require for its beginning a certain amount of warmth and moisture. It may also, to some extent, be affected by the presence or absence of light. But once started and brought up to the surface by the employment of the materials which the mother-plant has provided for its use, it now enters upon a career of its own, rising higher and higher above the ground, developing more and more joints of stem, and more and more leaves, as the roots, simultaneously produced below, continue to supply it with more and more material for the purpose.

14. THE FOOD AND WORK OF PLANTS.

This brief review of the life of plants may now be closed with a very few words as to the sources from which their food is derived, the way in which this is worked up by the plant into its own substance, and a few of the products which are thus formed.

PLANTS DERIVE THEIR FOOD MAINLY FROM THE MINERAL WORLD. — Of the substances thus taken, one of the most abundant is Water, as indicated by the necessity for the frequent watering of plants, the effects of prolonged droughts, and the entire absence of vegetation in rainless regions. But with this water various other mineral substances, in a state of *solution*, are taken in as well. These include compound of soda, potash, lime, iron, etc., which are found in the ash when the plants are burned, and sometimes so abundantly that wood-ash is a common source of *lye* or potash. Of course these mineral substances can only come from the soil, and their presence or absence in the latter may determine the difference between a good soil and a poor one. Hence the importance, in some cases, of supplying the deficiencies of the soil by the addition of suitable manures. Hence, also, the importance of various well-known agricultural operations — such as ploughing, harrowing, fallowing, etc. — which have for their object the speedy restoration (by the action of the atmosphere chiefly) of the fertility of soils which may have been impaired by excessive cropping. As different crops require different forms of mineral food, an obvious advantage is sometimes attained by a judicious "rotation" of crops.

Another mineral substance absolutely required for the growth of plants comes mainly from the air, and is known as carbonic acid, being one of the substances formed when coal (or carbon) burns.

A few plants possess the power of capturing and using animal food, such as insects and the like, but though very curious, they are exceptional, and cannot be further noticed here.

PLANTS TAKE IN THEIR FOOD MAINLY BY THEIR ROOTS AND LEAVES.—This is obvious, as regards the roots, from what has been already stated. Any common garden plant plucked up by the roots during the active period of its growth soon begins to wither or decay. That the leaves are concerned in the same process is not so obvious, but yet the fact is one which has been placed beyond all question.

PLANTS TAKE IN THEIR FOOD BY MERE ABSORPTION OR SOAKAGE.—The surfaces of plants, so far, at least, as the stems and roots are concerned, exhibit no openings by which food may be introduced, and though, in the case of leaves, when highly magnified, they are found to contain numerous little apertures, chiefly on the lower side of the leaf, these are merely the openings of little tubes or winding passages by which (as in the case of our lungs) air is freely carried into the interior of the leaf. Nothing of the nature of true mouths is found in either. But openings are not required where the food consists simply of liquids and gases. It may and does pass in by simple soakage, much as water would pass through paper.

PLANTS ARE NOURISHED BY THE CIRCULATION OF THE SAP.— The food, as we have said, passes in, but into what? As there are no mouths, so (in ordinary cases, at least) there is nothing of the nature of a stomach. There are not even cavities or tubes visible to the eye. But just as water spreads through paper (itself a vegetable substance), so it spreads with ease through the material of the root, and from the root to the stem, and finally from the stem to the leaves, meeting there with other food which may have been imbibed more directly from the air. In the leaves much of the water which has been concerned in this process (the rise of the sap) passes off into the air, but a portion of it is retained, and out of it, in connection with carbonic acid, a variety of new products are formed, which are now suited, as the original or raw sap was not, to supply the plant's wants. These products are only formed in the leaves, and there only under the influence or through the power of the sun's rays. But it is not in the leaves that the material is required. It is needed elsewhere, either to be used for immediate growth, or, where occasion requires, to be stored up for future use. In the one case it is carried directly to the growing parts (chiefly in the form of mucilage and sugar), and there employed; in the other, as we saw in previous pages, it is carried to some place, root, bulb, tuber, bud, or seed, and deposited in a form (chiefly that of starch) in which it will be removed from ordinary sources of injury, and not be liable to change until it is again needed by the plant itself. The employment of common potatoes and wheat as sources of starch, and the similar employment of sugar cane, beet root, and maples as sources of sugar, are good illustrations of the facts above stated. So the sweetish taste of potatoes which are beginning to sprout, the similar change of hard (*i. e.* starchy) unripe fruit into what is soft, mellow, and sweet, or, on the other hand, the formation in certain portions or kinds of fruit (nuts, etc.) of very hard material, show the readiness with which the plant converts one of these substances into another as need may arise. By what power the plant effects these changes we do not know, any more than we do how the sap is directed from the roots to the leaves, and from these back again to the roots or other parts. It is simply one of the faculties which plants possess as *living beings.*

Having now learned something of the nature and life of Plants, we may proceed to notice very briefly those forms which, occurring within our own Province, may, in one way or another, be regarded either as serviceable or as a source of injury to its inhabitants. In so doing we may at the same time learn something further of their botanical relations.

The Useful and Hurtful Plants of New Brunswick.

SERIES I. FLOWERING PLANTS.

All the plants of this series are possessed of true flowers, containing stamens and pistils, and forming true seeds; *i. e.*, seeds having within a true, though usually minute plantlet, or embryo. As these latter differ, however, in possessing either two or only one seed-leaf, so the whole structure and mode of growth of the plants springing therefrom present corresponding differences, and lead to the subdivision of all flowering plants into two great groups or classes, the Outside Growers (or Exogens), and the Inside Growers (or Endogens).*

Class I. Exogens.

The plants of this group possess two seed-leaves in the embryo, and in growth form stems embracing a true bark, wood, and pith, the wood increasing by annual zones or rings on the outside next the bark. (See Plate II., and Page 50). The leaves are *netted-veined; i. e.*, their veins form an irregular network, and their flowers have the parts usually arranged in *fours* or *fives*.

In the greater portion of the group, the seeds, while ripening, are enclosed within and protected by an external covering or "seed vessel" (either a berry, pod, nut, or core), but in the Pine Family the seeds remain uncovered, being borne upon the inner side of the scales of cones.

Again, while many plants have flowers in which all the several parts are present, and the leaves or petals of the corolla quite distinct and unconnected, in many others these are more or less united into one piece, while in others again they are wholly wanting. These characters are taken advantage of in the further classification

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* For the features of the latter group see page 73.

of plants. In the following groups, forming the natural orders or families of the Vegetable Kingdom, the first thirteen, as far as and including the Witch Hazel Family, have both calyx and corolla, the petals being at the same time distinct. They are therefore termed *Polypetalous*, or Many-Petalled Flowers. The next seven, from the Honeysuckle to the Mint Family, inclusive, usually have the petals more or less united into one, or are *Monopetalous;* while after these are a number of other plants in which the corolla, and often the calyx as well, is wanting, they being therefore known as *Apetalous*. These all have flowers with covered seeds. The naked seeded plants include in this part of the world but one family only—that of the Pine and its relatives—often known as Cone-bearing Plants. The various families of Flowering Plants may accordingly be arranged as follows:

SUB-CLASS 1. PLANTS WITH COVERED SEEDS.

DIVISION I. POLYPETALOUS PLANTS.

CROW-FOOT OR BUTTERCUP FAMILY.

The most familiar representative of this family is the common Buttercup. To it belong, also, the Clematis or Virgin's Bower, the Anemone, the Goldthread, and the Columbine. With the possible exception of the Goldthread, whose yellow bitter roots are sometimes employed in curing sore mouths of children, their value rests solely in their beauty. From an agricultural point of view, buttercups can only be regarded as weeds. The Aconite or Monkshood, often cultivated in gardens, and the Baneberry of our woods and meadows, are noticeable as dangerous poisons.

WATER-LILY FAMILY.

Water-Lilies have no direct utility, nor can they be regarded as noxious. As the ornaments, however, of our inland lakes and streams, they well deserve a passing notice. Yellow pond lilies are common everywhere. The far more delicate, beautiful and fragrant white lilies are less frequently met with.

MUSTARD FAMILY.

The members of this family, of which the wild Mustard may be taken as a type, are, so far as our native species are concerned, noticeable only as noxious weeds. This is seen in the Wild Mustard itself, and again in the common Shepherd's Purse of the gardens.

Introduced and cultivated forms are, however, of more value; including, as they do, Nasturtiums or Water-Cresses, Cabbages, Turnips, Mustard, and Radish.

VIOLET FAMILY.

The Violets are valued only for their beauty. There are several kinds, of which some are common and others rare. To the same family belongs the Pansy of the gardens.

PINK FAMILY.

The wild members of this family, including Corn-cockle, Chickweeds, and the like, are noticeable only as troublesome weeds. The cultivated members include the Pinks and Carnations of the gardens.

LINDEN FAMILY.

Two kinds of Linden or Lime Trees exist in New Brunswick; viz., the American and the European. Both are handsome trees, with tall trunks, branching freely, and densely clothed with foliage, making them admirable shade trees. They are also noticeable for their conspicuous flowers and fruit. They are, however, apt to be infested with insects, which often lead to their premature decay. The native species is far from common.

The wood of the Linden, sometimes known as Basswood and Whitewood, is of considerable value, being soft, white, and of a fine close grain. It is also very tough and pliable, with little tendency to split from change of temperature, and is hence largely used for making the curved fronts of sleighs, panels of carriages, etc. It is also used by stair-builders. It is readily carved and turned, and has been employed in the making of figure-heads of vessels, also in domestic utensils.

Its inner bark is tough and fibrous, and hence adapted to the manufacture of rough cordage, but is not often so used here.

THE VINE FAMILY.

We have apparently but one native species of Vine, the Winter or Frost Grape. It has been observed at a number of localities along the St. John River and its tributaries, but in the wild state is far from common. It is often cultivated for the shade which it affords to arbours and verandahs, as well as for its fruit. The latter is small, with a tough skin and decidedly acid flavour, but yields a juice from which may be obtained a wine which to many is not unpleasant.

CASHEW FAMILY.

The representatives of this family in the Province are the Sumach and the Poison Ivy. The former is not uncommon along the borders of fields and gardens, where its leaves and fruit, especially in autumn, are quite conspicuous and ornamental. Its bark and leaves are also said to be serviceable in tanning. The Ivy, on the contrary, is a plant to be mentioned only as one to be avoided: its long vines, creeping over rocks or climbing upon trees and shrubbery, being highly poisonous to the touch, though more so to some persons than to others.

THE MAPLE FAMILY.

Five kinds of Maples are to be found in New Brunswick, four of which are common. Of these the most valuable in every way is the Rock or Sugar Maple. Not only is it a majestic tree, beautiful alike in form and foliage, and serving admirably the purposes of shade or ornament, but its wood is also one which is highly esteemed. Hard, dense, and compact, it takes readily a high polish, and in the several varieties of Curled Maple, Birds-Eye Maple and others, is highly valued for interior decoration, especially of railway carriages. As fuel its value is unequalled. The Rock Maple is also the source from which maple sugar is obtained, holes being bored for this purpose into the trunk, and the liquid sap which escapes being boiled down until it assumes the sugary condition. Large quantities of such sugar are annually manufactured in the County of Madawaska, and but little of any other kind is there used.

The Red or Swamp Maple is next in importance to the Rock Maple, but is usually of smaller size, and with a wood which is weaker and less durable. It is, however, capable of being readily turned and polished, and finds useful application in the making of furniture. It is also sometimes used in house-building. Similar remarks apply to the rather rare White or Silver Maple.

The two remaining varieties of Maple; namely, the Striped Maple and Mountain Maple, are both much smaller, not often exceeding a height of fifteen or twenty feet, and, though not devoid of beauty, are of no special interest. The Striped Maple is sometimes known as Moose-wood, it being said to be the favorite food of that animal.

The cultivated Horse-Chestnut is closely related to the Maples.

THE PEA FAMILY.

The members of this family, one of the "royal families" of plants, are readily distinguished in most cases by the resemblance of their blossoms to that of the Common Pea, and of their fruit to an ordinary Pea-Pod. Their most important representative, next to the Pea itself, is the Common Clover of our fields, so highly valued both by bees and cattle. Locust Trees, frequently planted for ornamental purposes, belong to this group, as do also the different kinds of Vetch, often found in gardens and trailing over bushes along river banks.

THE ROSE FAMILY.

The characters of this family are well exemplified in an ordinary Rose, but it embraces also many other forms which differ widely in size and general appearance.

Among these we have first the different varieties of Cherries, of which several kinds (the Dwarf Cherry, the Wild Red Cherry, the Choke Cherry, and the Wild Black Cherry) are found in the Province. With the exception, however, of the Black Cherry, whose wood is sometimes used for cabinet work, they possess but little value. Choke Cherries are prized by children, but, especially if not quite ripe, at the risk of stomachal disorder.

Next to the Cherries stand the Thorns, or Hawthorns, noticeable alike for the feature to which their name alludes and for their bright red berries in autumn. There are two species, both of which are often employed for hedging. A related tree is the Shad Bush, or Service Berry, of common occurrence in the Province, and which is quite attractive, but has not as yet been brought under cultivation.

Still another tree, belonging to this family and valued for ornamental purposes, is the Mountain Ash. It favours low, cold and moist ground, but will grow almost anywhere, and is often cultivated for the beauty of its foliage and its groups of bright red berries. The common Apple and the Pear also belong here.

Besides the above-named trees, the Rose family includes a number of important Berries, including the Strawberry, the Raspberry, the High and the Low Blackberry or Dewberry, and the Swamp Blackberry. Of these, by far the most abundant as well as the most valuable, are the common Strawberry and the Raspberry, which abound in all parts of the Province, and especially about newly-cleared settlements. In the peat bogs of St. John and Charlotte counties, especially near the coast, a little berry known as the Cloud Berry occurs abundantly, and, under the designation of Baked Apple, is highly prized for the making of preserves. The Thimble Berry, found in some parts of the Province, is also a delicious fruit.

Three species of Rose grow wild in New Brunswick in addition to the Sweet Brier, which is common about gardens. In the valley of the upper St. John the banks of intervales and islands, during the latter part of July, are often gay with the blossoms of the Early Wild Rose.

CURRANT FAMILY.

This family embraces both the Currants and the Gooseberries, of which several varieties grow wild in the Province. They are, in some instances, not unpleasant to the taste, and may be advantageously used, either alone or with other fruits, in the making of preserves, but are greatly inferior to the cultivated varieties.

THE WITCH-HAZEL FAMILY.

The Witch-Hazel deserves mention, partly as being worthy of cultivation as an ornamental shrub, and partly as being the plant from which wood is often sought for the manufacture of the so-called "mineral rods," sometimes used in the search for water, precious metals, and the like. As the practice of using such rods still prevails in some portions of the country, it may not be out of place here to say that, for the purpose referred to, they have, and can have, no value whatever.

DIVISION II. MONOPETALOUS PLANTS.

HONEYSUCKLE FAMILY.

This family embraces several flowers which are deservedly esteemed for their beauty, including the fragrant little Twin Flower, several varieties of Honeysuckles, some of which may be used for hedging, and the two kinds of Elders, as also the High Bush Cranberry. The latter is not a true Cranberry, but its large red and handsome berries have a flavour not altogether unlike the latter, and are regularly brought to market in considerable quantities. In its cultivated state this plant is the Snowball of the gardens.

HEATH FAMILY.

The true Heaths are wanting in New Brunswick, but many members of the family are found here, some of which are valued for their flowers and others for their fruit. Among the former stands out prominently the well-known Mayflower, the much-prized and beautiful harbinger of spring; also the different species of Laurel, Rhododendron and Labrador Tea, which, blossoming almost simultaneously, for a few weeks in spring, add such a richness of red and purple colour, mingled with white, to the surfaces of bogs and swamps.

Of the fruit-bearing species, the most important are the Cranberry and the Blueberry. Cranberries grow in great abundance in peat bogs and marshes near the coast, and thousands of bushels are annually gathered there. Blueberries are also common on rocky and swampy tracts. Winter-green berries may also be mentioned here as affording a familiar flavoring extract.

THE ASTER FAMILY.

This family, as represented in a wild state, embraces but few useful forms, but is worthy of mention as embracing many which, owing to the ease and rapidity of their multiplication, are apt to become pernicious weeds. Pre-eminent among these stand the different kinds of Thistles, which, once that they have gained a foothold, are found so difficult to eradicate. Here, also, belong the Ox-Eye Daisies, Burdock, Fire-weed, and the Yarrow, all common weeds. Here, too, belong the Dandelion, the Michaelmas Daisy, and the Golden-rod, though in these latter cases the beauty of the flowers make some atonement for more objectionable qualities. Dandelions are also valued for "greens." The Thoroughwort, common along streams, has some useful medicinal qualities; as have also Arnica, Chamomile, Wormwood, and Tansy, all members of the same family. The common Sun-flowers of gardens also belong here. In all the plants of this family what seem to be single blossoms are in reality composed of many flowers, closely clustered into more or less dense heads, and by this feature, among others, the members of the family may generally be distinguished.

OLIVE FAMILY.

This family is represented in New Brunswick only by the Ash, of which two species are common. Of these the most valuable is the White Ash, which is found in most parts of the Province, and forms, under favorable circumstances, a tall tree, fifty or sixty feet high. It is most abundant in rich loamy woods, and in the vicinity of streams. Its wood is strong, tough and elastic, and is extensively employed by sleigh and carriage makers, as well as in the manufacture of furniture and agricultural implements. It is well adapted for the making of oars.

The Black Ash is a less valuable tree, but still yields a wood possessing remarkable toughness, strength, and durability. It has been employed to some extent in the manufacture of furniture, in the panelling of railway cars, and largely in the construction of sleighs and pungs. It is generally employed by the Indians in the making of basket-work. It may be seen in great quantities along the borders of the larger streams which are tributary to the upper St John.

CONVOLVULUS FAMILY.

The plants of this family deserving mention here are the Hedge Bind-weed, often called Convolvulus, and the Dodder. The former is noticeable for its handsome and conspicuous flowers, to be seen in great numbers along the banks of the St. John, and often cultivated for ornament; the latter only as a worse than useless weed, destitute of any foliage of its own, but twining its long yellow and leafless stems around those of other plants, and living at their expense.

The common Sweet Potato is the imported root of a plant of this family. The ordinary Potato, on the other hand, is not a root, but the greatly thickened underground stem of a plant of the nearly related Night-shade family. Tobacco is composed of the dried leaves of a plant of the Convolvulus family. Red or Cayenne Pepper is also derived from the same group.

FIGWORT FAMILY.

This group is noticeable only as containing several very common weeds. Among them may be mentioned the Mullein, the Toad-flax or "Butter and Eggs," several kinds of Veronica or Speedwell, and the Yellow Rattle. The latter has spread widely through the southern counties, giving a yellow colour to the fields, but is rarer in the interior.

MINT FAMILY.

The members of this large family, embracing only herbs, are usually readily recognized by their square stems, opposite leaves, and the two-lipped character of their flowers. Among them the Mint itself is one of the most common, to which may be added the Catnip, which sometimes escapes from gardens, and both of which are valued for their medicinal properties. Here also belong several weeds, such as the Brunella or Heal-All, common in field, and pastures; the Hemp-Nettle, equally common, and the Motherwort.

Among cultivated plants the Thyme, Marjoram, and Summer Savory, all valued for culinary purposes, belong here.

DIVISION III. APETALOUS PLANTS.

The flowers in this group are without petals, the flower-leaves, if present, representing the calyx, but often wholly wanting.

BUCKWHEAT FAMILY.

The only important member of this family is the Buckwheat itself, one of our most valued and reliable crops. The other, or wild species, including several kinds of Polygonum, and the Dock or Sorrel (Rumex), are only pernicious weeds.

ELM FAMILY.

As an ornamental tree the Elm has probably no equal among the native trees of the Province. Growing to great heights, branching freely and gracefully, and often feathered with drooping branchlets, it is a conspicuous feature in the landscape wherever it occurs. It is especially noticeable about islands and intervales, and much of the beauty of the St. John river valley is due to the many fine specimens of Elms which skirt its banks. Trees are occasionally met with girthing twenty feet. On uplands it is comparatively rare, and is wanting where the soil is poor.

The wood of the Elm is strong and elastic, and is used to some extent in connection with the furnishing of ships; but owing to peculiarities of grain, is somewhat difficult to work.

The Nettle, a pernicious weed, well known for its stinging properties, is, though only an herb, nearly related to the Elms. The cultivated Hop and Hemp also belong here.

WALNUT FAMILY.

The sole representative of this family in New Brunswick is the Butternut, and this is found only in certain portions of it, including parts of the southern counties and the valley of the St. John, especially above Woodstock, where it often forms beautiful groves.

The wood of the Butternut is highly esteemed in cabinet making and for purposes of interior decoration, having a rich reddish-yellow colour, which deepens with age, and bears some resemblance to that of the English Oak. It is especially well fitted for the interior of churches, and has been so employed in the Cathedral at Fredericton and elsewhere. It is also valued, owing to its lightness and durability, for the making of carriages. The young nuts are often employed in the making of pickles.

OAK FAMILY.

The chief members of this family in the New Brunswick woods are the Red Oak, the Beech, the Hazel, and the Hornbeam, known also as Iron-Wood and Lever-Wood.

The Red Oak is a rather common tree to be found in most parts of the Province, and, owing to the beauty of its trunk and foliage, deserves a place among ornamental trees. Its wood, however, is of little value. White and Grey Oak also occur at a few points, but are comparatively rare.

Lumbermen and others distinguish several kinds of Beech, but these are regarded by botanists as only accidental varieties of a single species. This is an abundant tree throughout the Province, especially upon the southern coast, and where the conditions are favorable, attains a vigorous growth, trunks being sometimes met with seventy feet or more in height. Its wood is highly valued as a fuel, being second only to that of Rock Maple. It is also durable when kept dry, or, as in the holds of vessels, permanently wet, but decays readily when these conditions are frequently changed. It has been found to answer well in the manufacture of carpenters' tools and farm utensils. Its ashes yield large quantities of lye, available in the manufacture of soap.

The Hazel is rather a small shrub, two to five feet high, and of no great value.

The Hornbeams are both comparatively rare, but the hardness and density of their wood, to which the name of Iron-Wood alludes, makes them well suited for certain kinds of work in which compactness and solidity are required.

BIRCH FAMILY.

The important members of this family, which is sometimes combined with that last noticed, are the Birch and the Alder.

Five kinds of Birches are found in New Brunswick, of which four are quite common. The first, in point of value, is the Black Birch, which is found in all parts of the Province, but especially about the deep and shady banks of rivers, and on gravelly ridges along the shores of the Bay of Fundy. Its principal use is in the manufacture of square timber for export and for ship-building. It has a fine close grain, is readily polished, and, having a rich mahogany colour, is well suited for chair and cabinet work. Carriage-makers employ it for panels, and shoe-makers for lasts. It also makes an excellent fuel.

The Yellow Birch is also a large and valuable tree, attaining sometimes a height of seventy feet, and a diameter of two or more feet. It grows in rich, moist lands, in company with spruce and ash, and is used for the same purposes as the Black Birch.

The Paper Birch is nearly as large a tree as those last mentioned, but is easily distinguished by its tough and separable bark, the latter being the material employed by the Indians in the manufacture of canoes. The wood is fine and glossy, soft, and of a handsome color, but lacking in durability and strength. It answers moderately well for fuel, and is said to yield an excellent charcoal.

The White Birch is a much less valuable tree, growing chiefly upon the poorer classes of soils, and not often exceeding thirty or forty feet in height. Large quantities are cut for fuel, but for this, as for other purposes, its quality is greatly inferior to that of the other Birches.

The Alders are common everywhere along the banks of streams, and should be mentioned, if for no other reason, that they help to protect these latter from being washed away. When dry they make good fire-wood, though of small size, and also yield excellent charcoal.

WILLOW FAMILY.

This family is represented in New Brunswick by ten or twelve kinds of Willow, two Aspens, and as many Poplars. Of the Willows, only one, an introduced species, is of large size, and is not unfrequently planted as an ornamental tree. Its wood, owing to its pliancy, is well suited for basket-work, and is often so used. The Balsam Poplar or Balm of Gilead also thrives well under cultivation, and is frequently planted. The Aspens are common forest trees, readily noticeable for the continual agitation of their leaves, and possess some beauty, but are otherwise of little value.

THE PINE OR CONE-BEARING FAMILY.

No group of plants found within the Province is better characterized than this, or contains more forms of economic value. This will be at once apparent from the simple statement that it contains the Cedar, the Hemlock, the Spruce, the Fir, the Pine, and the Hackmatack or Larch. These include the greater part of what are commonly known as "soft-wood" trees, and also of "evergreens," while from the peculiarity of their fruit, consisting of many open pistil-leaves closely crowded together, they are also often known as "cone-bearing" plants.

THE PINES.—Of the true Pines we have three species—the White Pine, the Red or Norway Pine, and the Gray or Northern Scrub Pine. Of these the first is by far the most valuable, and its exportation at one time constituted one of the most important sources of revenue to the Province. Large trees of this species have, however, now become very scarce, the extensive forest fires which have at times devastated the Province having removed it from large areas in which it was formerly abundant.

The Red Pine, improperly known as the Norway Pine, is also a valuable tree, its wood being strong and durable, and was formerly largely employed in the construction of vessels. It has, however, like the White Pine, become greatly reduced in numbers, and large trunks, such as were at one time abundant (with a height of eighty or ninety feet, and a diameter of three feet or more), are now rarely met with.

The Scrub Pine, known also as Banks Pine, is greatly inferior to the other pines both in size and value. The wood is very hard, full of pitch and free from sap, but is apt to be full of streaks. It is especially abundant over portions of the mountainous country bordering upon the South-West Miramichi River.

THE CEDARS.—The so-called Cedar of our woods is properly the Arbor Vitæ. It is a common tree in the Province, being especially abundant in low boggy grounds, where it often grows in almost impenetrable masses, forming what are known as "cedar swamps." The largest and best trees occur intermingled with hardwood. Very large tracts of land are thus covered in the counties of Victoria and Madawaska, as well as about the head of the Restigouche, many of the trees being three feet or more in diameter. The wood of the Cedar is soft, light and fine grained, having a slightly reddish tint, and an agreeable aromatic odour. It is used in very large quantities for the manufacture of railway sleepers and shingles, the fact of it being unaffected by changing conditions of dryness and moisture especially suiting it for such uses. It is also, from its durability, especially suited to the making of fences.

What is known as Red Cedar, but more properly as Juniper, is found, occurring sparingly, along the southern coasts, and on the beaches of Restigouche county. It is here, however, only a low prostrate shrub, of little or no value.

THE SPRUCES.—These are very valuable trees, and their wood constitutes one of the most important exports of the Province. There are two kinds, the White, or Single Spruce, and the Black Spruce. The latter is the most valuable. At one time it covered vast areas of the Province in dense forests, but fire and the axe of the lumberman have now greatly reduced its supply. It is most abundant in the southern and middle counties, growing usually around lakes and in low situations. Its wood is strong, light, elastic, and durable, and is extensively used in shipbuilding, especially in the making of yards and topmasts. Very large quantities are manufactured into deals, clapboards, and battens for exportation. It is also used to some extent in the making of shingles.

The White Spruce is a larger but more slender tree than the Black Spruce. It is also of less frequent occurrence. Its wood is white and soft, and generally free from knots, but it possesses less strength and elasticity than the last named variety, and is therefore less valuable. The spruce deals shipped from the northern counties are largely made from this tree.

HEMLOCK.—Another important tree is the Hemlock Spruce, or Hemlock. It is one of the most abundant of our evergreen trees, and is found on almost every variety of soil. Under favorable circumstances it reaches a height of seventy or eighty feet, with a circumference of from six to nine feet. It is of more frequent occurrence in the southern and middle than in the northern portions of the Province, and is rare north of the Grand Falls. Both its wood and its bark are of value. The former, being deficient in resin, decays readily under exposure, but is well fitted for the construction of dwellings, out-buildings, and the like, and is largely so employed. The bark is valued for tanning purposes, and enormous numbers of trees are annually stripped with this object in view, the bark being partly used directly, partly exported, and partly employed in the manufacture of bark extract. A large proportion of the trunks felled for this purpose have been left in the forests to decay and to help the spread of forest fires.

HACKMATACK, TAMARACK, OR LARCH.—This is another of the more valuable trees of New Brunswick, easily distinguished by its numerous horizontal and irregular branches, and by its bright red flowers or catkins. Its favorite place of growth is near the banks of sluggish brooks and around the borders of bogs, and here it sometimes attains a height of forty or fifty feet; but on the bogs themselves, though abundant, the trees are generally much smaller. In such situations the trees have, within the last few years, been subject to a disease or blight, the work of insects, and over large tracts along the upper St. John they present an appearance as though they had been blasted by fire.

The wood of the Hackmatack is valued on account of its durability. It is very resinous and compact, as well as strong, and is therefore admirably adapted for the requirements of the shipbuilder. From its trunk he obtains timbers and beams, and from its roots, knees. It is also well adapted, on account of its hardness and durability, for floor-boards and door-steps. The supply, however, is now greatly reduced as compared with that of former years.

BALSAM FIR.—This tree, more commonly known under the simple name of Fir, is only mentioned here as a tree of rather frequent occurrence. It is a handsome tree, and one of rapid growth, but is short lived and rarely attains a large size. Its wood also is of little value, lacking the desirable qualities of hardness, strength, and elasticity. It is most abundant in the northern counties. From it may be obtained the substance known as Canada Balsam, used in medicine and in the making of varnishes.

Class II. Endogenous Flowering Plants.

The plants of this class have a stem which is not distinguishable into bark, pith, and successive zones of wood, the latter being irregularly scattered through the stem, and mostly near the centre; hence called Endogens, or Inside Growers. The leaves have the veins usually arranged in parallel lines rather than branching, are not toothed, and generally clasp the stem. The parts of the flower are usually in *threes*, and the embryo possesses but a single seed-leaf.

The group embraces quite a number of families, of which, however, only a few can here be noticed.

ARUM FAMILY.

This family derives its name from the Wild Arum, or Indian Turnip, commonly met with along the borders of brooks and in shady woods. Its tuber, or thickened underground stem, is remarkable for its intensely biting taste, and when grated and boiled (when it loses its acridity), is a popular medicine in the cure of coughs and consumption. A plant of more real value for its medicinal properties is the Sweet Flag, or Calamus, not unfrequently employed in the diseases of children. It is found in river intervales, and about the borders of lakes and ponds.

LILY FAMILY.

But few members of this family are noticeable as useful plants, but many are deserving of mention for their beauty; one, the Onion, constitutes an article of food, and another, the Hellebore, is a violent poison. Among the forms noticeable for their beauty may be mentioned the ordinary Yellow or Orange Lily; the true Canadian Lily, the ornament of intervales and meadows; the Bellwort, common also in similar situations; the Adder's Tongue, or Dog's Tooth Violet; and the Trillium, whose flowers, especially of the white or painted variety, are among the most common and beautiful blossoms of early spring. All of these plants are capable of successful cultivation. The cultivated Onion is of course familiar to every one, while wild Onions abound along the banks of the upper St. John and its tributaries. The Hellebore, on the other hand, is less widely distributed, but is not uncommonly met with along the banks of intervales, where its broad green leaves and luxuriant growth can hardly fail to attract attention. The poisonous qualities reside chiefly in the root.

ORCHIS FAMILY.

This family is here alluded to simply for the reason that it includes some of the most beautiful and curious, though not the most abundant, of our wild flowers. One of the most familiar forms is the Lady's Slipper, whose flowers, including both white and pink varieties, are among the choicest ornaments of our vernal woods.

IRIS FAMILY.

The two representatives of this family here found are the common Blue Flag, occurring everywhere in wet places throughout the

Province, and the Blue-Eyed Grass, abundant in fields. Both are noticeable for their beauty. Cultivated species of Iris, with large and showy blossoms, are common in gardens. The Crocus and Gladiolus are related forms.

Rush Family.

The Rushes are only noticeable as weeds. Five or six species are of common occurrence, but are for the most part homely, worthless, and troublesome.

Cat-Tail Family.

The Cat-Tails, or Flags, are common in wet and muddy places. They have no important applications, but their dried spike-like fruits and long sword-like leaves are often employed for interior house decoration. The leaves are sometimes made useful for weaving the seats of chairs.

Grass Family.

Though usually of small size individually, of simple structure, and with inconspicuous flowers, no group in the vegetable kingdom is more deserving of mention than that of the Grasses, for this, if for no other reason, that it affords so large a proportion of the food both of man and beast. Thus, within this family are included not only all the ordinary grasses of fields and pasture lands, which, either in the green state or as hay, form the chief means of subsistence of all our domesticated cattle, but here also are found such invaluable plants as Rice, Wheat, Rye, Barley, Oats, Indian Corn, and Sugar Cane.

SERIES II. FLOWERLESS PLANTS.

The plants referred to this great division of the Vegetable Kingdom differ from those previously noticed in that, though they conform to the general plan of vegetable growth, they fail to form either true flowers or seed, multiplication being effected by *spores; i. e.*, minute seed-like bodies borne upon the leaves, but which contain within no ready-formed plantlet or embryo.

To this series belong (1) the Ferns or Brakes; (2) the Club-Mosses or Ground Pines; (3) the Mare's Tails or Scouring Rushes; (4) the true Mosses; (5) the Mushrooms; (6) the Lichens; and (7) the Sea-Weeds, with a multitude of related forms.

The Ferns are especially noticeable for their abundance and their beauty, being unexcelled in the whole vegetable kingdom for the delicacy, variety, and elegance of their foliage. They are also well adapted for garden and house cultivation. The Club-Mosses are also beautiful plants, well adapted, by their trailing stems and spruce or pine-like leaves, for interior cultivation and decoration. The Mare's Tails are common about ponds and wet situations, but are of no special interest. The Mosses, the Fungi or Mushrooms, and the Sea-Weeds (better known as *Algae*) all embrace many beautiful forms well worthy of consideration by the lover of Nature. Their study is, however, too difficult for the young beginner.

EXPLANATION OF PLATE IV.

FORMS OF ANIMALS.

FIGS. 1–21.—VERTEBRATE, OR BACK-BONED ANIMALS. Figs. 1–10. Mammalia: 1. Man; 2. Monkey; 3. Lynx; 4. Cow; 5. Bat; 6. Bear; 7. Rabbit; 8. Star-nosed Mole; 9. Seal; 10. Whale. Figs. 11-17. Birds: 11. Hawk, and 13, Owl, birds of prey; 12. Wood-pecker, a climbing bird; 14. Fowl, or scratching bird; 15. Heron, a wading bird; 16. Wren, a perching bird; 17. Duck, a swimming bird. Figs. 18–20. Reptiles: 18. Turtle; 19. Snake; 20. Frog. Fig. 21. Fish (Smelt).

FIGS. 22–25.—ARTICULATE, OR RINGED ANIMALS. 22. Spider; 23. Butterfly; 24. Worm; 25. Lobster.

FIGS. 26–29.—MOLLUSCAN ANIMALS, OR SHELL-FISH. 26. Squid; 27. Periwinkle; 28. Snail; 29. Clam.

FIGS. 30–34.—RADIATE, OR RAYED ANIMALS. 30. Sea-Urchin; 31 and 32. Star Fishes; 33. Jelly-Fish; 34. Coral.

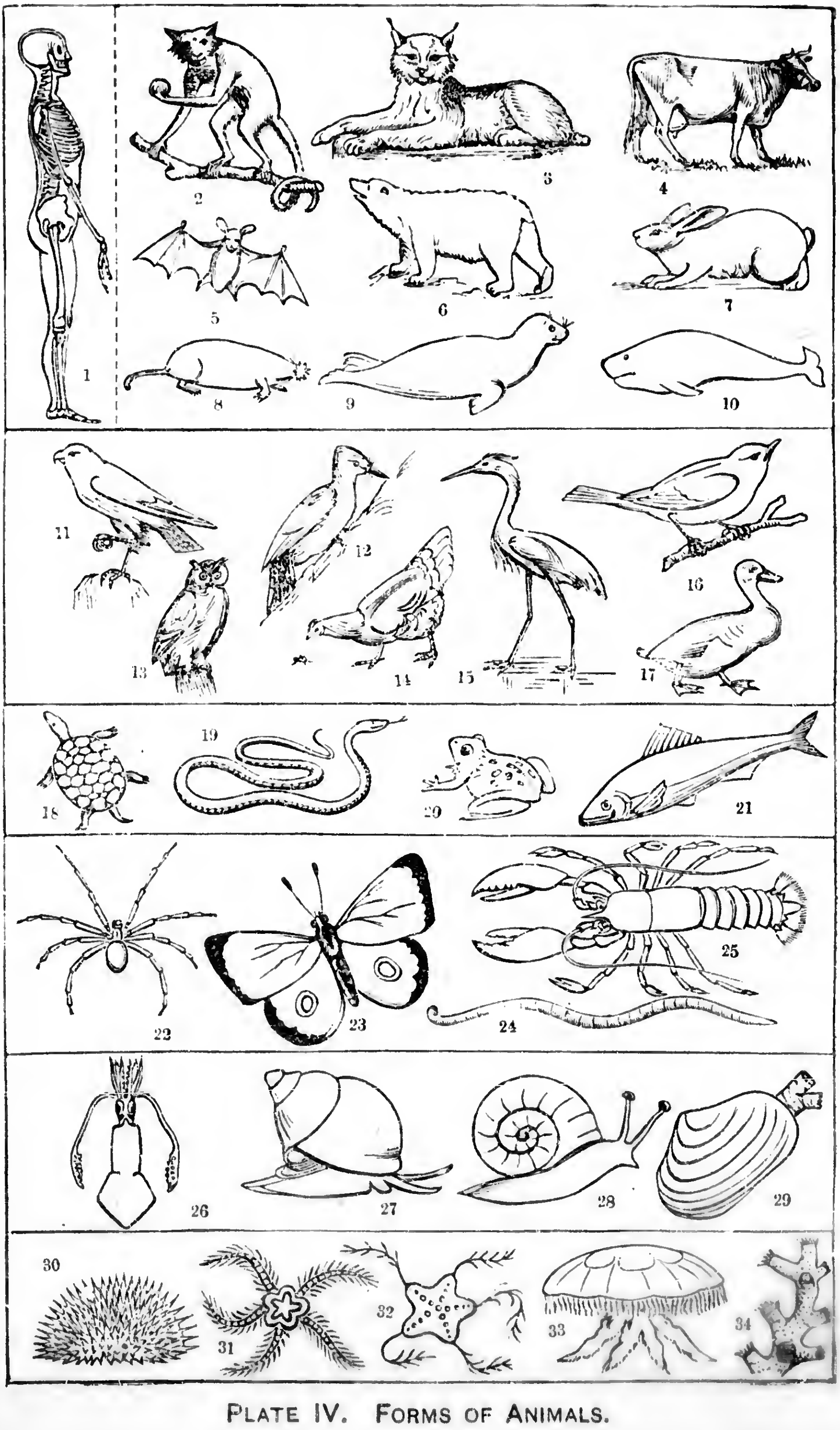


PLATE IV. FORMS OF ANIMALS.

III.

THE ANIMAL KINGDOM.

ANIMAL LIFE.

IN an earlier portion of this work referring to the general characteristics of living beings, some of the main features of distinction between these and the lifeless objects of the mineral world have already been enumerated; and in the study of the life of plants these distinctions have found illustration in the various kinds of work performed by the latter, as well as in the various implements or organs by which it is accomplished. But animals also work in many more and in much higher ways than plants, and the organs possessed by them are, as a consequence, also far more varied and of higher and more complex structure. We have now to consider, somewhat more fully, what these organs are, how they are constituted, what is the special work performed by them, and what are some of their modifications in different animals.

In studying this subject the same method may be followed as has already been employed in the study of plants. That is to say, the student may first make himself acquainted, as far as is possible, with the general structure of some one animal with which he is familiar, and then, taking this latter as a standard or pattern for comparison, ascertain wherein others differ therefrom. By so doing he will very soon find that, as was the case with plants, there are certain common features in which all animals agree, certain kinds of work which they all perform, certain general plans of structure, few in number, in accordance with one or the other of which they are all constructed. The differences arise from the several ways in which the required work is done, and the various modifications of their organs which thus result. A summary of the common features referred to will not only serve to illustrate these principles, but to exhibit more strongly the features both of resemblance and of difference between animals and plants.

It makes but little difference what animals we choose, but selecting the following as being familiar, and at the same time of somewhat varied structure — viz., a dog, a cat, a horse, a cow, a bird, a snake, a butterfly, and a snail — a little observation will suffice to show that they possess, each and all of them, the following features:

(1.) **The Animal Moves.** It is by this power of motion that the existence of an animal is most commonly recognized. But plants, as we have seen, also move; and this power, taken alone, will therefore not always suffice to distinguish them. To say nothing, however, of the difference in the two cases as to the amount and rapidity of the movements, there is this essential difference; namely, that animals possess, what plants evidently do not, instruments or organs which are constructed and adapted for this special purpose. These are as various as are the animals in which they are found — taking the form of legs, wings, fins, etc., and determining, as the case may be, an equal variety of movements, as walking, running, leaping, flying, crawling, gliding, and swimming; but they are in general accomplished by a special machinery, of which the following are the most essential parts. In the first place there are certain hard parts, through which the force producing the motion is applied, and which are jointed or hinged together much as in ordinary machinery. These are what are termed the *bones*, or, in some instances, the *shell*. Secondly, there are between these movable pieces fibrous cords, which, much like ordinary cords of elastic, have a peculiar power of contracting, and thus of pulling upon the bones or other parts with which they are connected. These are the *Muscles*, the appearance of which is familiar in ordinary lean meat. The muscles are commonly connected with the bones or other hard parts through the agency of *Tendons*, which act much like the straps and belting used in mills to convey the power of the engine to various distances and in various directions. Oily matter is also provided about the joints to prevent friction. Lastly, the power of contraction on the part of the muscles is called into play through the agency of what are termed the *Nerves*, which, starting from the *Brain*, the great centre of life and power, extend, in the form of delicate cords, to all parts of the body, and especially to the muscles, which without their control can do nothing. How the Brain and Nerves act upon the Muscles we do not altogether know, but in many particulars the action is very similar to that exerted by an electric battery in ordinary telegraphy.

Nothing in any way resembling the apparatus of nerves and muscles is ever found in plants.

(2.) **The Animal Directs and Controls Its Motion.** This is obvious from the nature and purpose of the motion itself. In plants the source of the motion is in general from without; *i. e.*, it is dependent on the action of the sun's rays. In animals it comes from within, and is used for a definite purpose.

(3.) **The Animal is Conscious of External Objects.** Without such consciousness the power of motion would only be a source of danger. It would also be totally useless even if, under such circumstances, it were possible. This power of recognizing and distinguishing objects outside of the animal's own body resides in what we term the *Senses;* viz., those of Touch, Taste, Smell, Sight, and Hearing. Each of these is constructed in its own special way, and in different animals presents great differences of detail, in form, number, complexity, etc.; but their general mode of operation is much the same in all, depending upon a second power possessed by the nerves, and through which certain peculiar impressions are conveyed to the brain.

(4.) **The Animal Seeks, Selects, and Seizes Food.** In the case of plants, their food — the earth and air — are everywhere, and everywhere essentially the same. Hence they do not require, and are unable, to make any selection. With animals the case is different. Their food must be sought, and a choice must be made between such kinds as are, and such as are not, suited for the purpose. This they do through their organs of locomotion and their organs of sense. In addition to this, however, their food must be seized; and in many cases, where such food consists of other animals, these have to be attacked and overcome. The limbs are the organs most commonly used for this purpose, being armed with claws, talons, hoofs, etc., but many other parts of the body — lips, tongue, teeth, nose, tail, etc. — may be similarly employed; or, as in some snakes, the body itself.

(5.) **The Animal is Nourished by Food Taken Into Its Interior and There Digested.** Plants, as we have seen, take in their food by mere absorption over their outer surface, and chiefly through their roots and leaves. Some animals of very low organization and simple structure also subsist by mere absorption through the surface; but in all the higher forms the food is never thus taken, being first introduced into an interior cavity, where it becomes subjected to a variety of changes which render it better fitted to serve its purpose. This interior cavity is the *stomach.* In some animals it is a mere sac or bag connected with the mouth, but in many it forms only one portion of a lengthened tube — the food canal — having connected with it a variety of accessory organs, such as the liver, spleen, etc., which add to its efficiency. To facilitate the passage of food through this canal it is first cut, torn, or otherwise divided (in the case of man it is also often cooked), and when introduced into the mouth is further subdivided by the action of the *teeth.* These are very various in number, form, and structure; but always exhibit the most exact adaptation to the kind of food upon which the animal subsists. The final result of the process of digestion is the formation of *blood.*

(6.) **The Animal Possesses a Heart (or some Related Organ) and Blood Vessels.** Blood is to animals what sap is to plants — a nourishing fluid; hence it requires to be conveyed to all parts of the body where growth or change is in progress. In plants the sap flows by mere soakage; but in most animals a more complex machinery is provided, consisting of a central reservoir, the *heart,* and of a system of pipes or tubes, termed *blood vessels,* by which the blood is more rapidly conveyed from one part of the body to another. The heart, besides being a reservoir, is also a sort of force-pump, by whose action the blood is constantly kept in motion, being drawn from one portion of the body and driven to another. The tubes conveying blood from the heart are termed *arteries,* and those which carry blood to that organ are known as the *veins.* The entire movement is called the Circulation of the Blood.

(7.) **Animals Breathe.** The animal body has been compared with a machine, but, like a machine or engine, its powers can only be kept up by the constant use of fuel, which is as constantly consumed. The fuel of the body is the food, converted into blood, and then into the various organs of which the body is constituted; its consumption is effected, as in an engine, by air taken into the interior and there made to unite with the blood or other parts. The apparatus for this purpose consists in some animals of lungs and in others of gills; but the purpose is the same in either case, and leads to the same results. One of these results is the production of power, either nervous or muscular, or both; the other is the production of heat. Those animals which, like our ordinary beasts and birds, breathe pure air and have good lungs, are warm-blooded; those which have poor lungs, like reptiles, or only gills, like fishes, have blood which is cold. The former also have a body covering, consisting of hair, fur, wool, or feathers, by which the warmth of the body is preserved; while reptiles and fishes have only scales serving the purpose of defence.

(8.) **The Animal Rests Portions or the Whole of its Body.** The nutritive processes described above require time, and when material is consumed more rapidly than it is renewed, derangement follows, producing the sensations of fatigue and pain. Rest is required. This is attained, as regards separate parts of the body, by ceasing to make use of them; it is accomplished for the entire body through the medium of sleep. Even plants have periods of inactivity, determined by alternations of light and darkness, the varying seasons, and other causes. In the case of certain animals, such as the bear, bat, etc., a considerable portion of the year is passed in a dormant state.

(9.) **The Animal Grows.** This is not directly obvious, but, as in the case of plants, it becomes so when we compare together the body at periods more or less apart. In most cases the change from any one of these periods to another is gradual, and no difference is observable other than that of *size;* but in other instances the change is more abrupt, and the animal, in successive periods, presents features of a wholly unlike character. Thus the fish-like tadpole becomes converted into the frog, and the worm-like caterpillar into the bright-winged butterfly.

(10.) **The Animal gives Birth to Young.** This it may do either directly, or indirectly through the egg. The former is the case with all our ordinary quadrupeds, as well as bats, seals, and whales—in other words, with all Mammals, or animals which suckle their young; all others, whether birds, reptiles, fishes, insects, or the like, are born from eggs. The egg is with animals very much what the seed is with plants; and as from the seed a new plant is developed, so from the egg a new individual is hatched. The important part of the egg is the yolk, for out of this the new animal is directly made. The white of the egg and the shell when present merely afford nourishment and protection.

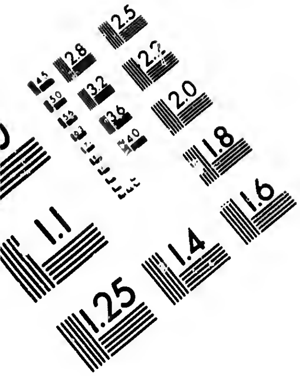
It is interesting to notice that, besides forming eggs, corresponding to seeds, animals may, like plants, in some instances multiply also by a process of budding, and thus build up a sort of community of animals, all bound together as are the separate branches which make up a common shrub or tree. The most noticeable example of this kind of growth is furnished by the coral animals of tropical seas, and it is by their power of so multiplying that they come to build the extensive reefs which skirt many tropical islands, or even themselves form islands in the midst of the ocean.

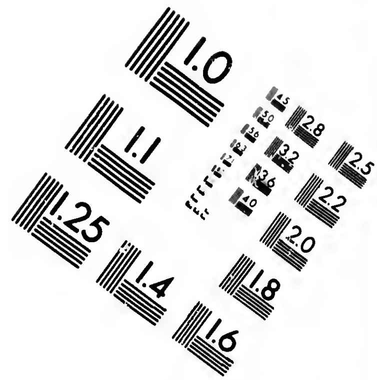
(11.) **The Animal Dies.** The duration of all living things is limited. Subject at all times to internal change, subject also to accident and disease, as well as liable to be attacked and destroyed by other animals, each kind, or rather each individual, having served its purpose, and having given birth to new individuals, becomes the subject of decay, and, dying, becomes resolved into the elements out of which it was made.

THE CLASSIFICATION OF ANIMALS.

In the study of natural objects, as in all other kinds of study in which comparisons are made, the mind is naturally led, as the result of these comparisons, to group or classify the objects or ideas thus considered according to their features of resemblance and of difference. We classify familiar objects as houses, churches, barns, and the like; we classify words as nouns, verbs, adjectives, etc.; in the first part of this work we distinguished rocks from minerals, and metals from bodies which are not metallic; and, finally, we grouped or classified plants in a number of distinct families, each of which had some representative member and some peculiar features of its own.

The classification of animals has the same object in view, and is effected in the same way; viz., by bringing together into distinct groups those animals which have common features or which stand more or less nearly related to each other. The classification of animals, however, is not nearly so easy as that of minerals or plants, because they are of a far more complicated structure, and the grounds of comparison are at the same time much more numerous





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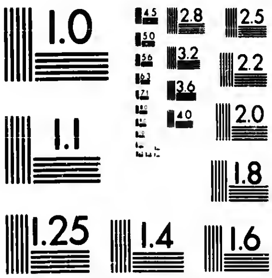

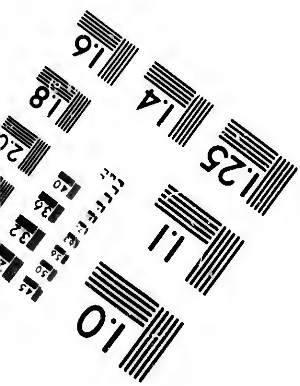

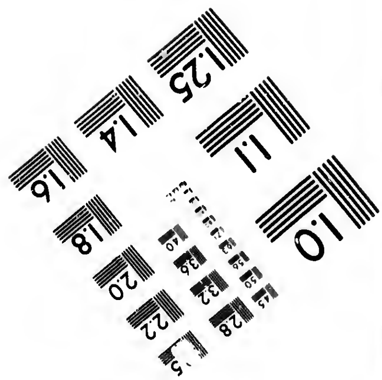

and less thoroughly understood. Hence naturalists are not altogether in accord as to the number and relative importance of the groups to be adopted, but certain general principles are, nevertheless, recognized by all. These principles will be best understood by a few simple illustrations.

If we were called upon to classify the books of a library, we might, as a matter of convenience, do so with reference to their relative *size*; or, as a matter of taste, from the character of their binding; or yet again, with reference to the dates of their publication. But such classifications would be of little or no value for any one who wished to know what sort of books the library actually contained. For this purpose he would need to go beneath the surface and know something of the subjects of which they treat. So with the different varieties of buildings; we distinguish and group them together with little or no reference to their size, colour, amount of ornament, or other unimportant features of like kind, but with reference to the plans of their architecture and the purposes for which they are to be employed.

It is the same with the classification of animals. The first and most important feature to be determined is that of their *plan of structure.* According to what general pattern are they built? In the Vegetable Kingdom we found but one such plan, but in the higher Animal Kingdom this number is considerably increased; four, if not a greater number, of distinct patterns being here recognizable. The first of these patterns finds illustration in the case of our own bodies, as well as in all ordinary quadrupeds, birds, reptiles, and fishes, the common feature which they all possess being that of having an internal bony skeleton, with a back-bone for an axis. The division or branch of the Animal Kingdom possessing this common feature is hence called that of Back-Boned (or Vertebrate) Animals. The several groups referred to may be regarded simply as representing so many modes of carrying out this one idea or pattern, and they make up so many classes into which the Vertebrate Branch may be subdivided. So each class may, with the varying complexity of its members, their form and mode of life, be subdivided into smaller groups, known as orders and families, genera and species. The plan is the same in all, but is variously expressed.

In addition to the Back-Boned or Vertebrate plan, three other plans are recognized by most authors, known respectively as the

Articulate or Jointed Plan, the Sac-like or Molluscan Plan, and the Ray-Formed or Radiate Plan — plans which are equally to be found in all the various animals which belong to each, however much they may vary in individual peculiarities. These, therefore, make three more branches of the Animal Kingdom, and they in similar manner are subdivided into classes, orders, etc., according to the varying ways in which the one common plan is executed.

Finally, it has been found necessary to adopt a fifth branch (Protozoa) to include a number of forms, mostly of minute size, the structure of whose bodies is so simple that they can hardly be regarded as being built upon any definite plan.

Referring once more to our architectural comparisons, we may regard the four main types of animal structure as corresponding to the different styles of building distinguished by architects — the Grecian, the Gothic, the Norman, the Elizabethan, etc. The employment of any one of these styles, such as the Gothic, for building a castle, a cathedral, or a house of parliament, as the case may be, is paralleled among vertebrate animals in the adaptation of some to life on the land (Quadrupeds), others to life in the air (Birds), and others again (Reptiles and Fishes) to life which is essentially aquatic. Again, a cathedral or a castle, built upon any one pattern, may be large or small, may be simple or complex, and may have various relations to its surroundings; and so any one class under any one branch of the Animal Kingdom may have members presenting similiar diversity. Finally, to complete the same comparison, the members of the fifth branch, which are not constructed upon any particular plan, may be regarded as corresponding to rude huts and hovels, which, in like manner, cannot be referred to any particular architectural method, though they necessarily exhibit many of the more essential features upon which all edifices are built.

The following systematic but simplified classification of the Animal Kingdom will afford further illustrations of these simple principles, as it will also give opportunity for reference to some of the more important wild animals of our own woods and waters.

Branch I. Back-Boned or Vertebrate Animals.

This branch embraces all animals possessing an internal, usually bony, framework or skeleton, having the back-bone as an axis, enclosing distinct organs of sense, of digestion, of circulation, and of respiration, and supporting externally two pairs of limbs, variously modified. The right and left sides of the body correspond, and the head is distinct and well defined.

The branch embraces four classes, exhibiting adaptations to as many distinct conditions of life, as follows:

Class I. Mammalia. Vertebrate or Back-Boned Animals bringing forth and suckling a living young; adapted in most instances to life on the land, and hence having their limbs developed into legs and feet for walking, leaping, running, etc.; possessed of a four-chambered heart, with a double and perfect circulation,* and lungs inflated with air; warm-blooded, and having the body more or less protected by a covering of hair. In addition to ordinary quadrupeds the group includes also Man, Monkeys, Bats, Seals, Walrus, Whales, etc., which, though not all four-footed, and in some instances not inhabitants of the land, are yet true Mammals, possessing all the essential features of the group.

Omitting Man, the following are the chief orders in the Mammalian class, with some of their Provincial representatives:

1. QUADRUMANA. The Monkey Tribe, including Apes, Monkeys, Baboons, etc., only seen in imported specimens.

2. CARNIVORA. Flesh-Eating Animals, or Beasts of Prey, having usually strong, well-knit bodies, keen senses, and active movements; having also mouths provided with sharp-pointed and cutting teeth, and feet armed with claws. Their entire structure adapted for the recognition, pursuit, capture, and digestion of living prey.

   In addition to domesticated dogs and cats, this group is represented among the wild animals of the Province by the Wild Cat, the Canada Lynx or Loup-cervier, one or more species of Fox, the Weasel, the Raccoon, the Sable, Mink, Otter, and Ermine, highly valued for their furs; the Skunk,

* A perfect and double circulation is where the whole of the blood, in addition to traversing the body, is driven through the lungs, and thereby purified. The heart, in such cases, always consists of four cavities, and the blood is constantly and thoroughly renewed.

the Bear, and one or more Seals. Wolves were at one time common in the Province, but seem to have entirely disappeared.

3. HERBIVORA. Plant-Eating Animals, adapted externally and internally for subsistence upon vegetation; having bodies often large, but weaker and generally less active than those of carnivorous animals; their senses often acute; their teeth adapted for chewing rather than for tearing or rending; and their feet armed with hoofs instead of claws.

   The domesticated representatives of this group are our common and most useful animals, the Horse, the Cow, and the Pig. Among wild forms we have in the Province the Moose, the Caribou, and the Red (or Virginian) Deer. The two former are becoming lessened in numbers by the wholesale slaughter to which they are subjected by hunters, but the last named appears to be upon the increase.

4. WHALES. These very peculiar forms of Mammals, which, with the closely allied forms of porpoises, are generally mistaken for fishes, are not unfrequently seen upon our coasts, and are of several different kinds. Their main peculiarities are their enormous size, their water residence and fish-like form, the absence of hind limbs, and the imperfect development of their teeth.

5. BATS. These are another exceptional group, being adapted, though true mammals, to life in the air. They are possessed of powers of flight; but these, instead of being effected through a true wing, composed of feathers, as in birds, are the result of a mere expansion of the skin, stretched upon and moved by the greatly lengthened fingers. They are small-sized, feeble animals, living in dark situations, flying only by night, and passing the winter season in a state of inactivity. We have three species, but only one of common occurrence, in the Province.

6. INSECT-EATERS. The only representatives of this group within our borders are the Shrews and the Moles, of which there are several kinds. Both are very small and feeble animals, subsisting upon insects, burrowing under the ground, and

rarely seen by day. Their feet are adapted for digging; their fur is very soft and fine, and their eyes remarkable for their small size; features all connected with the conditions of their underground life.

7. GNAWERS. These include the Rats, the Mice, the Squirrels, the Woodchucks, the Muskrats, the Beavers, the Rabbits, and the Porcupine. They are all plant-eaters; but in addition to being of small size and feeble structure, are peculiar in having their jaws and teeth (especially the two front teeth in either jaw) adapted for gnawing. The three animals first named, as well as Rabbits, are common everywhere. The Porcupine, remarkable for its covering of quills (really modified hairs), is also not uncommon, frequently coming even into settlements. The Beaver, on the contrary, though once abundant, is now rare, being confined to the least frequented and most inaccessible portions of the Province, where the occurrence of their dams and houses attest the results of their activity and singular habits.

The other groups of mammals met with in foreign countries need not be noticed here.

Class II. Birds. Vertebrate animals, developed from eggs, and adapted for flight. The fore-limbs formed into wings, and the body covered with feathers. The circulation double and perfect, the respiration aerial, and the blood warm. This class may be divided into several groups, distinguished by peculiarities of their bills and feet, of which the following are the most important:

1. BIRDS OF PREY. Hawks, Eagles, Owls.

2. CLIMBING BIRDS. Woodpeckers.

3. PERCHING BIRDS. Sparrows, Warblers, Swallows, Thrushes, Humming-Birds, Crows, Blackbirds, Blue-Jays, etc.

4. FOWLS, ETC. Including Barnyard Fowls, Pigeons, and Partridges.

5. WADING BIRDS. Heron, Snipe, Woodcock, Curlew.

6. SWIMMING BIRDS. Ducks, Geese, Loons, Gulls.

Class III. Reptiles. Vertebrate animals, developed from egg and adapted for land life, for water life, or for both. The limbs a short, rudimentary, or altogether wanting; motion being slow, l creeping or gliding. Circulation double, but imperfect; the blo being only in part conveyed to the lungs (or gills), and but partial renewed. Respiration either through air or water, or through bot but inactive, with development of little power, and leaving the blo cold. The body covering is composed of scales. The following a the subdivisions of this group:

1. TRUE OR SCALY REPTILES.
   (1). *Turtles.* Having the body enclosed in a shell made the back-bone, ribs, and hardened skin. The mou bird-like, without teeth.
   (2). *Lizards.* Having a lengthened body, not enclosed in shell, but covered with scales; limbs present. Th mouth provided with small teeth.
   (3). *Snakes.* Having bodies greatly lengthened and destitu of limbs, motion being effected by gliding. The mou is provided with small teeth. In venomous serpen these are replaced in part by fangs, connected wi poison-glands, but none of this character are to be foun in New Brunswick. About four species of snakes occ in the Province, all of which are harmless.

2. AMPHIBIAN OR NAKED REPTILES.
   (1). *Frogs and Toads.* Reptile-like animals, which in ear life live, as tadpoles, in the water, being fish-like form, and breathing by gills, but subsequently chan to land-life, acquiring limbs and lungs. The body short, with distinct head, and soft membranous skin.
   (2). *Newts and Salamanders.* Lizard-like animals found cellars, wells, and similar situations, but, unlike lizar having a body without scales, and breathing more less by gills.

Class IV. Fishes. Vertebrate animals developed from eg (roe), and adapted exclusively to a water life; the body lengthene horizontal, and cylindrical, without marked inequalities, and cover with scales; the limbs developed into fins; the circulation perfe but single, the blood passing but once through the heart, and renewed by gills instead of lungs.

The three principal groups of fishes, all of which have representatives on our shores, or in our lakes and rivers, are:

1. BONY FISHES, including nearly all *food-fishes*, such as Trout, Salmon, Perch, Herring, Mackerel, Pickerel, Cod.

2. CARTILAGINOUS FISHES, destitute of a bony skeleton, and mostly injurious, as the Sharks and Rays.

3. STURGEONS, having the body more or less covered with bony plates. They are often of large size, and are common in the St. John river, where they are captured in considerable numbers for the oil which they yield.

Branch II. Jointed Animals or Articulates.

The animals of this branch are without an internal framework or bones of any kind, the hard parts of the body being external. The body is usually lengthened, and more or less conspicuously divided into rings, which are articulated or jointed together, and which, on the outside, have attached to them the organs of locomotion, seizure, respiration, etc., variously modified. The right and left sides of the body correspond. The branch embraces the following classes:

Class I. Insects. Terrestrial or Aerial Articulates, having the horny body divided prominently into *three* distinct parts (the so-called head, chest, and tail), living in and breathing air, and usually provided with wings for flight. They pass through several stages of growth, of which the first (as grub, caterpillar, or maggot), is worm-like. The principal groups are the following:

1. BEES, WASPS, AND ANTS. Social insects, living in communities, and working for common ends. Of service as affording honey, but also often injurious to growing vegetation.

2. BUTTERFLIES AND MOTHS. Four-winged insects, the tribe of beauty, and of service in connection with the fruiting of plants, but as caterpillars often highly injurious.

3. BEETLES. "Hard-shelled" insects, with four wings, of which two only are used for flight. The mouth is provided with jaws. They include—besides all varieties of Beetles—June Bugs or Cockchafers, Potato Bugs, etc., many of them working incalculable injury.

4. FLIES. Two-winged insects, including the common House-fly, Bot-flies, etc.; in part beneficial as scavengers, but apt to become pests by their numbers and habits.

   Fleas are related wingless forms.

5. GRASSHOPPERS, CRICKETS, AND LOCUSTS. Winged insects, having the framework of the wing arranged in straight continuous lines. They are highly injurious to vegetation.

6. DRAGON FLIES. Four-winged insects, having the framework of the wing exhibiting numerous branches, and the mouth provided with jaws. Though formidable in name and aspect, the dragon-flies are wholly harmless to man; affording, on the contrary, much service by preying upon and therefore reducing the number of injurious insects. Though not confined to such situations, they are most commonly found about ponds, lakes and rivers.

Class II. Spiders. Air-breathing, articulate animals, related to the Insects, but destitute of wings, and having four instead of three pairs of legs. The body, which is soft, is usually divided into two distinct parts. They live largely upon insects, which they capture with the assistance of their webs; but some forms are plant-feeders, and very destructive to vegetation.

Class III. Crustaceans. Jointed animals, having a body covered with a hard and rigid shell, the pieces of which are so united as to divide the body into two prominent regions. They are confined to the water, and breathe by gills. Of familiar forms there are but two groups; viz., (1) the Crabs, and (2) the Lobsters and Cray-fish. They are largely employed as human food.

Class IV. Worms. Articulate animals, with a soft body consisting of an indefinite number of similar rings, with or without external appendages. They are confined to water and damp earth, breathing either by gills, or by the general surface of the body. Besides the ordinary earth, or angle worm, they include also the Leeches, often found in ponds, and many marine forms. Earth worms are of service as helping in the formation of soils, and leeches for medical purposes.

Branch III. Soft-bodied, Sac-like Animals. Mollusca.

Animals destitute of a bony framework, consisting essentially of a soft fleshy unjointed bag, containing the stomach and other organs, and usually protected externally by a limestone shell. The numerous (over 20,000) distinct forms are mostly referable to three groups, as follows:

Class I. Cephalopods (HEAD-FOOTED). The Squid and Cuttle tribe, having well defined heads, surrounded by long arms, employed for seizure and locomotion, and (in our species) destitute of a shell. The species of our coast are mostly small, but some in the North Atlantic attain a length of forty feet.

Class II. Gasteropods (BELLY-FOOTED). Molluscs, enclosed in a shell usually composed of a single piece (univalve) and coiled spirally, as in the Snail. The body consists of a distinct head, with eyes and feelers, and of a soft, fleshy disc, containing the stomach, etc., by which motion is effected.

Class III. Bivalves. Molluscs enclosed in a double or two-valved shell opening by a hinge, as the Oyster and the Clam. They are destitute of a distinct head, and, in most instances, of locomotive organs. Respiration is effected by plate-like gills (the combs of the oyster), or by a system of water tubes.

RELATIONS OF THE MOLLUSCA TO MAN. These are varied and important. In the first place they yield, as in the case of the oyster, clam, and some other forms, valuable articles of food; some of them are available as bait; and many animals of importance to man, including various food-fishes, and even the gigantic whales, obtain in them a large part of their subsistence. Their shells, from the lime which they contain, are valuable as fertilizers, and owing to their beauty, for the making of ornaments. Mother of pearl is a portion of the inner layer of shells of this group, and the pearl itself is similarly constituted. On the other hand, they may also be injurious, partly as preying upon other animals, as in the case of the cuttles; or by preying upon plants, as with the slug and snail. Finally, by the power which they in some instances possess of boring into wood and stone, they may work immense damage to such human structures as are exposed to their attacks. The ship-worm (not really a worm, though commonly so called), is one of this character, and produces incalculable injury.

Branch IV. Ray-Formed Animals, or Radiates.

Animals destitute of a bony framework, but often possessing a calcareous skeleton, with the organs of the body, external and internal, arranged radially around a central axis. This branch includes two main divisions, mostly marine, and several subordinate ones, as follows:

Class I. Echinoderms. Having generally an external body-covering, composed of many calcareous pieces, and bearing more or less prominent spines. Their most familiar forms are the Sea Urchins and Star-Fishes, abounding on the coast.

Class II. Jelly Fishes (and Related Forms). Having soft, jelly-like bodies, of very simple structure, growing and multiplying much like plants.

Class III. Corals (and Related Forms). Having the simple, sac-like body divided by radiating partitions, which, with the body itself, generally become hardened by stony material into an enduring skeleton. Growth and multiplication resembling that of plants.

RELATIONS OF THE RADIATES TO MAN. Except that these, in various degrees, eat and are eaten by other animals, they are—at least in our waters — of little direct importance to man. In warmer latitudes, however, they play a part of the first importance in the building up of limestone reefs, such as surround many tropical islands, and may even form the bulk of the islands themselves.

Branch V. Protozoa.

These are systemless animals, having the simplest possible structure, possessing few, if any, distinct organs, and not built upon any definite plan. They are mostly of very small size individually, or even microscopic; but, by a process of budding, build up large, somewhat plant-like, communities. The most familiar example is ordinary sponge, varieties of which are common in our ponds and upon the coast. The best sponges come from the Mediterranean. Ordinary *Chalk*, which we employ as a writing material, has a somewhat similar origin.