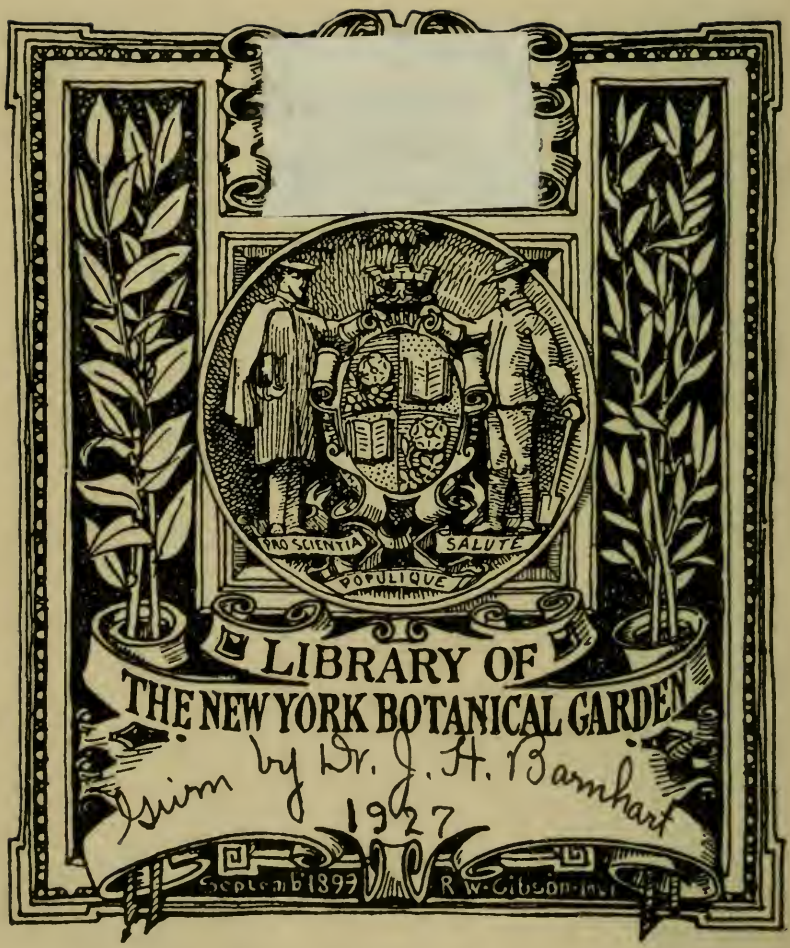
PERSONALITY *of* PLANTS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PERSONALITY OF PLANTS

The Fuchsia has a Distinctive and Esthetic Manner.

PERSONALITY OF PLANTS

By ROYAL DIXON *and*
FRANKLYN E. FITCH

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To
EDWIN MARKHAM
and
ANNA CATHERINE MARKHAM
who live their poetry.

"That nothing walks with aimless feet;
  That not one life shall be destroyed;
  Or cast as rubbish to the void,
When God hath made the pile complete;

"That not one worm is cloven in vain;
  That not a moth with vain desire
  Is shrivel'd in a fruitless fire,
Or but subserves another's gain."

—*Tennyson.*

INTRODUCTION

"THE natural world, so to speak, is the raw material of the spiritual. Therefore, ere man can understand the spiritual, he must understand the natural," writes Thomas Gentry.

The authors of this book would go a step further and say that the natural world *is* the spiritual. Soul and body, ephemeral and material, on this plane of existence are ineffably bound together. If you would climb to sublime heights of ghostly exaltation, study first the grass at your feet. If you would unravel the mysteries of the universe, desert the cloistered hearth for the wonders of woods and meadows. Slow-thinking man will never understand the secret of his own existence, until he thoroughly understands the plants outside his window.

For one to examine dead, withered specimens and hope to understand Nature is as if a person should analyze hundreds of Egyptian mummies in order to acquaint himself with the

human race. You must seek the flowers on their native heath and treat them as friends and equals. Too often is the human creature inclined to look upon members of the vegetable kingdom as things apart from the world of life—insensate beings which can be cut down and trampled without offense—mere "growths," more akin to earth and stone than to himself.

As a matter of fact, among the many forms of matter which exist on this earth of ours, the only clear-cut division is between the organic and the inorganic. The primary characteristic which distinguishes a living creature from inanimate objects about it is, in the words of Arthur Dendy, its power of "reacting toward its environment in such a manner as to conduce to its own well-being; of controlling not only its own behaviour but also the behaviour alike of its fellow creatures and of inanimate objects, in its own interests, thereby maintaining its own position in the universal struggle for existence."

If this, then, is the one characteristic which distinguishes all terrestrial life, it follows that all creatures from the unicellular protoza to man himself are intimately related, are all part and

parcel of the same system, are recognizable by differences in degree but not in kind, and are all interesting manifestations of that mysterious thing we call life. No creature lives or dies to itself. The correlation of organisms in Nature is similiar to the correlation of organs in individual plants and animals.

If the reader will but face this fact, he will approach the study of Nature with a new reverence. He will recognize the oneness and kinship of all life.

It is largely the object of this book to explore the inner recesses of breathing and thinking plantdom—to take the reader beyond the limits of text-book botany into regions of sympathetic insight—to show how even human arts and sciences are unchangeably bound up with the lives and hopes of the grasses and flowers.

To do this comprehensively, it has been thought wise not only to indicate how plants think and act but to incorporate a broad general history of their race stretching back to their first appearance on the planet and carried forward to the Burbank creations. With this knowledge in hand, we are better equipped to approach

that fascinating realm which touches on the intelligence, the spirituality, the mysticism, the psychic phenomena, the higher life of plants.

In all this, the manifest independence of plant life and purpose is convincingly apparent. The plants have their own lives to lead and their own evolutionary processes to carry on. They completed the conquest of the earth long before the first human being appeared on its surface. Out of approximately a hundred thousand species of flowering plants, it has been estimated that only two hundred and forty-seven render direct and important service to man, and of these, only about fifty-four are utilized by him to any great extent.

While today it is no longer the fashion to believe that plants were created for man's *sole* benefit, yet it cannot be denied that, because of their physical limitations and inferior intelligence, the plants frequently become very docile servants of the human race, thereby thriving mightily and to their own great advantage. This is as it should be. It is a law of earthly life. The danger lies in the contempt which this servitude engenders in the consciouness of man, the

master. The plants are inferiors but very wonderful inferiors. We should accord them the highest respect. We should accept our dominion over them as a favour of a beneficent Providence,— a priceless gift which it is criminal to squander or misuse.

CHAPTER I

Origin of Plants

"'Tis a quaint thought, and yet perchance,
Sweet blossoms, ye have sprung
From flowers that over Eden once
Their pristine fragrance flung."

"IN the beginning God created the heaven and earth. And the earth was without form and void; and darkness was upon the face of the deep. And the spirit of God moved upon the face of the waters. And God said, Let there be light: and there was light!"

There is no greater mystery than the mystery of creation. Nowhere is its story told more eloquently and more scientifically than in the opening words of Genesis. All the fruitage of centuries of research but reaffirms this ancient narrative.

In the early days of this planet, when its crust was scarcely hardened from the molten state, there reigned what might be called the age of water. The entire surface of the globe was cov-

ered with a sea of restless, moving liquid, overcharged with a heavy atmosphere of vapour, so dense that not a single ray of light could penetrate it. As the process of cooling went on, more and more moisture condensed out of the air, until finally the first ray of light reached the universal sea and terrestrial day began.

Here in this dim, watery world, about the time that the first land began to emerge from the deep, by some divine, mysterious agency, the first life was born.

No doubt it was one-celled, free-moving, and like modern Flagellates, partaking of the nature of both plant and animal.

Slowly, and in response to evolutionary promptings, simple aquatic plant forms began to develop from the primary single cells. Animal life may have begun a simultaneous development, but if it did, it did not become strong enough to make any impress on the geologic rock from which we draw our data.

Certainly the plants were in the ascendency. The mobile green Algae were characteristic of the time. It is a remarkable thing that though they are probably the progenitors of all that

vast world of vegetable life which enriches the world today, the Algae have always gone on reproducing their own kind. Today we can watch, under a microscope, the activities of the first form of terrestrial life, born incalculable aeons ago.

Mayhap the earth would be peopled exclusively by Algae and similar forms today, if it had not been for a prehistoric accident. One day, the water suddenly receded from a bit of land and left some Algae in the mud behind it. Now, the Algae had always been used to plenty of water and they saw that unless they did some quick thinking, they were in danger of drying up and blowing away. Accordingly, by common consent, they secreted and surrounded themselves with a jelly-like mass capable of absorbing and holding water. The amphibious Liverworts and the *Ricciocarpus Natans* do the same thing today.

With the Algae successfully living in the mud, surrounded by their mucilaginous water-reservoirs, it was but a step for some enterprising individual to extend a portion of his own tissue in search of more water. By this simple

act, the first root came into being, and lo! there were terrestrial plants.

It is to be noted that all development in the plant world is born of necessity. To the plants, dependence upon water, food and the impulse to reproduction may be ascribed the start of many a new form among them. In the more complex groups we seem to see a conscious striving for higher and better things, but the lowlier species often need the goad of circumstance to force them to attainment.

When the plants first emerged upon the land, a number of structural changes became necessary. Whereas in the marine world, water is absorbed directly by all parts of the plant, in land life special organs of absorption and conductivity must be developed. At first, the roots were mere rhizoids or hairs, aided by water-drinking leaves and tubers, as in the Mosses and Liverworts today; but it was not long before true root and vascular systems were evolved. Other changes which came with terrestrial life were greater rigidity of tissue and devices to guard against evaporation. Leaves were developed for the purposes of manufac-

turing starch by photosynthesis, spreading out into thin layers in order to present the greatest possible surface.

These lower land plants retained and still retain some characteristics of their aquatic ancestry, notably swimming spore cells, as in the Mosses. The formation of rigid cellulose about vegetable cells stops their movement, except when cilia or projections of protoplasm extend through openings in the cell walls. The Liverworts were probably among the first real land plants: their spores are non-motile and they have a massive, foot-like organ for the absorption of water.

To the liberality of Nature we must ascribe the development of the law which ties the plants to the soil. They started out as animals, but enjoyed such an abundance of food that it became unnecessary for them to go in search for it. Water and carbon dioxide, which formed their principal means of subsistence, were all about them; they settled down to a life of quiet ease. When Corals, Sponges, Oysters and other lower animals are similarly situated, they become as firmly rooted as any plant. Moreover,

they have free-swimming larvae analogous to the active zoospores of certain members of the plant world.

The first land vegetation of the globe must have presented a curious spectacle. Imagine a forest consisting of endless repetitions of Algae, Fungi, Lichens, Liverworts and Mosses, with many forms of gigantic sizes. The fresh-water Algae early developed a clever device to save their race from extinction by drought. Certain cells in each plant became hard and devoid of water, presenting that phenomenon of suspended animation to be observed in many of the higher seeds. When drought overtook any particular plant, it died, but these special restive cells lived, and were carried about by the wind or other agencies until a new abundance of moisture called them out of their trance. As zygotes, they exist in the Nostoc today.

The first plants were non-sexual and propagated by cell division. They were therefore capable of little advancement. With the introduction of the sex element, infinite possibilities for racial improvement and differentiation were opened up. The Mosses and Ferns

belonging to the family *Archegoniatae* early established an alternation of generation in which the spores give rise to a small plant which looks like a Liverwort and bears the reproductive organs. The fertilized ovum of this plant grows into a leafy, sexless individual which produces spores non-sexually. We therefore have a generation endowed with sex organs making for development and progress, alternating with a sexless generation calculated to continue the tendencies of the race.

It is undoubtedly the sex element which accounts for those "sports" or mutations in plantdom which occasionally overstep the limits of species to form new species.

In the luxurious atmosphere of the early globe, vegetation waxed strong and vigorous and attained remarkable proportions. The primeval woods served to draw the superabundant carbon from the air and in millions of decayed bodies store it up as graphite, coal, petroleum and illuminating gas. The present day graphite beds alone represent vast quantities of ancient vegetation. It is a unique experience to be able to write or draw pictures of these prehistoric plants

and use, in the carbon of our pencils, portions of their very bodies.

Everything was on a grand scale in the "Old Red Sandstone" age. There were no real trees yet, but the Asterophyllites, with their tall, slender stems, looked much like Palms. The Eryptogams were immense Mushrooms. Algae, Zostera and Psilophytons covered the shores with a tangle of seaweed vegetation.

In the succeeding carboniferous period, the plant world reached the climax of its dominion. While the variety was still very much limited, its vigor and luxuriance were astounding. The Tree-ferns seem to have come down to us unchanged from that time, but other plant descendants have dwindled in size greatly. Our humble Mares' Tails were then twenty or thirty foot trees called Calamities. The Club-Mosses were giant Lepidodendruns. Other immense plants which have no direct descendants were the Sigillarias and the Lomatophylos. With its flexible, fluted and checkered stems, saw-edged leaves, and hanging garlands of parasitic Ferns, the carboniferous forest presented a remarkable scene.

The air was still very moist, covering the entire earth with a permanent fog and a uniform temperature. It is said that certain present-day islands in the Pacific Ocean approximate these ancient conditions.

All the plants of that time were flowerless, and belonged to neither the monocotyledonous nor the dicotyledonous classes, which include the greater number of families today. Thanks to many excellent speciments found in coal mines, it is possible for scientists to classify as many as five hundred families. It is believed that coal itself was mostly formed from small plants, but often entire trunks of the tree-like forms are found in bituminous strata. Bits of bark, cones and petrified leaves have also been unearthed at different times.

In the course of evolution, the Conifer trees were the next to develop extensively. They gained a great ascendency, but were succeeded by Palms, Alders, Cypress and Elms. By the Miocene period, all the forms known in tropic Africa today had come into existence, but were restricted by no such regional limitations as they labour under now. Oaks and Palms, Birches

and Bamboos, Elms and Laurels grew side by side. The Palms reached as far north as Bohemia, Switzerland and Belgium. Maples, Lindens, Planes, Spruces, Magnolias, Persimmons and Pines flourished in Greenland. The Silver Fir and the Southern Cypress advanced to within two hundred leagues of the North Pole. The California Redwoods and Sequoias are survivors of a race which flourished in this age.

Man came very late in the earth's evolution, but he has had a profound effect upon the plant world. His most noteworthy feat has been to take comparatively weak plants like the grains and, for his own purposes, give them large areas in which to grow. Wheat, Maize, Yams and Tobacco became widely diffused as cultivated plants before the historic era. It is probable that Rice and the Legumes were first domesticated in Asia; Barley and Wheat in Egypt; and Maize, Potatoes, Yams and Manico in America.

The origin and development of plants is a fascinating study. So authentic are the records which they have left in the eternal rocks that we have little difficulty in reconstructing their entire race history.

THE LIFE OF A DAISY IS SPENT IN BRIGHTENING OUR FIELDS AND PASTURES

CHAPTER II

Life of a Plant

"We cannot pass a blade of grass unheeded by the way,
For it whispers to our thoughts and we its silent voice obey."
—*J. E. Carpenter*

THE growth and development of a plant, though such a common thing, is full of very real wonder and mystery. It takes only a little observation to discover the various stages in the process, but how they are brought about and by what laws they are governed, not even the most astute investigators can always say.

To the lay mind, the statement that the plants depend upon the soil for their nourishment is quite self-evident, yet it is extremely inaccurate. It is now quite certain that the vegetable world relies upon the *air* for its largest and most important food supply. The great mass of carbon which is the chief constituent of all plant structure is drawn almost exclusively from the atmosphere. While it is true that many vital elements are obtained from the earth, all green

plants manufacture the greater part of their solid material out of the carbon dioxide of the air. Of what the plants do obtain from the soil, water makes up the largest bulk. The bread and meat of the plant world is carbon dioxide; the drink is soil water in which is dissolved certain essential salts and condiments.

A chemical analysis of a Green Pea will show approximately 46.5% of carbon, 4.2% of nitrogen and 3.1% of all other elements, exclusive of the hydrogen and oxygen which make up the water permeating all tissue.

This is truly a startling fact. Instead of belonging to the earth, the plants then belong primarily to the air. The air is their natural habitat; the earth serves to give them a fixed place in the world and provide them with flavoured water to drink.

Plants are born from seeds, the joint product of two previous individuals; they live by eating and drinking; they marry and in turn rear families of their own. It is our purpose in this chapter to show, in a very definite way, that this is not mere figurative language but a common-sense statement of fact.

The cycle of plant life can be illustrated by any dicotyledonous, herbacious annual. If one is so inclined he may hark back to his high school days and plant a few Beans in a box as a practical illustration of the facts stated here.

The first action of the planted Bean is to absorb water to a prodigious amount, and so wake the quiescent life forces which may have been slumbering within it for years. It is a law of animal and vegetable life that all vital processes must be performed in solution. Without water, life is dead or somnolent.

When Nature made the Bean, she left a small opening or window in its skin-wall called the micropyle. Through this opening of the water-swollen seed, now issue two pale sprouts. One is long and pointed; it is the radicle or incipient root. The other is stubbier and is tipped by a cluster of folded, yellow-green leaves; it is the plumule or incipient stem. With unerring exactness, the radicle grows down into the soil and the plumule feels its way up into the air.

By this time, the seed has burst its walls and split into two halves, which indicates that it belongs to the dicotyledonous group of plants. As

the seedling continues to grow, these cotyledons begin to shrink and shrivel. The plant is living on their substance until it can begin to make its own. In the case of the Bean, the stem lifts the emaciated cotyledons up into the air, where they act as leaves until the tiny green things at the stem's tip have expanded into those important organs.

When the first leaves have fully opened and the spent cotyledons have dropped off as mere empty shells, the independent life of the plant may be said to have begun. We are now in a position to examine its methods of living.

Examining the root, we find that by this time it has expanded into many branches. Each tip is a tiny mouth through which the plant drinks the all-important water and mineral salts. Root tips exercise great ingenuity; they feel their way underground, touching here, recoiling there, and searching out the elements necessary to the plant's economy with wonderful sagacity.

The actual absorption is done by minute filaments or hairs which take in water and its dissolved contents by osmotic action. They secrete a digestive fluid which renders certain

minerals soluble, and by a strange intelligence, select the kind and amount of material they take in. In certain groups of plants, notably the Legumes, colonies of Bacteria take the place of root hairs, and by a reciprocal action, provide the plant with the nitrogenous elements which it craves.

The principal food of most vital importance taken in by the roots is nitrogen. Nitrogen is one of the basic elements of protoplasm, the life fluid of the living cell. Where there is life, there is nitrogen. Sulphur, phosphorous, silica, iron and other elements are also needed in small quantities.

The root hairs are constructed so as to allow fluids to pass in but not out. The continual absorption of water results in a mechanical pressure which automatically forces the sap up through the stem to all parts of the plant. The process is aided by the evaporation of water from the leaves, through the partial vacuum created by them at the top of the system. Pushed from below and pulled from above, the sap of a tree, for instance, moves with a pro-

pulsive power greater than the blood pressure of the strongest animal.

Above the roots and the stem of the developing plant are the branches. Their function is too well known to need much comment. They raise the leaves up into the air and the light. They act as conduits for ascending and descending sap. They give the plant strength and rigidity. Each main stem is a clever bit of plant engineering, so built as to withstand all kinds of heavy strains and stresses.

The leaves of our seedling are extremely important parts of its anatomy. Pluck them off and it will die in a few hours. They are mouths, stomachs and lungs all in one. Their surfaces are broad and flat, in order that they may catch and devour every particle of carbon dioxide which comes their way. To us, carbon dioxide is a negligible part of the atmosphere, but out of this intangible product of combustion, arising from fires, breathed out by animals and expelled by volcanoes and hot springs, the tallest tree builds its greatest structure. Is it any wonder that it takes so long!

In the inner tissue of each leaf is a substance

called chlorophyll. It is the material which gives leaves their green colour. It is one of the most important substances in plantdom. Under the influence of sunlight, this chlorophyll takes the carbon dioxide of the air, and, with water and certain minerals, makes starch, the raw material of plant construction. This process, called photosynthesis, goes on while the sun shines, and stops with the approach of darkness. The necessity of plenty of light cannot be overestimated.

In the manufacture of starch, oxygen occurs as a by-product. As the plant has no use for this element, it is breathed out from the surface of the leaves. From the standpoint of man, this makes plants atmospheric purifiers. At night, when the making of starch is suspended, there is often a superabundance of carbon dioxide within plant structures. It is this gas which is now exhaled, though in very small amounts. Some authorities maintain that the excess of carbon dioxide is contained in water absorbed by the roots. In the daytime this is welcomed as additional starch material, but at night there is no use for it.

Another substance which is always present in excess of plant needs is water. It is essential as a tissue builder and also as a carrier of nourishment. Its continual evaporation from the leaf surfaces furnishes one of the sources of motive power for the circulatory system. The rate of evaporation is controlled by the stomata, little pores or mouths which have contractible lips. In the Lilac there are as many as one hundred and twenty thousand stomata to the square inch. They are nearly always located on the under surface of the leaves.

Certain plants like the Cacti seem to be able to get along without leaves, but thick, fleshy sections of stem perform all their functions. The Fungi and other parasites differ from most plants in that they have no chlorophyll for starch-making but live on the already elaborated tissue of living or dead neighbors.

When our seedling grows old enough, it marries and has a family. Among the higher plants, the sexes are quite distinct. There are such things as male plants and such things as female plants, but more often both sexes occur in the same individual and frequently in

the same flowers. The Hop, Nettle, and Date Palm are one-sex plants. Maize has flowers of different sexes on the same stem.

Flowers are the reproductive organs. In the blossom of the Bean, the stamens are the male organs and the pistil is the female organ. The stamens produce dust-like pollen which is conveyed by the wind to the pistil of some other flower. Pollen grains deposited on the stigma of the pistil are held there by a sticky secretion until they can grow a long tube which travels down the style, eventually reaching and fertilizing the tiny ovules or eggs.

The ovules then develop into seeds and the pistil grows into a pod, on both of which the parent plant bends all its energies to give a good start in the world.

The cycle is now complete. We have another Bean and are back to where we started, ready for some other fellow to plant the new Bean and perform the experiment all over again.

This is the story in brief, but there are many other details. The different plants have invented and perfected all kinds of devices to secure the effective propagation of the race.

The Hazel and the Grasses hang their stamens out in the wind in order that it may blow their pollen to some other plant, which is waiting with feathered pistil to catch it. Most garden plants depend on the insects to act as pollen carriers and display gorgeous flower-petals and nectar pits with which to attract them. Many plants aim to prevent self-fertilization by having the stamens and the pistil come to maturity at different times.

The plants go to great lengths to secure an advantageous distribution of their offspring. The nature of a plant is to live by growing. When it has reached a prescribed height, it must continue the process by producing new individuals to carry on the cycle. It gives its children a start in the world by providing them with wings, bladders, feathers, spikes, thorns, sticky secretions, submarines, boats, and kites, according to the method of travel they are to use. Sometimes the matured pistil or fruit is dispersed entire. Sometimes it opens and shoots the seeds out. The Violet and Oxilis act like veritable guns, so vigorously do they expel their seeds. There are seed-capsules, like

those of the Primrose and Xanthium Spinosum, which open at the top so that only a high and efficient wind can dislodge the seeds.

The problem of food storage is an important one in plantdom. Annuals die when they have flowered and produced seed. Perennials wither but persist for a number of seasons and sometimes many years. Those whose stems or trunks are permanent withdraw their starch and chlorophyll into their cambium layer where it is safe from freezing. Those which die down to the ground each fall store up food material in underground stems and roots in sufficient amount to get a good start the following season. The Potato is an enlargement of the underground stem, but Carrots, Beets, and Turnips are bulbous roots. Hyacinths, Tulips, Daffodils, Snowdrops, Crocuses, and Buttercups all store food material in bulbs. Practically all wild flowers which come up early in the spring, feed upon the nutriment manufactured during the previous season.

Buds represent the foliage of the coming season. Each fall, trees and bushes prepare

for next year's growth by putting forth miniature shoots and leaves folded up in warm brown overcoats. At spring's urgent call, the buds have merely to cast aside their coverings and step out into the warm sunlight. These buds really make a tree a community of individuals, because each one is capable of reproducing everything that has occured on the plant up to that point. This is the principle on which grafting is carried on.

The most wonderful thing in all plant structure is the plant cell. There are anywhere from six thousand to twelve thousand of these living units to the square inch. In their restless, moving protoplasm lies the mystery of life —the directing energy which controls the plant's activities and makes it a conscious, intelligent organism.

IF THIS AGED CEDAR COULD TELL ITS LIFE'S STORY, WE WOULD FIND IT
FULL OF ROMANCE AND ADVENTURE

CHAPTER III

Migrations of Plants

"Race after race of leaves and men
Bloom, wither and are gone;
As winds and water rise and fall
So life and death roll on."

WE are so in the habit of thinking of plants as fixed and static things that it rarely occurs to us that they migrate over the earth's surface quite as extensively as do men or animals.

While it is probably true that vegetation originated simultaneously at different points on the globe's surface, not much observation is necessary to indicate that it does not always stay where it is put. Plants are peculiar and native to certain lands in a very definite way, but their love of adventure often carries them to the far corners of the earth. They are the most energetic and effective colonizers in existence. The complete history of plantdom would include the stories of invasions, con-

quests and revolutions quite as stirring as anything in human annals.

If it is absorbing to follow the racial movements of man, ancient and modern, it is equally fascinating for a lover of plants to investigate *their* migratory habits. We have exact records of many of their travels and can make interesting conjectures about the rest.

To a layman, the present distribution of plants may seem chaotic. He reads that certain families are natives of Europe and Australia, or North America and Africa and are absent from all intervening countries. The Alpine species *Primulas* and *Saxifrages* are common to both the Arctic and the Antarctic. There are fifty-eight European and New Zealand species which are identical. The British Grass *Poa Annua* is also found in the Andes of Brazil. Through what thousands of years of change and evolution have these things come about! Yet the results are no more complex than was the filling of America with its mixed and conglomerate human population.

In a general way, there is a measure of fixity to plant distribution. Certain plants have elec-

ted the tropics as their home; and only under the greatest stress of circumstance can they be induced to go elsewhere.

Tropical heat and moisture make for luxuriance of vegetation. There is a much greater variety there than in the North. Woody Vines climb the tallest trunks, where they intermingle their leaves and blossoms with those of their host. Gorgeous Air Plants beautify and perfume the forest. Stately Palms wave magnificent bouquets of pendulous fronds.

As we travel away from the equator, the vegetation takes on a simpler aspect. There are more annuals and more herbs. The number of Ferns, Grasses, and catkin-bearing Trees, like the Alder and the Birch, increase. The limited growing seasons make for a more restricted accumulation of tissue. Such tropic plants as have braved the rigours of the colder climates have dwindled much in size. The Castor Oil Tree becomes a humble annual (*Ricinus Communis*) only three to eight feet in height. Other tropical trees become so small that temperate zone folk tread them under foot.

When we get into the polar regions, all the plants take on a stunted and dwarfed appearance and, in some cases, retire almost entirely under ground. The number of genera and species is much reduced. The Oak, Walnut, Chesnut and Elm are replaced by the hardy conifers. At the point where vegetation becomes almost extinct are dwarf Birches, Willows and polar Blackberries (*Rubus Arcticus*). The simple Mosses and Lichens mark the last lingering evidences of life.

A curious feature of plant life in the polar regions is the rapid growth which it often exhibits. The summer of the Far North is short but it is one day of intense and blinding light. The sun shines continually throughout each twenty-four hours. By virtue of its stimulating power, plants are able to perform in a few weeks processes of development which take months under ordinary conditions.

It is illuminating to take a single country in a more favoured climate and, as far as possible, trace its plant history. The British Isles, because of their limited area, are a convenient field of study. An investigation of their set-

tlement by plants gives us many hints about prehistoric climatic and geographical changes.

Geologists generally believe that the British Isles were once joined to the mainland of Europe. It was at this time that they were settled by vegetation. Some of this plant life came from Spain and some from southwest France; there was also a Germanic group. The floating ice of the glacial period brought over hardy visitors from the Scandinavian peninsula. A few plant immigrants arrived from North America and landed on the west coast of Ireland.

St. Helena is an isolated volcanic mass built up seventeen thousand feet from the bed of the ocean. It therefore has its own peculiar vegetation, a portion of which is believed to have been evolved on the spot from the one-celled state. According to Sir Joseph Hooker, forty out of fifty flowering plants and ten out of twenty-six Ferns "with scarcely an exception cannot be regarded as very close specific allies of any other plants at all." Sixteen of the Ferns are common to Africa, India or America and were probably carried there by the wind.

Ocean currents also brought other species from Africa.

In 1883, a most interesting thing occured on the Asiatic island of Krakatoa. A violent volcanic eruption wiped every vestige of life off its surface. When the flow of lava ceased and the earth cooled once more, Krakatoa was to all intents and purposes a volcanic island newly risen from the sea. It presented the exact analogy of a recently created bit of land waiting to be settled by the plants. In 1883, it was as barren as the face of the moon. In 1888, a Mr. Hemsley described its appearance as follows:—

"The first phase of the new vegetation was a thin film of microscopic fresh-water Algae, forming a green, slimy coating, such as may often be seen on damp rocks, and furnishing a hygroscopic condition, in the absence of which it is doubtful whether the Ferns by which they were followed could have established themselves. Both Algae and Ferns are reproduced from microscopic spores, which are readily conveyed long distances by winds. Eleven species of Ferns were found, all of very

wide distribution, and some of them had already become common the fourth year after the eruption. Scattered here and there among the Ferns were isolated individuals of flowering plants, belonging to such kinds as have succulent seed-vessels eaten by birds, or such as have a light, feathery seed-vessel like the Dandelion and a host of others, and are wafted from place to place by the winds.

"On the seashore there were young plants and seeds (or seed-vessels containing seeds) of upwards of a dozen other herbs, shrubs and trees, all of them common on coral islands, and all known to have seeds capable of bearing long immersion in sea water without injury. Among the established seedlings were those of several large trees, and a Convolvulus that grows on almost all tropical coasts, often forming runners one hundred yards in length. There were Cocoanuts also, though none had germinated."

The farther such an island is from the land, the longer will vegetation take to get established. Darwin found that the isolated islands

of Keeling, after thousands of years of existence, contained only twenty kinds of flowering plants.

Although plants have no legs they are not devoid of mobility. When man uses the propulsive power of steam to travel by, he shows no greater ingenuity than do plants in their use of special devices of locomotion.

Species like the Tumble Weed (*Amarantus Albus*) pull up stakes, and, consigning themselves to the swift autumn winds, race across country at great speed, scattering seeds as they go. The Utriculariae or Bladderworts are true sailors and float about on inland streams like little ships. The Duckweeds and Wolffias also have aquatic habits.

However, most plants prefer to travel in embryo. In the form of small and microscopic seeds the force of gravity has little influence on them, and they can journey for long and incredible distances.

To this end practically every seed in existence is provided with some apparatus or appendage designed to help it make its way in the world. The Elm, the Linden, and the Ash

bear winged seeds, which are so efficient in riding the breeze that they are really miniature aeroplanes. The double wings of the Maple are very much like those of an insect. The seeds are released from their container in such manner as to acquire a whirling motion as they fall.

The progeny of the Willow is provided with long projecting hairs which curl together to form a tiny balloon. Feathery attachments called pappus enable the children of the Dandelion, the Thistle and the Fire Weed to go on long jaunts of exploration.

The seed-pods of the Sycamore are great rollers. Even ordinary nuts and fruits may be blown to considerable distances by the strong winds of autumn. The many edible seeds and fruits are carried gratis by birds and animals. The Mistletoe, for instance, is distributed entirely by them.

Walnuts, Butternuts, and Acorns bear water travel well, as do certain of the hard seeds. The Arrowhead (*Sagittaria*) has a self-made water-wing on which its offspring float.

Plant seeds, which like to travel on animals, all provide themselves with grappling irons in the shape of sharp hooks, spurs and spines with which they cling to their carriers. Everybody in the northern United States knows of the avidity with which the Cockle-bur clings to any passing object. The Touch-me-not (*Impatiens*), the Wistaria, and a host of others, actually shoot their seeds from their pods as from a gun.

Every vagrant breeze, every purling brook, every deep river, every ocean current, is a highway of travel in plantdom. The birds, the beasts, the insects, and not least, man himself, are involuntary vehicles on which our vegetable friends tour the world. The spores of Mosses, Lichens, Fungi and other cryptogams are so light that they find no difficulty in mounting into the air and traveling across the Atlantic or Pacific Oceans at will.

The complete record of plant conquests would fill many volumes. Their operations have extended into every land and have had influence on the world's history. It very often happens that plant invaders become so quickly

and thoroughly naturalized in a strange country that they go a long way toward supplanting the original inhabitants in a very short time.

It was Darwin who first noticed the extensive conquests of the Cardoon Artichoke (*Cynara Cardunculus*) in South America. In one section, these prickly plants covered an area of several hundred square miles, having entirely superceded the aborigines.

It is well known that the most troublesome of the American weeds are of British origin. On the other hand, the American water weed *Anacharis* blocks up small English streams. The grass called *Stipa Tortilis* has captured the steppes of southern Russia. The love of change seems to be an inherent tendency in plantdom. The Pigweed and the Morning Glory have come north from the tropics. The Canada Thistle, originally a foreigner in North America, has spread all over Canada and New England. The American *Erigeron Canadense* has emigrated to all parts of the world. The flora of Scandinavia, like its people, are aggressive colonizers. More than one hundred and fifty species have reached New Zealand alone

and nearly as many have established themselves in the eastern United States.

Some plants seem to be able to adapt themselves to any climate and therefore are born explorers, but the greater number are too fastidious regarding conditions of soil, heat, light and moisture to thrive well everywhere. It is a noticeable fact that the most successful plant invaders usually come in the wake of human colonizers and stick to the sphere of man's influence. For example, the Butter-and-Eggs (*Linaria Linaria*) has followed the railroad tracks almost entirely over the tropical and semi-tropical world. Sometimes, however, hardy plants advance into the primeval jungle, there to give battle to its lusty inhabitants.

On the whole, annuals have a better chance than perennials to gain a foothold in a new country. Every spring the weeds, grasses, and common flowering plants have to start all over again from a seed beginning. The spores of newcomers, therefore, have almost an equal chance with the established inhabitants. On the other hand, the bodies of perennials occupy the land in close-packed ranks all the year,

ready to dispute every inch of ground with an aggressor. It is very hard for new plants to gain entrance into a well-grown forest.

Man has been of tremendous aid in the distribution of plants over the earth's surface. Either consciously or unconsciously he takes his plants with him wherever he goes.

It was the Emperor Chang-Chien who carried the Bean, Cucumber, Lucern, Saffron, Walnut, Pea, Spinach and Watermelon from Asia to China about 200 B. C. The period of Roman conquest was a great epoch in the history of plant migrations. The Peach and the Apricot first became prominent as fruits at that time. Roman generals introduced the Pear, Peach, Cherry, Mulberry, Walnut and many ornamental shrubs into England.

From an obscure native of Bengal, the Sugar Cane has become an important plant of wide distribution. Coffee, a wild berry of Arabia, is now the chief crop of whole countries in the West Indies and South America. The yellow Maize of America has become a citizen of the world. The weak and humble Wheat is the

sole possessor of thousands of square miles of land in America, Russia and elsewhere.

All this has been wrought by man's efforts. When it is to his interest, he fights the battles of plantdom, and because of his superior knowledge and equipment is of tremendous service. Sometimes, however, he gives aid to his plant friends through motives that are quite unselfish. A romantic story is related of a French naval officer named Declieux who once elected to carry a Coffee Plant to the Colony of Martinique. The supply of water ran low during the voyage, and, rather than see the plant die, the man shared his daily glass with it, at considerate discomfort to himself.

Until man becomes all-wise, he will continue to make mistakes; and not least of these will be in connection with his investigations into the mysteries of Nature. It has happened more than once that he has introduced some new plant into an old land, or vice versa, and lived to thoroughly regret his action.

Sometime in 1890, a generously inclined individual threw a Water Hyacinth into the St. Johns River in Florida. In the space of a few

short years, that single plant had multiplied so prodigiously as to seriously impede navigation, lumbering and fishing.

Jack London tells of a similiar thing that happened in Hawaii: "In the United States, in greenhouses and old-fashioned gardens, grows a potted flowering shrub called Lantana; in India dwells a very noisy and quarrelsome bird known as the Myna. Both were introduced into Hawaii—the bird to feed upon the cut-worm of a certain moth; the flower to gladden with old associations the heart of a flower-loving missionary. But the land loved the Lantana. From a small flower that grew in a pot, the Lantana took to itself feet and walked out of the pot into the missionary's garden. Here it flourished and increased mightily in size and constitution. From over the garden wall came the love call of all Hawaii, and the Lantana responded to the call, climbed over the wall, and went a-roving and a-loving in the wild woods.

"And just as the Lantana had taken to itself feet, by the seduction of its seed it added to itself the wings of the Myna, which distribu-

ted its seed over every island in the group. From a delicate, hand-manicured, potted plant of the greenhouse, it shot up into a tough, and belligerent swashbuckler a fathom tall, that marched in serried ranks over the landscape, crushing beneath it and choking to death all the sweet native grasses, shrubs and flowers. In the lower forests, it became jungle, in the open, it became jungle only more so. It was practically impenetrable to man. The cattlemen wailed and vainly fought with it. It grew faster and spread faster than they could grub it out."

Then ensued a battle royal between man and plant. The man called to his aid hosts of insect mercenaries. "Some of these predacious enemies of the Lantana ate and sucked and sapped. Others made incubators out of the stems, tunnelled and undermined the flower-clusters, hatched maggots in the hearts of the seeds, or covered the leaves with suffocating fungoid growths. Thus simultaneously attacked in front and rear and flank, above and below, inside and out, the all-conquering swashbuckler recoiled. Today, the battle is almost

over, and what remains of the Lantana is putting up a sickly and losing fight. Unfortunately, one of the mercenaries has mutinied. This is the accidently introduced Mani Blight, which is now waging unholy war upon garden flowers and ornamental plants, and against which some other army of mercenaries must be turned."

Such unfortunate occurrences are sure to become more and more infrequent as plant emigration and immigration finds itself under increasingly drastic governmental regulation.

The Foreign Seed and Plant Introduction Service of the United States Department of Agriculture makes a scientific examination of all plants brought into the United States for propogation purposes. It rids them of objectional Bacteria and insect pests and refuses them admittance entirely if its experts decide that the newcomers will be harmful or injurious in any way.

The agents of the Service are constantly scouring the far corners of the earth for new and rare plants. In the twenty-four years of its existence it has introduced from abroad some

fifty thousand specimens of seeds and plant cuttings. Some of the successful immigrants have been Feterita (from Egypt), Sudan Grass, Bamboo and Alfalfa. New Zealand has yielded new types of Potatoes. Dwarf Almonds and strange Cherries and Apricots have come from Turkestan. All these have proven of commercial importance, as has Durum Russian Wheat, credited with opening up new areas in the Northwest, and the Navel Orange from Brazil which has created for itself a California industry covering thirty thousand acres and valued at fifteen million dollars per annum.

Painstaking and scientific methods are best when man attempts to aid Nature in her evolutionary processes, especially when they are in connection with the migration and distribution of plants.

CHAPTER IV

Comrades of the Plant World

".....which links by a fraternal tie
The meanest of His creatures with the high."
—Lamartine

THE first and greatest problem for every terrestrial creature is to live. The chief means of doing so is to eat. Therefore, the relation of being to being and species to species is dominated by the necessity for food. Among man this fact is somewhat masked and obscured, but in the rest of the world it is entirely plain and obvious. Again and again on every hand, we see that plant, animal, and man all maintain their life impulses by consuming the tissue of their fellows.

In view of this fundamental fact, we can afford to look with some degree of charity upon that class of plants which are termed parasites. These interesting creatures are merely carrying out in a very direct and apparent way a principle which permeates all domains of life. A

Tiger kills its prey; an Ox devours unoffending Grass; the parasitic Dodder robs some healthy neighbour of part of its juices.

The word "parasite" originally referred to a member of a college of priests who had their meals in common. Later, it came to mean living at another's expense, as large numbers of people did in classical times. When one realizes that there are twenty-five hundred species of parasitical seed plants, he hesitates to brand them all as thieves and degenerates. Taking into consideration plants which depend upon the soil fungi for part of their sustenance, we should have to call half the seed plants in the world "parasites." On a basis of strict accountability, it would also be necessary to classify all fruits as "parasites" as they draw nourishment from the parent boughs and give no return.

The fact is there are very few plants which are not more or less dependent upon some living fellow creature for their food supply. Sometimes the relation is strictly reciprocal; sometimes the advantage appears to greatly favour one or the other of the participants. In other cases the occurrence arises accidently

through chance proximity, without a conscious pact or deliberate contract.

Edward Step in his illuminating book *Messmates* sums up the matter admirably: "Two friends in good health, each able to earn his own living, agree for the sake of companionship to live together, but each defraying the cost of his own necessities and luxuries. This is a case of mutualism. Two other friends also agree to share quarters and have a common table; but one may be infirm and wealthy whilst the other is strong and comparatively poor. The infirm one offers to pay two-thirds of their common expenses if the other will contribute one third, plus his protection, cheerful companionship or other valuable help. This is a commensalism. The pair are messmates, each contributing to hotch-potch according to his ability or endowment, each affording what the other lacks, and both, therefore, benefitting from the partnership."

It must be admitted that there are cases of plant companionship in which, to all human perception, the material benefits seem directly one-sided, but who can conclusively deny that

the nourishment-giving partner may not receive some psychic or spiritual benefit from the union? The Orchids and many other tree-parasites bear flowers of exquisite beauty. Can we be quite sure that the trees do not like to adorn themselves with gorgeous ornaments of this kind? Such a desire would be quite natural.

Plants which are low and weak in the scale of evolution are very prone to enter into symbiotic relations. The Lichens are compound organisms in which green Algal cells live between fungous threads. The Fungus sucks up the water and mineral salts from the soil and the Alga combines them with carbon dioxide from the air to form palatable food for both. Such plant-partners have been observed to live together amiably for twenty-five years or more.

The Fungi and all plants which are "pale, fleshy, as if the decaying dead with a spirit of life had been animated" have no chlorophyll, the mysterious green substance which is necessary for the production of starch. They must either make alliances with plants which possess this vital elixir or live on decaying mat-

ter which contains elaborated food material. Many choose the latter course, but a goodly number, especially those of primitive structure, have entered into profitable partnerships.

The minute one-celled plants called Zoochlorella or Zooxanthella have chosen the fresh water sponge *Ephydatia Fluviatilis* for their messmates. Sometimes they live with the Hydra called *Viridis* and impart to it a bright green colour.

There are whole regiments of microscopic parasites which thrive on living plant tissue and cause spots and rust to appear on Apples, Peaches, Pears and other fruits and number among their cohorts Rose-blight, Wheat-rust, and various Mildews. The larger messmate does not receive very much benefit from the relation, in this instance, except when the minute guests serve to cover a cut or an abrasion with a protective mantle, just as Mildew shields cheese or jelly from decay.

Cases where Fungi render very valuable services to larger plants are exemplified by the Monotropa or Indian Pipe. This pallid scavenger grows on the decaying vegetable matter

of the woods. It toils not, neither does it make plant starch, but it is able to produce pretty, ghostly flowers and white scale-like leaves. On its roots thrive species of Fungi which perform the part of root hairs and in return receive nourishment from their host. Certain authorities claim that the Fungi get the better of the bargain, as the Monotropa has been known to maintain its health without them in laboratories. But the fact is the relation *does* exist with undisputed benefit to both parties.

Beech Drops germinate in contact with roots of the Beech tree, attach themselves there and raise yellow, seared stems covered with scales instead of leaves but bearing perfect flowers. The Broom-Rapes get their nourishment from the roots of Tobacco and Hemp in the same way.

Prominate among the larger parasitic plants is the Dodder or Devil's Thread. This vine derives all its sustenance from other plants and, as far as can be determined, gives no material return. From this standpoint, the Dodder is a robber pure and simple, a degenerate outcast from the community of decent plants. From

the viewpoint of this chapter, it is possible to believe that the host of the Dodder derives some spiritual or hidden material benefit from the union which makes it distinctly worth while. If such were not the case, it would seem that, through ages of evolutionary development, such plants as Flax would have devised means to escape the Dodder's clutches.

The Dodder inhabits low ground and pokes an inquiring head above the surface each spring much like any self-sustaining plant. However, it is not long before it attaches itself to some lusty neighbour by root-like suckers, which pierce the stem and extract the nourishing juices. If the supply seems adequate, the Dodder winds its yellow, yarn-like tendrils about the host and allows the roots which connect it to the earth to wither. Its absorbing tubercles look like caterpillar feet; their cells form a perfect graft with the host and gradually disperse through its body. If other plants are near enough, the Devil's Thread will reach out and tap their food supplies also. A single Dodder has been known to draw nourishment from five or six other plants of different fam-

ilies at the same time, thus indicating that it must have digestive machinery enough to appropriate these varying saps to its own uses. The Dodder has no chlorophyll and therefore no leaves but bears pretty little bell-like flowers which later produce seed.

In the tropical jungles are many parasites of brilliant aspect, which, having no leaves or root hairs, germinate directly on supporting plants and apply suckers to the tissues of their hosts. When seen from the ground, their short stems make them seem all flower, and often very handsome ones. The *Rafflessia Arnoldi* of Sumatra is a notable example.

Man cannot help condemning such plant practices. Yet all Nature is a struggle for existence. Does it not require some courage and hardihood to come out and do in a bold and open way what the rest of the universe is doing by indirect or underhand methods?

The beautiful Orchids belong to a botanic group of Epiphytes which may be classified as guests or lodgers. Being green, they are able to gather their own living from dust, rain and carbon dioxide in the air. All they

ask from their tree-hosts is a branch on which to perch. There are probably few trees which are not delighted to have such delicate, fairy-like creatures add to their own beauty and charm. They wear them much as a woman wears a rose in her hair.

In America there are well-mannered parasites such as the decorative Spanish Moss so common throughout the South. This plant is normal in all respects; except that, perched on a kindly tree, it draws all its nourishment from the air instead of through soil-piercing roots.

The Mistletoe is a perfect example of a mutualist. Early in its aerial life, it sends a root through the bark of its tree companion and during the spring and summer, absorbs much food. When winter days come, and the tree has lost its leaves, the grateful messmate reverses the process and sends into the heart of its friend the larger part of the nourishment which it has been able to store up during the prosperous weeks of summer. The seeds of the Mistletoe are interesting because they are covered with a sticky fluid which enables them to travel from tree to tree on the feet of birds.

That some plants are parasites from necessity or laziness rather than choice is indicated by a Brazilian variety of the Cuckoo-Pint which sits far up on some tree branch and, like an immense spider, sends down to the earth long delicate tubes through which it sometimes sucks food and water.

One of the most interesting facts in plantdom is the alliance maintained by Clovers, Beans, Vetches and other leguminous plants, with Bacteria belonging to the class *Pseudomonas*. No soil can be fertile unless it contains organic compounds of nitrogen. The earth Bacteria have discovered methods of producing these important substances, possibly extracting nitrogen distributed through the ground. These minute parasites attach themselves to the roots of the larger plants, which promptly enclose them in cysts or nodules where they can lead a sheltered life and manufacture assimilable food compounds for their hosts. When they die, the owners of the roots feed upon their bodies.

What is the art of grafting but a form of artificial parasitism? Very often a branch or

cutting is made to form a bodily union with some plant of an entirely dissimilar species. In some cases, the intruder sends roots into the tissue of its host like a true dependent. Grafts of Prickly Pears, Mexican Grapevines and Agaves put forth food-suckers in the soft flesh of the Giant Cactus or the Barrel Cactus much as they would do if planted in the earth. There is here no true diffusive union of partners but mere absorption on the part of the invader.

Even grafting of allied species of Grapes sometimes results in the young plants sending roots through the tissues of the scion, eventually reaching the earth by way of the body of the host. In such cases, the parasite also draws nutriment from its messmate by means of a superior osmotic pressure.

Almost everything lies in the point of view. No man, no animal, no plant is so debased and degraded that it does not radiate some little measure of helpfulness. If "all things work together for good," even that member of a plant union which seems to act upon that inverted principle of "all coming in and nothing going

out" has its legitimate place in the world. As for those numerous examples of share-alike partnerships, they illustrate the principle of the divine law of love which lies back of and above the very real hardships and cruelties of this work-a-day world.

FRIENDLY ALLIES BY THE WATER'S EDGE

CHAPTER V

Allies of the Plant World

"I wish I were a willow tree—
Young wind in the green hair of me
And old brown water round my feet,
And a familiar bird to greet."
—Elizabeth Fahnestock.

EVERY division of terrestrial life constitutes a struggle. The plants grow and carry on their business and social activities so unobtrusively that we seldom think of them as appealing to arms—yet their whole existence is a battle royal. They must fight with aspiring neighbours for every inch of their upward growth, and at the same time wage incessant warfare against a hundred insects and animal foes.

Under such strenuous conditions, it is only to be expected that the plants should seek profitable alliances with birds, insects and animals having interests similiar to their own. Such pacts are described by botanists as examples of

symbiosis; they most frequently occur between plants and insects, but the plants also have their working agreements with members of the other two great kingdoms of life. In fact, all Nature is a vast system of checks and balances, with every creature preying more or less upon every other creature, except when they can gain more by joining their efforts. Certain Humming-Birds lie in wait near plants which by their nectar-sweets attract swarms of insects, and hard by, Snakes lie in wait for the Birds. The Birds rid the plants of destroying pests; the part of the Snakes in a beneficent scheme of existence is not so apparent, but merely because we cannot see good in a thing is no argument that it does not exist.

Many of the most important alliances of plants are made in response to the law that "Nature abhors perpetual self-fertilization". This principle is one of the greatest in plant-dom; there is a constant necessity for the intercrossing of independent life-streams. The plants go to great lengths to see that the multiplication and evolution of the species is properly carried on.

We always associate Bees and flowers, yet it is probable, that, as a whole, the plants, especially in the tropics, depend more upon Ants than upon any other insects. Many vegetable folk deliberately employ them to keep their leaves and stalks free of obnoxious visitors. The Cow-Horn Orchid, like most plants which perch on trunks and branches, produces pseudo-bulbs into which its vitality can recede in dry seasons. There is always a small opening at the bottom of each of these little tubes, through which Ants enter. They honeycomb the interior with cells and galleries where they can be perfectly dry in the wettest weather. On the approach of Caterpillars, Cockroaches and other Orchid enemies, the residents issue in great swarms to protect their combined host and home.

The species *Coryanthes,* instead of pseudo-bulbs, grows great masses of fibrous aerial roots among which the Ants dwell. They are ever ready to repel invasions of Cockroaches and other crawlers who seek to eat the tender growing root-tips.

An Epiphyte which is particularly solicitous for the welfare of its insect allies is the Ant-nest Plant, *Rubiaceae Myrme.* This ingenious creature not only builds nests but builds them made-to-order. Certain enlargements on its stem are hollowed out into chambers with connecting galleries quite ready for their intended tenants. All the Ants have to do is to move in. The kind that usually enter the plant's service are fierce warriors, *Iridiomyrmex Myrmecodiae,* with very powerful stings. They form a formidable bodyguard.

Sometimes the Ant warriors of such compacts are quite satisfied to accept the free rental of their snug quarters as sufficient pay and seek their food elsewhere. More frequently, the alliance includes "board and lodging" with the plant issuing wages in the form of nectar, sweet pulp and other food.

The Cherry and Vetch are among plants which secrete a candy-like substance on their stalks which serves as an allurement for Ants to climb and establish their homes there. In many cases, these excretions are also barriers which prevent the Ants from hunting among

the plant's blossoms for honey, as they would thus destroy the precious grains of pollen.

The South American Imba-uba Tree, Cecropia, has a hollow trunk in which Bees and Ants dwell together amicably. The Polygonums Tree of the same continent has so many Ant allies that it is often entirely hollowed out by them. The process often operates so far that men break off the smaller twigs and use them as ready-made pipe stems. The Melastroma Plant of South America provides pouches on each leaf-stalk for the benefit of its black guardian Ants. The Tococas and Mermidones also have Ant-sacs.

In China it is a common practice of the Orange-growers to encourage the visitation of non-vegetarian Ants by placing selected species on trees and connecting the trees by bamboo poles over which the faithful insects can rush their forces to particularly threatened points.

Everyone knows of the large part the industrious Bee plays in the economy of the plant world. Few plants, there are, which are not aided in their love-making by this tiny brown

buzzer; some flowers depend upon him entirely in their efforts to propagate the species.

The Bees and their relatives are particularly welcome to the flowers because they do the work of fertilization so well. Wingless insects are undesirable because they offer little guarantee that they will successfully carry pollen to some other flower of the same species. Even if it is not brushed off in the course of their laborious travels, they are not at all particular what kind of flowers they visit and so offer small hope of carrying pollen to its correct destination. Flying insects of the Bee family seem to have the work of cross-fertilization directly assigned to them. On each of their separate, pollen-gathering journeys, they are partial to one particular kind of flower. As they flit from blossom to blossom of the same species, going in and out of flower and flower, rubbing against a group of stamens here and brushing against a pistil there, they fertilize plant after plant in grateful acknowledgment of the store of sweets they are collecting.

Many and ingenious are the methods which flowers adopt to make sure that only invited

and useful guests come to their nectar-feasts. The very Ants which guard the lower portions of a plant so well, might become mere greedy plunderers, if allowed to crawl within the flowers. It is not often that they do. Sometimes, the stalks and even the petals of flowers like the Rock-Lichens and the Butter-Wort are coated with some plant chemical exceedingly disagreeable for an insect to crawl over. Various alkaloids, resins and oils in the cell juices also make the flower and its leaves obnoxious to grazing animals. Many plants, like the Mullein and Stinging-Nettle, use bristles and prickles to repel Slugs and Caterpillars.

A common protective device is for a flower to place its nectar at the bottom of a long, narrow tube only accessible to a flying insect having a proboscis. In the *Antirrhinum* the entrance to the flower is closed to small crawlers by a very heavy corolla. Bees, because of their size and strength, can force their way through. It is said that as soon as the stigma of this flower has been fertilized, the corolla relaxes and Ants and their kind are free to enter and partake of such dainties as are left.

Nettles, Passion-flowers, and Lilies frequently line their interiors with stiff, in-pointing hairs which oppose a most effective palisade against anything that crawls, whereas a flyer provided with a proboscis can stand on the edge and, inserting his straw, drink up the best soda water in plantdom. This existence of proboscides in insects which help to cross-fertilize flowers is the very finest example we have of true mutualism. Here is a case where members of two supposedly different worlds of life have developed highly specialized organs in order that they might help each other.

It is said that Charles Darwin, after noting the extraordinary length of the spur of the Orchid *Angraecum Sesquipedale* of Madagascar predicted that some day there would be found in that country a moth with a proboscis ten to eleven inches long. Not many years after, Dr. Fritz Müller verified the sagacity of the famous scientist by finding an insect exactly answering this description.

The Birth-Wort (*Aristolochia Clematitis*) takes no chances with its insect visitors. In entering it, a Bee brushes easily by the down-

pointing hairs only to find that, when he attempts to go out again, the bristles present stiff, unyielding obstacles against his egress. In his excitement at this discovery, he buzzes around quite angrily and, without noticing it, thoroughly showers the stigma with pollen and incidentally covers his own body with a good supply to be carried on to the next stop. When this process is quite complete, the flower graciously relents, relaxes its hairs and allows the exasperated insect to escape.

The *Pedicularis* family uses similiar coercive methods, and by sharp teeth, forces insect-visitors to take a course through the flowers which brings them in contact with both stamens and pistils.

The purple Loosestrife, pretty dweller by banks and meadows, sets a rich table and so always has plenty of insect visitors. It produces six different kinds of yellow and green pollen, and is therefore sure to suit every taste. Incidentally it has two different sets of stamens and stigmas of three different lengths.

Night-blooming flowers only entertain after the sun goes down. All day long they look

withered and dead, but with the coming of the stars, they open up to show conspicuous white or light-tinted interiors. A flower like the Silene also exhales a rich, sensuous odor, which, with its light colour, serves to attract such insects as are abroad at night.

Sycamore and Lime trees have humble allies in the tiny mites which live in the retreats built of hairs to be found at the places where the veins of the leaves fork. During the day they hide away from sight, but at night they come out and scour the leaves clean of noxious bacteria and fungus spores.

Pollen of different plants, when examined under the miscrope, reveals wonderful facts about the reciprocal relations which exist between plants and insects. Wind-fertilized plants are nearly always without any special beauty of form, colour or scent, while plants which are fertilized by insects are most always conspicuous, brightly coloured and highly scented. In the same way, pollen of the Hazel, Birch, and Balsam Poplar, which is carried by the wind, is small, light, practically spherical and devoid of proturberances. Pollen of the

Primrose, Cowslip and Polyanthus, often carried by insects, is deeply furrowed, covered with spines and knobs, strung together by sticky threads and, in other ways, provided with apparatus which enables it to adhere to any object which it touches.

The pollen of the Hollyhock and the Dandelion consists of large, beautiful, spherical grains covered with spikes. The Rhododendrons, Azalias, and Fuchias produce great masses of grains bound together by viscid threads. Many of these bits of life-principle are geometric masterpieces. A pollen grain of the *Cobaea Scandens* is one of the most fascinating objects of the microscopic world. It is perfectly spherical and cut into small hexagonal facets like the eyes of a fly. Grains of pollen of all kinds vary between one two-thousandth and one two-hundredth of an inch in diameter.

Alliances between plants and birds are more important than we imagine. The tropical Humming-birds and the eastern Sun-birds are in habits exactly like the pollen-carrying insects. To watch one of these brilliantly coloured creatures hovering over a flower or flying

directly into a blossom after nectar, is to almost always mistake it for a Butterfly.

Many birds are invaluable allies of the plant world. They devour thousands of leaf-eating insects per day and so keep down the army of enemies which would otherwise destroy whole forests. Birds like the Woodpeckers rid tree bark of wood-boring crawlers.

In the human world every partner does not always live up to his agreements. And there are evidences that both plants and their allies sometimes engage in questionable practices, bordering on deception and chicanery.

The insects are often enough the offenders, and their crime is most frequently one of robbery. If they can get the sweets they are after without carrying out their share of the bargain, they will do so. Bumble Bees have been observed to cut through the flower-walls of a Nasturtium and so extract its nectar without coming near the pollen-producing stamens. Sweet Peas frequently ignore the insects and fertilize themselves. The Hawkweed (*Hieracium*) has so little faith in insect allies that it produces

seeds parthenogenetically, that is, without the union of sex elements.

Alliances which start out advantageously for both parties sometimes degenerate into mere sinecures for one or the other. The naturalists Ihering, Ule and Fiebrig, working in South America, a few years ago concluded that the association of the plant Cecropia and the Aztecan Ants, long regarded as a classic example of mutualism, is by far of greater benefit to the Ants. The openings which the Ants make into the hollow interiors of this plant also allow the entrance of certain destructive insects, and the Ants themselves attract Woodpeckers which damage the plants. It is also alleged that these same Ants, and the ones which inhabit the *Humboldtia Laurifolia,* are often so busy feasting on nectar that they do not stop to repel invasions of foliage-destroying insects.

While man is the greatest enemy of the plant world, he is also at times its greatest friend. When it is to his advantage or when he is prompted by a sincere love of Nature, he becomes a strong and helpful ally. He aids his fellow creatures of the vegetable world when

they are sick or injured and, by improving their environment and protecting them from attack and danger, enables them to develop to best advantage. A wizard like Luther Burbank helps them in their efforts at race improvement and development.

In Egypt and Arabia, man has acted as carrier of pollen for centuries, and has thus insured an abundant Date crop. The same thing is often done in other parts of the world with Apples, Pistachios, Melons, Cucumbers and other plants having unisexual flowers.

CHAPTER VI

Marriage Customs of Plants

"Pale primroses
That die unmarried."—Shakespeare

"LOVE consumes the plants" once wrote Linnaeus, and the observation of every student of Nature goes to confirm his statement. The plants marry and are given in marriage. Reproduction is undoubtedly their chief end in life.

The simplest and most primitive plants have no sex but produce new individuals by splitting their single cells in two. It is in the thread-like bodies of Pond Weeds that we find the first beginnings of the principle of generation by union. These lowly creatures consist of single cells strung end to end like beads in a necklace. When two of the living chains happen to find themselves parallel to each other, certain of the cells reach out and join those opposite them to form new cells. Such a mixture of life forces is always beneficial to the race.

In the higher plants the same process is carried out in a little more elaborate way. Of the two cells which unite, one is small and active, and is called the male or pollen cell. The other is larger, richer and more passive, and is the ovule or female cell.

It is one of the main objects of each plant's life to see that its ovules are fertilized by pollen grains from some other member of the same species. When this is impossible, flowers are reduced to fertilizing themselves, but if this continues very long, degeneracy is very apt to result. It is not wise to marry one's first cousin.

Many plants depend upon the wind to distribute their pollen. Such species bear slight, inconspicuous flowers which not infrequently cluster together in long, pendent catkins. This was undoubtedly the first and original form of plant marriage. Though often successful, it is very wasteful and undependable. "The wind bloweth where it listeth" and loses a million grains of pollen for every one it lodges.

One hazy day in the long ago, some plant had a brilliant idea. "There are a number of insects which are in the habit of paying me

unwelcome visits for the purpose of eating pollen. Why can't I make use of these thieves and turn their marauding habits to my own advantage?"

No sooner said than done, though it doubtless took many centuries to get the plan in thorough working order. It was a new departure in the plant world and led to various revolutionary changes. In all probability, there were no bright-hued flowers before the advent of pollen-eating insects. In the beginning, at least, flowers were developed as the signs by which plants advertised their wares. "We will make ourselves luringly attractive," reasoned the plants. "We will add to our bright-coloured petals the sweet delights of nectar and honey. While the insect is eating at our table, we will shower his back with pollen and, going forth to some floral neighbour, he will unwittingly become the marriage priest of our race."

This was the idea, and in many diverse and wonderful ways the plants have carried it out. The first flowers were developed by training certain stamens to flatten and expand themselves, daub their surfaces with colour, and so

become petals. This evolutionary fact can be seen today in the white Water Lily, where concentric rows of stamens gradually merge into petals. Double Roses and Poppies are examples of the same thing.

The formation of flowers was only the first step. It is not enough to get the insect to come to the plant. Once he is there, means must be found to make sure that he performs the marriage duties assigned to him. Each flower takes care of this problem in a different way.

At ordinary times, the Gorse is a closed flower, provided, however, with a little step or platform on which a Bee can alight. As soon as an industrious honey-seeker has settled down on this little floral porch, his pressure causes the entire corolla of the flower to spring violently open and shower him with pollen. A Gorse flower which has thus unburdened itself at once hangs down dejectedly and is no longer the object of insect regard. The Lupine and the English Bird's-Foot Trefoil entertain their tiny visitors in a similiar way.

There are two different arrangements of sexual organs in the Primrose. One variety is

provided with long stamens and a short pistil. The other has the reverse combination of short stamens and a long pistil. In both cases, the nectar is in a pit at the bottom of the flower. As long as an insect visits short-stamened flowers, he collects pollen on the upper part of his proboscis. Happening to enter a short-pistiled flower, this portion of his drinking tube is now opposite the female organ and fertilizes it. In the same way, the insect's feet gather pollen from the long-stamened flowers and deposit it in the long-pistiled variety. By such involved methods does this particular flower make sure of fertilization.

Sage flowers have only two stamens but they do the work of forty. Using their power of movement, they bend forward and deliberately embrace a bee as soon as he enters their chamber. They do not release him until he is covered with their yellow pollen.

The English Figwort has adopted repulsive methods of entertainment. It has contrived to make itself look like and give forth the odour of decaying meat, because it knows that it will thereby attract certain Wasps. The South Afri-

can Stapelia does the same thing with the idea of alluring Carrion Flies. Still another imitator of similiar kind is the pale-green Carrion Flower whose visitor is the Blow Fly.

When in repose, the stamens of the pink-white Mountain Laurel (*Kalmia Latifolia*) curve so that their anthers or pollen-bags fit into corresponding pits or depressions in the petals. When a Bumble Bee happens along and blunders among these delicate organs, the stamens spring up and shower his back with pollen.

Everyone is familiar with the purple barber pole of the Cuckoo Pint which stands up straight out of a pulpit-shaped leaf. This barber pole is the upper end of a fertilizing device of marvelous efficiency.

Down in the shelter of the cup-shaped leaf, the pole is covered with primitive male flowers, without petals or without sepals, in fact, nothing more than simple stamens. Below them are rudimentary female flowers consisting of unadorned pistils. Certain Midges and Flies are attracted into the leaf cavity of the plant by the store of sweets at its bottom. Traveling down

the pole, these would-be feasters readily pass the guardian hairs just above the stamens, pass the stamens themselves and unintentionally fertilize the pistils with pollen they have picked up on other marauding expeditions. Having partaken of honey, the Flies seek to escape, but now find the way barred by the down-pointing hairs which have bristled up in a militant manner. The insects must stay until the plant decides to release them, which is never until the stamens have ripened and showered them with a fresh supply of pollen.

The Orchids are among the most beautiful and extraordinary flowers in the world. Their noteworthy development has come about through their efforts to secure abundant and efficient insect fertilization. So certain are their methods that they ordinarily do not require the services of more than one stamen.

In one variety, the English Spotted Orchid, the pollen is enclosed in two sacks or bags provided with long stems. These sacs are lodged in special cavities near the pistil in such a manner that the sticky ends of the stems come in contact with the head of a nectar-sucking Bee.

They adhere firmly. When he departs he has two bulbous ornaments for a crest. At first they stand erect, but as he flies, the air dries them and they incline forward on curved stems. When he is ready for his next cup of honey, they are hanging down in front of his eyes like a new kind of pawnbroker's sign. It is no mere happenstance that in this new position the pollen sacs are deposited on the stigma of the second flower's pistil. By such ingenious marriage customs, the Orchids have become a dominant family in plantdom. They are in the ascendency even in the tropics, where their frail bodies have to compete with hosts of plants which are physically much more vigorous.

Between the Yucca and the Yucca Moth exists a wonderful life-long partnership for the purpose of furthering the reproductive processes of both. Surely, Nature moves in mysterious ways.

Insects are the chief marriage priests of the plant world, but in the tropics they are aided and abetted by Humming-Birds, Sun-Birds and Lories, which are all provided with long, tubular tongues.

Most insects act as if they were unaware of the important place they occupy in plant hymeneals. So intent are they on their honey-gathering that they become covered from head to foot with pollen without appearing to notice it. Yet in a few instances, the Bees not only recognize that they have been pressed into the plant's messenger service, but by underhand methods seek the rewards of labour without giving adequate return. They have learned how to cut a hole in the calyx tube of the Bean and the Scarlet Runner, and get at the precious honey by short cut. If all Bees and other fertilizing insects should master this trick, the flowers would have to wear defensive armour or perish.

Pollen to be effective must remain dry. The plants have perfected many devices to shield it from moisture. Frequently, the flowers hang so that their petals act as tiny umbrellas for it. Others wear rainy day hoods, and practically all close when the night mists are abroad.

The necessity for dry pollen obtains even among the water plants. If they are surface-floaters like the Pond Lily or the Victoria Regia,

it is easy enough for them to thrust their blossoms up into the air, where they may be as dry as though they were on land. The sub-aqueous plants have a harder problem and are sometimes driven to developing their flowers in leaf air-chambers below the surface. The Water Chestnut (*Trapa Natans*) makes itself buoyant at its flowering period with generated air and rises en masse to the surface. After fertilization, it sinks again to its sub-aqueous quiet.

Self-fertilization in its strictest sense occurs within the individual flower. Plants only resort to it as an extreme measure and commonly make use of many devices to prevent it. In the Iris, the petal-like stamens are in direct contact with the pistil and yet self-fertilization does not result, because the pollen surface is always carefully turned away from the ovary.

By bringing their pistils and stamens to maturity at different times, many flowers make sure that they will not fertilize themselves. Such is the case in the Bulbous Buttercup and the Arrowhead.

Flowers of the same tree or bush might be called distant cousins. Their union results in

healthy offspring, though the marriage of still more divergent individuals is preferable. Plants like the Begonia, which bear single-sex flowers, often grow in somewhat isolated positions and so must intermarry a great deal among themselves. Staminate flowers at the top of a stalk can shower pollen over many female flowers growing below them.

The exception always proves the rule, which explains why we find a few flowers which deliberately choose to fertilize themselves. In the Fuchsia, the flower droops, throwing the long pistil below the stamens, which can readily drop pollen onto it. Minute hooks hold the petals of the Indigo and Lucerne partly closed until the flower is completely developed. When they give way, the petals fly back, so shaking the whole flower that the anthers shower pollen on the pistil. The single-sex flowers of the Aloe bend near each other at mating time.

The Violets and Polygalas are also largely self-fertilizing. They are, therefore, borne under the leaves or close to the ground, where they attract little attention.

The love and marriages in plantdom may

seem to be largely instinctive and mechanical, but that is probably because we have not investigated them sufficiently. The Persian poet Osmai believed that the plants had affairs of the heart as real as those recorded in the human world. Here is his account of one:—

"I was possessor of a garden in which was a Palm Tree, which had every year produced abundance of fruit; but two seasons having passed away without its affording any, I sent for a person well acquainted with the culture of Palm Trees, to discover for me the cause of the failure.

"'An unhappy attachment,' observed the man, after a moment's inspection, 'is the sole cause why this Palm Tree produces no fruit.'

"He then climbed up the trunk, and looking around, discovered another Palm at no great distance, which he recognized as the object of my unhappy tree's affection; and he advised me to procure some of the powder from its blossoms and to scatter it over the branches. This I did; and the consequence was my Date Palm, whom unrequited love had kept barren, bore me an abundant harvest."

FLORAL OFFERINGS IN A MOUNTAIN CATHEDRAL

CHAPTER VII

Art in the Plant World

"As if the rainbows of the fresh mild spring
Had blossomed where they fell."

THE plants are perfect artists. From the budding of the Rose to the sudden shooting forth of the seeds of the Wistaria, everything they do is in perfect taste. Ugly flowers are decidedly uncommon. Those which human judgment declares to be less lovely than their fellows have their attractive points, if we take the trouble to look for them. If art is a desire for beauty, a searching after perfect harmony, then the plants and flowers are the most artistic creatures in the universe.

Plant colours are particularly interesting. The flowers are master-craftsmen when it comes to the adornment of dainty, delicate petals with pigments which are the distilled essence of a thousand rainbows. No other quality in the natural world gives man a deeper emotional enjoyment. Floral colours speak a

whole language of their own of which we can get only faint interpretations.

Cold biologists explain that the beautiful hues and shades of plantdom are largely designed to attract insects and so secure a necessary distribution of pollen. There is no doubt that this is true, but for one to believe that this is the sole function of a flower's beauty is to reduce the world to a materialistic basis and banish all thoughts of the esthetic, the spiritual and the ideal. The flowers are permitted to adorn themselves in bright raiment at least partly in order to satisfy the universal craving for the delicate and the artistic.

It should not be imagined that the gayest and most brilliantly coloured members of the plant world are always residents of the tropics. The hot countries undoubtedly produce many specimens of startling hue and pattern, but it is often their ostentation and exotic character, rather than their beauty or charm, which attract attention. They are apt to be a bit barbaric and not as numerous as they are reputed to be. For great masses of beautiful flowers, we do not go to Mid-Africa or Cuba, but to the

mountain-bound meadows of the Alps, the plains of Australia, or the prairies of America. What is more startlingly beautiful than a field of Yellow Buttercups or Black-eyed Susans which can be seen anywhere in the eastern United States? Where can our eyes feast upon a more wonderful scene than a field of Wild Verbenas and Delphiniums as found in Texas? In the tropics the flower masses are more scattered. Even the far-famed Orchids are only abundant in occasional favoured spots.

The gardens of our large country estates offer floral displays which cannot be rivaled anywhere. Our temperate zone Roses, Peonies, Hollyhocks, Wistaria, Lilacs, Lilies, Tulips, Hyacinths, Gentians, Asters, Anemonies and Poppies are the most delicate colour creations in existence. For brilliance and alluring charm nothing surpasses the Mountain Laurel and Rhododendrons of the East, or the Trumpet Vine and Yellow Jessamine of the South. The gorgeous Azalias, Camellias, Pelargoiums, Calceolarias and Cinerarias also belong to the regions which have cold periods in their annual weather schemes. Even the humble Gorse is

clothed in gold, while the prickly and much-despised Cactus bears little crimson-coloured bells.

It is quite evident that man got his original idea of colour from Nature, particularly the plant world. Why is it that we are inclined to wear green in spring, brown in autumn, and all manner of colours in summer? Simply because, consciously or unconsciously, we are imitating Nature. We take pigments and dyes and get a pale similitude of an exquisite flower. If it happens to be a Rose, we name the colour after it. Sometimes we name tints after the sky or an animal or a bird, but in these cases, we might just as well have gone to the flowers for our nomenclature.

Every tint and hue which we can ever hope to reproduce is present in the plant world. The flowers by no means monopolize them. On close examination, a single stalk and leaf exhibit a wonderful variety of colour. In the Begonia and the Sea Holly, the stalks are exactly the same colours as the flowers. The wild Cranesbill sports a crimson stem. The stalks of Poplar leaves are a vivid yellow. To speak of "green

leaves" is to speak in the most general of terms. What is more exquisite than the silver gray to be seen on the backs of many tree-leaves, notably the Alders, Willows, and Poplars? Many leaves join the Wild Lettuce in having purple backs. The reverse sides of Magnolias and Rhododendrons are red-brown. In the autumn, nearly all leaves show brilliant patches of colour.

In borrowing Nature's colours to set forth our ideas, we have become possessors of a mighty vehicle of expression. With yellow, we can speak of life, light, cheer and vitality. Red tells of fire, heat, blood, excitement and passion. Blue indicates coolness, quiet and restraint. In choosing green for its most universal colour, Nature harmonizes life and restraint, warmth and coolness, as represented by the component blue and yellow. In the same way, when she wants to concentrate the maximum colour power in a single fruit or flower, she uses orange, a combination of light and heat, vitality and excitement. Purple represents a neutralized idea. Red vitality is tempered with blue restraint, which results in mysticism.

Nature clothes the Poppy in red to suggest power and strength. The royal purple of the Aster and the Violet is purposely calculated to arouse a feeling of mystery and awe.

Our man-made cloth designs often show various plant forms intact in the weave. The same is true of lace, while one has only to look at the miniature flower gardens which women wear on their heads to realize the potent influence of plants in the domains of millinery. An important plant element seems to run through many fields of applied art.

In some ways, the beauties of form and structure are more appealing than chromatic charms. Lines are more refined and fundamental than colours. A feathery mass of tree-twigs seen against a distant horizon is exquisitely beautiful. A symmetrically shaped tree comes very close to presenting an idea of pure form. One may argue that it is impossible to dissociate all idea of colour from a natural object. This is theoretically true, but practically, while we are impressed by thc colour of the Rose, it is the structural beauty of the Palm and Weeping Willow which attracts our eye.

Nature is the true and original sculptor. From her we learn our rules of symmetry and design. All her plant creations are finished with a faithfulness to artistic principles which is quite exact. Nor does she build houses with false exteriors. Her structures show forth the necessity of truth in real esthetic creation. Bartholdi's exquisite Statue of Liberty, viewed from the interior, is an ugly, hollow tube. A stalk of corn not only has a pleasing exterior but is made up of symmetrically formed and packed interior cells. From a giant Redwood to a microscopic vegetable organism, every line and structual unit in the plant world is perfect in its inception and execution.

Each plant, viewed as a whole, has its own peculiar style of structural beauty—the variation of line and form which stamps it with charm. This differentiation extends to all parts of the plant and gives character to leaves, stem, flowers and fruit. Marvellous is the art worked out in the minute parts. The tendril of the Passion Flower, the radicle of a Seedling Maple, the feathery hair on a stalk of Mullein—all these are shaped according to the unknown

law of beauty. Probably every geometrical form exists in some seed pod or fruit. The artistic little seeds of the Milkweed and the Dandelion are packed into their containers with a skill which cannot be duplicated, once they are dislodged. There are a million seeds in the capsules of certain Orchids. Many seed vessels are tipped, balled, carved and frescoed.

The same delicate touch is seen down to the last cell. Plant stems range from the common tubular variety to four-sided, hexagonal and octagonal forms. Trees exhibit exquisite mosaics in their rough bark. Bell-shaped flowers and flowers which are tubes, rings, ovals, trumpets, horns, and cones are only some of the pleasing shapes to be found in this part of vegetable anatomy.

It is a significant thing that there are few straight lines in plantdom. Everything is built in fascinating and alluring curves. There is a definite idea of symmetry to be observed everywhere. The beautiful, five-pointed leaves of the Sweet Gum Tree are arranged so that each one fits into an interstice between two others and so obtains a maximum supply of air

and light. In general, leaves nearest the ground are largest, thus insuring each its supply of sunshine.

When we study ornamental design, ancient and modern, we see plant forms on all hands. The Greeks and the Moors were the only nations to be content with geometric shapes and lines—and they were only content at times. All other peoples have given plants and flowers a large place in their decorative conceptions. The Egyptians and the Assyrians, who may be considered the first civilized artists, used the Palm, Papyrus, Lotus and Lily. The Greeks and Romans were partial to the Acanthus, Olive, Ivy, Vine, Fir and Oak. The Gothic art of Germany, France and Spain featured the Lily, Rose, Pomegranate, Oak, Maple, Iris, Buttercup, Passion Flower and Trefoil. The modern Chinese are more conservative and seek inspiration only from the Aster and the Peony. The Japanese use the Almond, Cherry, Wistaria and the graceful Bamboo in their art work. These various plant forms are sometimes quite conventionalized but are readily recognizable, whether they occur in architecture, carvings,

paintings, illuminations, tapestries or cloth fabrics.

The plant world has been man's most constant and readily apprehended artistic model. Yet when we see the multitude of attractive lines, curves and shapes in Nature's great garden, we wonder that he has so limited his imitation. One rarely sees the Thorn-Apple, the Hawthorn, the Daisy or the Tulip in wood or stone, yet they are all exquisitely beautiful.

Again, artists and artisans throughout the centuries have nearly always confined themselves to but two phases of plant life — the leaves and the matured fruit. Tendrils have been neglected or treated with characterless mediocrity. Thorns, leaf stipules, buds, pods, and leaf scars have been universally overlooked. Who has ever seen the fruit of the Rose in ornamental art? Why is it no one has thought to use the leaf scars of trees like the Horse Chestnut as decorative units?

Grapes and Pomegranates are reproduced with some justice, but the various small berries almost always appear as miscellaneous spherical bodies, whereas they are really greatly

varied. The Snowberry, Privet, Laurel and Barberry have distinct characteristics of form and shape.

There are chances for worlds of artistic expression in various seed pods and fruit vessels. An open Pea Pod occurs in certain Renaissance ornament. Why not (and this is not intended to be humorous) a String Bean?

Even a lowly thing like the scarred stalk of an old Cabbage has a pattern worthy of imitation. The shields or remains of leaves of former seasons form an artistic detail of the growing Palm Tree. The Romans occasionally reproduced them on their columns. Leaf shields are also met with in Greek border ornament.

Why must our sculptors represent the various fruits as bursting with mature mellowness? In many cases, the unripe fruit is artistically more attractive than when in the later stages of development.

We rarely think of disease or decay as being pleasing, yet some plants are artistic even in their dissolution. Certain galls and cankers draw beautiful designs on the bodies of their victims.

Everything in plantdom has its own peculiar style of structure and beauty. All are worthy of imitation and reproduction, provided only it is done in the right place and the right way. It must be remembered that, in origin, ornament was first symbolic and then decorative. Real ornament is never unduly prominent but subordinates itself to the idea and structure of the whole.

Man has imitated the plants also in things of a lowlier nature. Cups, vases, pitchers and other utensils were undoubtedly first suggested by similar shapes in plantdom. It is not too fantastic to imagine that the smoking pipe is modelled after the flower known as the Dutchman's Pipe. An electric wire running down the chain of a suspended lighting fixture looks all the world like a climbing vine. Human jewelry has its prototype among the flowers. Our garden beauties powdered their faces long before their human sisters ever thought of that method of self-adornment. It is said that Greek dancers and athletes sometimes exercised before certain slender plants in order to pattern their bodies after them.

We are not all artists or interior decorators, and yet we can all make use of the artistic possibilities present and inherent in our plant friends. We can cultivate and further the use of plants and flowers in and about our homes. Europe is far ahead of us in this respect. In England, a city house may be ever so frowsy and run-down but it will be sure to have its well-kept window boxes. The suburban homes of labourers and other lowly folk are often veritable bowers of loveliness. The German must have a garden in which to drink his beer. If there is none handy, he builds one, and cool and delightful he makes it. In many European cities, all the houses come out to the building line and even arch the sidewalks. Not a bit of greensward is in sight. Yet shrubs, flowers and vines spring from every sill and balcony and so make the streets to blossom as the Rose.

American cities are too inclined to be barren wastes of brick and stone, with but scant provision for plant beauty. Even the rich, who have their elaborate and beautiful country gardens, seem to forget the plants and flowers when they come to the city. The self-tending

Ampelopsis and Wistaria vines are the only plants at all common. Our short summer season and the fact that so many people do not occupy their city homes in warm weather are a little discouraging, but need not shake the enthusiasm of any one really interested in plants. For a few dollars a season florists will assume all care of exterior plants and vines.

The man who has a little plot of ground before his door is indeed fortunate. Even a well-clipped grass lawn is a refreshing asset. Sweet Peas train well against a wall. Pansies flourish in shady spots and Nasturtiums wax beautiful where other plants fail.

A brown stone front, flushed to the sidewalk in the middle of a block, need not go without floral decoration. Even a terra cotta box on either side of the entrance is capable of holding much growing joy. Evergreen shrubs fit well into such surroundings. A window box has great possibilities. In early spring, Crocus, Narcissus and Hyacinth flourish in it to advantage. Ivy-Geraniums of smooth waxy leaves and graceful loose sprays will grow all summer. Vines of various kinds can be trained

so as to make very effective window screens.

The subject of home plants is fascinating. It is well to note that it is not always necessary to go in for the more elaborate varieties. It is surprising what a delicate and pleasing decoration is made by so humble a thing as a sprouting Carrot or a Sweet Potato Vine.

Outdoor and landscape gardening are whole sciences unto themselves. In general, a Renaissance house looks best surrounded by formal and well-clipt flower beds. Houses on the Gothic order should have undulating lawns and irregular groups of shrubs and trees about them.

Plants and flowers are the first and original artists. Their creations are our best and most worthy models. We can use them both as examples to be imitated and beautiful objects with which to surround ourselves. They are one of our greatest esthetic inspirations.

CHAPTER VIII

Music in the Plant World

"Many voices there are in Nature's choir, and none but were good to hear
Had we mastered the laws of their music well, and could read their meaning clear;
But we who can feel at Nature's touch, cannot think as yet with her thought;
And I only know that the sough of the pines with a spell of its own is fraught."

MUSIC is a language—a species of soft, dreamy speech which makes up for its lack of definiteness and precision by a beauty and harmony which can best be described as divine. Indeed, the ancient Greeks made music an all-inclusive term for the higher conceptions of life. Dancing, poetry, and even science were supposed to be under its sway, while the revolution of the heavenly bodies created that "music of the spheres" which entertained the gods.

It would be better for mankind if this sentiment were more popular today. It is a narrow notion which confines the idea of musical har-

mony to the sounds produced by certain man-made instruments. Art which is restricted to workings in oil may be very pleasing but it is also very much limited. Music which is only interpreted on a violin or a piano falls far short of its grandest possibilities. To certain minds, the sighing of the wind through a Pine forest is more exquisitely expressive than a hundred breath-blown symphonies. When men cannot agree as to what is music among the sounds produced by their self-created instruments, dare they lightly ignore the many pleasing sounds which accompany the operations of Nature?

To an American ear, Chinese singing sounds like squealing and a Fiji concert like a vociferous boiler factory. Yet a Chinaman or a Fiji Islander will leave our grandest operatic efforts in disgust, though he may be pleased with the preceding orchestral tunings. Where are we to set the standard? Is it not safest to fall back on Nature for our truest conceptions?

The real sublimity of Nature lies in her vocalism. A soundless world would be greatly lacking in charm. The endearing noises of the woods and the fields often become so familiar

that we fail to notice their individual merits. Yet they are there. Their sudden cessation would leave a terrible and unbearable gap. The woods are filled with gaily costumed feathered minstrels. The meadows are great emerald stages of song and fancy. The very grass roots are filled with little insect-fiddlers who chirp cheerfulness. Wind, water and rain all furnish a grand and beautiful accompaniment.

Nature sings in the inharmonic scale, that is, a scale which takes in all intervals. Between the piano notes "C" and "D" lies a great space. They only represent halting points in the ascent of sound. Just as in the spectrum there are a hundred variations of shade between blue and green, so the cultivated human voice can hint at a hundred intervals between "C" and "D". Nature uses all the tiny shades of sound there are, and certain humans have followed suit. To the Arabians, water "lisps in a murmuring scale."

Occasionally, Nature uses the diatonic scale familiar to our western civilization. When the wind unites its vibrations into the long shrill

note we call the whistle, it is playing according to our musical rules. Water, when falling perpendicularly from a great height also gives forth a long, steady note. Even the rhythmical quality so essential to good music is not lacking in such phenomena as rain pattering on dry leaves. This sound has proved unusually appealing to many people. The Mexicans sometimes attempt to imitate it by means of clay rattles.

Not only does the countryside continually sing a great symphony, but each region has its own acoustic properties. While large cities maintain a discordant and incessant roar, the country is filled with soft and pleasing voices. Birds, animals, water and wind give forth quaint musings of the most soothing nature. Once in a while the woods go on a musical jag and every instrument becomes discordant. Under the influence of the bright moonlight, the inhabitants of the South American jungles sometimes seem to go mad. The hoarse roars of the Tiger mingle with the piercing shrieks of Parrots and the shrill wailings of Monkeys, while the croaking of Bull Frogs and the dismal

hoot of Owls is deafening. Jaguars scream as they chase Monkeys through the tree-tops.

The various members of the plant kingdom are the principal instruments upon which the wind plays. Without the obstruction offered by plants, trees, rocks, and houses, we should not hear the wind at all. The trees, because of their size and exposed positions, are most noted as plant-musicians, but the grasses and herbs are also very susceptible to the caressings of the wind.

Who has not heard and gloried in the music of the Pines? The sharp needles of these big conifers seem unusually fitted for esthetic expression. They are the Aeolian harps of the woods. During a storm, they sing in a mighty chorus of acclaim. At such a time, the breaking of many small branches sounds like the snapping of overstrained violin strings.

Almost any tree located on a cliff or on the edge of a mountain, becomes a musician of the first order. It is apt to take on the sorrowful tendencies of solitude. The weepings, wailings, murmurings, groanings, sighs and whispers of the universe vibrate through its branches.

It would seem as if such a tree were trying to express many mysterious wonders of which man has little knowledge.

The trees are not altogether dependent upon their leaves for their music. The barren branches of fall and winter sing in a most attractive way. Their dry and discarded leaves litter the ground and carry on crackly songs of their own, or sing as they play tag in whirls of wind. The Elm is a pleasing autumn singer and the Willows, when covered with ice, rattle their twigs like a minstrel's bones. As the winter wind hums around the Cottonwood Trees, it rocks the seed balls in their natural cradles with a sighing, crooning sound. This is the way the Tree sings to her babies! When the wind soughs through a hollow tree, it produces a ghostly sound suggestive of a mourning or dying person. A current of air rubbing two boughs together causes a scrunching sound which sends the shivers up one's back.

It is reasonable to believe that every tree and plant has its own individual voice as set in motion by the wind. A Nature-lover does not have much difficulty in distinguishing a great many.

The desert Sage whistles in the wind; the Cedar laughs in the storm; the air rustles through a Wheat field; an agitated Sugar Cane or Corn field gives forth a sound like tinkling glass. The noise produced by a high wind in the Southern Smilax has been likened to a harp struck at random.

The bursting pods of the Witch Hazel pop gently and the seeds fall among the dead leaves like so many buck shot; the Oxalis sends forth its seed-babies with the crack of a pistol shot. Members of the Bean family moan in the breeze like plaintive violins. The Squirting Cucumber gurgles not unlike certain frogs. The Sunflower is a professional drummer who rattles his seeds about in his pods. The Rattlesnake Iris holds its seed-capsule in such a way that it gives an excellent imitation of the warning noise of the reptile for which it is named. Catalpa pods snap like horse-whips, but Cat-Tails sigh like small reed instruments.

Early man gained more inspiration and pleasure from the music of the plants than his wiser but more worldly successors. It is said that the idea for the first flute was obtained by lis-

tening to the wind sigh through the Reeds on the shore of a lake. The first stringed instrument was probably a fibre accidentally stretched across a hollow shell. The classic Aeolian harp consisted of a wooden frame containing a thin sounding-board over which were stretched a number of strips of cat-gut. If placed before a half-open window so that an air current strikes it sideways, it gives forth a great volume of harmonious notes in several octaves. This is a clear case of catching the music of the wind. In a cruder, less harmonious way, the Japanese glass tinklers of our day do the same thing. The humming of telegraph wires and the strange chirping of a wireless instrument are also a kind of singing.

All the plants are not expert musicians, which explains why they often seek to make up for their own deficiencies by hiring numerous birds and insects to make melody for them. These musicians are employed in the truest sense of the word and receive their pay in food, shelter and protection. In the air and on the ground, by day and by night, they sing and fiddle for their hosts. The broad leaves of the

Water Lily (*Victoria Regia*) are veritable music schools of Frog practice. Every voice from croaking bass to youthful tenor is heard! Every tree has its Frogs and Birds—every bush and shrub innumerable insect warblers.

The birds are the plants' vocalists. Their songs and delightful twitterings are among the most familiar things in Nature. The music of the large body of insect-instrumentalists is carried on in such obscure places, and often so far down among the very roots of the plants, that a considerable investigation of their methods may not be amiss. They are especially active after sundown.

The common Grasshoppers form a great corps of violinists. A large vein on the inside of their thighs makes an ideal bow. It is roughened not with resin but by a hundred minute spines. When this vein is rubbed to and fro on the serrated veins of the insect's wing-cover, a shrill tone is produced. Sitting on its haunches, the Grasshopper saws away with both hind legs at a great rate. The interesting discovery has been made that the velocity of the strokes increases with the tempera-

ture. Grasshoppers in large swarms emit a low roar.

The Locust is a near relative of the Grasshopper. His music is produced by scraping one wing across the other. The Cricket uses the same method. When he is a house species, he fiddles in a higher tone. The gold-green Muskback Beetle is an exquisite violinist. His instrumental methods are most peculiar. His sharp breast acts as a bow which he draws across a small group of veins on his wing covers. The resulting music is so faint as to be almost inaudible.

To Bees, Wasps, Hornets, Flies and Mosquitoes we may ascribe reed instruments. They depend upon the rapid vibration of their tiny wings to get their effects. The respiration openings distributed over the body of a Bee, by giving resonance to the tone, aid in the process and turn the whole insect's body into a small clarionet. The drowsy buzz of the honey-gatherer is only attained by swinging its wings at the rate of four hundred vibrations a minute. People who have good ears for music have observed that the ordinary Bee drones

his song out on G sharp. The House-Fly is credited with singing at F with a preliminary grace note on E. Everyone is familiar with the high thin plaint of the Mosquito.

There are many drummers in the insect orchestra. The Cicada operates a small kettle drum. On the front of its body, a tough membrane is stretched over a small cavity. When set in motion by a special muscle, it gives out a surprisingly agreeable sound. The Greeks enjoyed this music so well that they often caged the Cicada much as they would a bird. In the hatching time of the seventeen-year variety, the energetic drumming of thousands of the insects rises into a scream which is far from melodious. Under such conditions, the noise can be heard for half a mile. Travelers tell of a giant South American species which produces a drumming which is as loud as a locomotive whistle. An uncanny drummer is the "Death Watch Beetle." It uses its head for drumsticks and when in the wood of furniture often plays a tattoo with considerable skill. Superstitious people, for no apparent good reason, sometimes insist this is a warning of impending death. Even the pretty

little Butterfly on occasion is a drummer. With hooks on its wings, it makes a sharp crackle, not unlike one of the weird noises sometimes used by human "traps." Beetles play the bones.

The Bamboo Tree is sometimes the possessor of a whole corps of intelligent and efficient drummers. They attach themselves to the under side of the leaves, from which vantage-point they strike them with their heads whenever their services are required. An Ant of the *Sumatratran* species keeps wonderful time. Though spread out over a number of square yards of leaf space, a group of these tiny creatures will start and stop tapping at the same instant.

Perhaps in some far-distant age, mankind will begin remotely to understand the significance of the music of the plant world and its allies. We have no right to say that the plants are not true musicians. While we may only understand their system of harmony in part, we can realize it contains hidden beauties just as the presence of microscopic organisms in the world is indicated by their effects rather than by actual perception.

CHAPTER IX

Science in the Plant World

"Weak with nice sense, the chaste Mimosa stands,
From each rude touch withdraws her timid hands."

PLANTS are profound scientists. Their knowledge may not be as broad and far-reaching as that of man, but they are more successful workers than he. With all his wonderful discoveries in physics and chemistry, man as a class has not yet learned to conduct his own body so as to make it yield the highest efficiency. In fact, members of the human race are today wearing out their frames at a faster rate than ever before. Adept at running huge mechanisms of steel, they are neglectful of those most delicate and wonderful machines which are bound up with their own life processes.

Plants are not so prodigal. Whenever they are given a chance, they develop and expand their powers in the most marvelous way. They bring out the latent strength in their beings and so conduct themselves as to conserve their ener-

gies. Whether by instinct, reason or blind force they always know just what to do and how to make the most of their heredity and environment. Their efficiency rating is one hundred per cent.

As the whole life of all plants is a scientific progression, we can only consider in the brief limits of this chapter some of the more startling instances of the marvelous sense they exhibit in dealing with Nature's forces.

Probably one of the reasons we do not always think of plants in the human, sympathetic way we should, is that we are inclined to regard them as quiet, static objects, playthings of every wind that blows upon them. Such is far from the case. Life is motion and the plants are very much alive and very much in motion. From the tiniest cell to the largest tree they exhibit constant, pulsating movements. Many of the movements are described through so small a space as ordinarily to escape our notice, but a little observation makes them quite apparent. They all have a well-directed, scientific purpose.

What is plant growth itself but motion up-

ward and outward? If a telescope or an instrument such as Sir Jaghadish Bose's crescograph be trained on a healthy plant, it is possible to see the growth actually take place before the eye somewhat as it is managed in motion pictures. Travelers aver that if a Banana Plant be cut off close to the ground and the surrounding soil well supplied with water, the sturdy creature will make such strenuous efforts to destroy the effects of its mutilation that its growth may easily be perceived with the unaided eye, and a full-sized leaf produced in a single day.

Leaves and flowers are usually quite mobile. When they go to sleep, they droop and fold their edges together very carefully, sometimes to such an extent as to make themselves almost invisible. Even such an astute man as Linnaeus was once completely deceived by some sleeping specimens of Lotus. They were very fine red flowers and he was proud of them. Taking a friend to view them one evening by lantern-light, what was his dismay to find that they had completely disappeared. He concluded that they had been stolen or eaten by insects and went away, only to find them in full array

on his return the next morning. It took several nocturnal visits to unravel the mystery and discover that the flowers folded themselves and retired so adroitly into the surrounding foliage each evening that they were completely hidden.

The Acacia is a plant which closes up at night; the same phenomenon is very striking in the Oxalis. The common Bean sleeps standing: that is, its leaves close upward instead of downward. The little blue Veronica flower, so strikingly brilliant and attractive in the daytime, tucks itself in so snugly at bedtime that it becomes quite inconspicous. A Marigold called *Calendula Pluvialis* even contracts its corolla every time the sun is veiled by a passing cloud. These sleep movements all have a scientific purpose. Their main object, just as in animals, is to reduce bodily activities to a low ebb and so to give the plant a chance to recuperate for another day's efforts. The contraction of all surfaces cuts down the radiation of heat and moisture and presents less resistance to outside elements. The plant is in a quiescent, somnolent state.

There are other movements of leaves and flowers the object of which is not quite so apparent. For instance, there is the *Hedysarum Gyrans* or Oscillating Sainfoin. Each of its leaves has three folioles. The center one is very large and stands bolt upright, except at night, when it condescends to bend its head in sleep. The two lateral folioles are in perpetual oscillation both day and night. Nothing but a very hot sun seems able to stop their movement. Possibly, this plant is a fresh air fiend which requires a steady atmospheric flow upon its respiratory surfaces! The two lateral folioles of each leaf are delegated to act as fans and blow a constant supply of air upon their majestic brother.

Similar oscillations have been noticed in some Orchids, where a part of the flower's corolla rises and falls with a regular rhythm not unlike the beating of a human pulse.

The stamens and pistils of flowers sometimes have the power of movement. If an insect, wandering about in the flower of the Barberry Tree (Berberis Vulgaris), happens to touch the base of a stamen, it bends forward with a

quick, spring-like motion and presently straightens up again. The evident intent is to shower some pollen on the little intruder with the hope that he may carry its vital principle to some neighbour of the same species.

In the *Parnassia Palustris,* fortunate observers have sometimes seen the five stamens bend forward and beat on the head of the pistil in rotation as if on an anvil. Perhaps outside pollen-carrying agencies have passed this particular flower by and, in desperation, it is resorting to self-fertilization.

The *Junger Mania,* a plant allied to the Mosses, shows knowledge of the laws of mechanics when it uses a natural spring coiled in a small tube to project its seeds out into the world. Seeds of fresh-water Algae swim about for a few hours after leaving their mother-plant, vibrating their cilia with great rapidity. It is the ability of certain one-celled plants to move about freely which causes considerable discussion as to whether they are really not animals. The Diatoms are examples. They propel themselves through the water by oscillating their whole bodies from side to side. To

reverse their direction they go backward like a ferryboat.

The ancients as far back as Aristotle recognized the sensitiveness of plants to light and their eager use of its life-giving properties. In fact, one has only to watch the Sun-Flower follow the orb of day across the heavens to realize that there must be something vital in sunlight for the plants. What interests us is that they have the instinct or the knowledge to so present their surfaces to the light that they receive a maximum benefit from its influences. From the aristocratic indoor potted plant to the wild trees and shrubs on the edge of a thicket, we notice a vigorous straining toward the light. Each leaf is tilted at just the right angle to receive the largest possible share of energy, for the leaves are starch factories for which the sun furnishes the motive power.

Botanists tell us that this heliotropism or turning motion toward the light is due to the tendency of most leaves to arrange themselves perpendicularly to the sun's rays. Tendrils may be apheliotropic or tend to turn away from the light. Morning Glories or Wistaria, which

climb up whatever support is handy, exhibit insensibility to light no matter from what angle it strikes. Stems, flower and leaves of all plants each give a different and scientific reaction to light in a way which looks much like directing thought.

Nothing is more scientific than the skill with which plants co-operate with gravity in constructing their root systems. The roots are often trained to grow out horizontally and resist gravity for a certain distance. Then they gracefully yield to its pulling power, and, curving their tips downward, grow straight toward the center of the earth. Any secondary roots which are sent out again start horizontally to repeat the above process on a smaller scale. All this makes for an efficient, well-balanced root-system.

A curious motion which is not thoroughly understood is a slight gyratory movement observable in the tips of all living plants. It is possible that it is connected in some way with the earth's rotation or is it merely a kind of groping, feeling gesture? In the case of roots, where the same gyrations occur, it undoubtedly

serves that purpose. A revolving root tip makes a very efficient drill with which the hardy plant may bore a way through refractory soil. It is claimed that the great whirling sweeps made by tendrils of various climbers are merely amplifications of the circumnutation occurring in all plant terminals.

Before leaving the subject of scientific movement in the plant world, it will be of interest to briefly consider some of the vegetable motions which are called forth by the stimulus of touch. Almost everyone is familiar with the Sensitive Plant and its double rows of tiny leaves. Touch any one of them and the whole group will instantly begin to contract and bend toward the stalk. We say begin, for so slow is the transmission of the impulse that one can readily see its progress, as one after another of the leaves respond.

A motion which has forethought and design behind it occurs in the leaves of the famous and crafty Venus Fly-Trap. Two sections of leaves edged with teeth-like nerve-hairs form the two halves of an enticing-looking bowl and cover. The slightest contact with one of the delicate

hairs will cause the trap to shut together and imprison any sweet-toothed member of the insect world which has happened to stray inside. An aquatic form of the same thing occurs in a species of Bladderwort which spreads a leaf-net cunningly shaped to look like a fish's mouth. Frightened baby-fishes, accustomed to seek their mother's throat in time of danger, sometimes swim in and, brushing certain nerve-hairs near the entrance, cause the lips to close and leave them to slow dissolution. Both sinister and scientific are the movements of carniverous plants.

Far from being static or quiescent, the plant world is a kingdom of energetic, vibratory motion—a motion which is cool and calculating and which rarely fails to accomplish its purpose. Even the protoplasm of microscopic plant cells is in constant movement. If a thin slice of Sycamore bark be placed under a microscope, a regular circulation of cell-liquid, suggestive of blood circulation in animals, can be observed.

Plants show great skill in their use of water. It is their storage of liquid in their cells which

makes their soft bodies rigid and so makes movement possible. This property sometimes called turgidity was discovered by the scientist De Vries in 1877, the same year that Pfeffer established the theory of osmosis. This latter is a phenomenon which physicists find very difficult to explain and involves the transmutation of one liquid into another through the medium of an intervening membrane.

Some plants have aquired the faculty of storing water in their bodies, on which, camel-like, they can subsist for long periods of time. A certain large tree-cactus of the American desert sometimes stores up as much as seventeen hundred pounds or five barrels of water in the wet season. When drought comes, its roots dry up and it lives entirely on its internal resources. It is said that an eighteen-foot specimen can exist for a year on its stored-up liquid. A branch on such a plant may live and bloom after the trunk is dead. Many ordinary plants, such as Turnips, Carrots, and Beets, store water along with starch and dextrose in their underground tubers. Such subterranean reservoirs are preferable to those above ground.

Plants have paid particular attention to the manipulation of gases. They maintain an internal atmosphere of their own composed of oxygen, nitrogen and carbon dioxide in proportions varying greatly from those of the outside air. If the stem of a Water Lily be broken below the surface of a pond, gas bubbles will often be observed to issue from the wound, indicating that the internal gas pressure of this particular plant is greater than that of the external air. In other cases, the reverse is true and we find partial vacuums within the bodies of plants.

Man long ago found it impossible to "live on air" but the plants have solved the difficulty of aerial existence and have become creatures of the air rather than the earth, so far as their food is concerned. The great bulk of the largest tree is preponderantly composed of carbon, which has been slowly and labouriously extracted from the air. The mineral salts and water which have been filtered out of the ground by the roots are essential but are present in a much lesser quantity.

It is well known that plants breathe in carbon dioxide and breathe out oxygen. This can be

graphically demonstrated by placing a plant in a glass jar of carbon dioxide inverted in water. If its life processes are quickened by exposure to sunlight, the plant will replace the CO_2 with oxygen in a day. A more striking example is furnished by any aquatic plant accustomed to growing submerged in ponds and rivers. Placed in a water-filled bottle inverted in a pan of water, it will generate oxygen so rapidly that the bubbles can be seen forming on the leaves when the sun is allowed to strike them fully. The bottle will become filled with oxygen in a few hours, and its presence can be demonstrated with the usual ember test.

Opposed to the absorption of carbon dioxide and the breathing out of oxygen, which is really a digestive operation, the plants, queerly enough, carry on a directly opposite process which involves the absorption of oxygen and the breathing out of carbon dioxide. This is a respiratory process akin to breathing in animals. It is carried on in such a relatively small way that it does not seriously affect the statement that "plants breathe in carbon dioxide and breathe out oxygen" and so are purifiers

of the air which man and animals contaminate.

Besides this general use of gases common to nearly all plants, a few of the members of the vegetable world specialize in the production of protective and poisonous vapours of various composition. One of the most interesting of these is the Gas Plant of the South American jungles. This beautiful white-flowered inhabitant of the tropics is entirely protected from leaf-destroying insects and birds by the poisonous vapours it constantly pours forth.

The plants are expert chemists, and the reactions in which they engage are, on the whole, much simpler than those which go on in the bodies of animals. Vegetable tissue is largely carbon, hydrogen, oxygen and nitrogen. It is a curious fact that instead of using the abundant carbon compounds present in decomposed animal and vegetable matter of the soil the plants get most of their carbon from the carbon dioxide of the air. Inversely, they largely disregard the seventy-eight per cent nitrogen of the air, and extract that element from the complicated compounds found in the soil, or take it from the air only by aid of certain Bacteria.

Certain plants manufacture lime and metallic oxides with which to harden the protective armour they wear. Many others generate nitric acid, carbonic acid and ammonia for use in their interior laboratories. Roots nearly always secrete a fluid which aids in the absorption of minerals from the earth. It is so powerful that quartz, flint and limestone are often scratched and corroded by its action. Above and below ground, plants are active chemical laboratories.

The differences of taste, smell and colour which characterize leaves, blossoms and fruits are due to the presence of various organic compounds. These are largely volatile oils which are more complex than the substances involved in the simpler life processes. The slow or rapid evaporation of these oils influences the strength and character of an odour. When a flower or fruit passes through infinite gradations of colour, we can give no adequate account of the chemical changes involved. All we can do is to observe and to note. Sometimes infusions of iron sulphate or other chemicals in the soil darken the hues of flowers. Gardeners profit by

this fact in the cultivation of certain varieties of Hortensia.

The chemical activities of plants are of incalculable value to man. They change air, water and mineral salts into forms easily assimilable by the human system. Eliminate all the vegetable life from this planet, and the animals, including man, would perish in a few months. Man has also learned to make abundant use of plant substances for innumerable purposes. Potash is an example of how the plants come to our aid in furnishing us a valuable chemical. It is extracted from wood, Seaweed and Banana stalks. These plants have discovered a way of getting it out of its well-nigh insoluble earth combinations with silica. If it had not been for certain industrious sea plants, man would probably never have been aware of the important chemical twins, bromine and iodine, so important in photography. These plants patiently filter them out of sea water where they exist in microscopic quantities, and build them into their bodies. Beer is possible because germinating grains transform amylum or plant starch into sugar. We find ripe fruits palatable

because their acids change into sugar under the influence of sunlight.

Man seems to have outstripped the plants in the use of light, heat, electricity, and other physical forces, but the plants have more engineers among them than we imagine. In the fact that man has just learned to extract nitrogen from the air by the agency of electrical discharges, lies the probable explanation of how the plants have been doing the same thing for years. It is believed that the minute electrical discharges continually going on between the different air strata make small quantities of nitrogen assimilable for the plants. The microorganisms which also furnish nitrogenous material to the plants may get nitrogen from the air in the same way. It is quite certain that the plants are affected by the chemical state of the atmosphere.

Everyone knows what an important part light plays in plant physiology, but the fact that certain plants produce their own lights, while generally known, is not universally understood. The Austrian naturalist, Heller, was the first to demonstrate that the glowing of decayed

wood at night is caused by emanations of light from Fungus growing in the cavities. A similiar organism called Luminous Peridineas (sometimes classed as an animal) is responsible for the phosphorescence of the ocean and the night lights of many flowers.

About three hundred species of Bacteria and fifteen species of Fungus are recognized to be luminous. The dead leaves of the tropical Banibusa, Nephelium and Aglaia often glow at night with the light of these tiny creatures. Ordinary dead Oak and Beech leaves are luminous, sometimes shining in spots, but frequently glowing throughout with a soft, white, steady light. These miniature incandescent lights often shine for days, weeks and months, and with abundant nutriment at hand, sometimes for years. The light is slight in intensity, but uniformly steady and white, green or blue-green in colour. It is strong enough to enable the plants on which the Fungus grows to photograph themselves by long exposure to sensitized plates. The fungus light has also been used to influence the heliotropic movements of plant seedlings. In fact, a colony of Fungus has

sometimes been placed in an electric light bulb and made thus to serve as an illuminant.

No matter from what angle we study the plants, we find that they are extremely scientific. They conduct themselves and all their activities in a way to always get the best results. They show knowledge and acquaintance with all of Nature's laws, and they have learned to apply many of them with startling success.

MODERN NATURE WORSHIPPERS

CHAPTER X

Religion in the Plant World

"Denied in heaven the soul he held on earth."
—Byron

IN a sense, the entire plant world is a beautiful and expressive worship of a bountiful and beneficent Creator. No creed which does not deny God will fail to see the silent but reverent adoration exhibited by His handiwork. Every tree which raises its brave crest toward the heavens, every flower which greets the warming sunlight with a smile, is a testimony to the omnipotence of divine law. Fully explain the wonders of a single blade of Grass, and you have solved the mysteries which underlie the universe.

Primitive peoples, who are always closely attuned to natural influences, early discerned the divine thread which runs through all plantdom. In their incessant search for God, they did not overlook His manifestations in the plants and

flowers. Along with fire, water, stars, sun, moon, animals, birds and graven images, our wood-roving ancestors ascribed supernatural attributes to many trees and flowers. In various places and at various times, many different plants have been idolized as the material substance of an ethereal or spiritual being. Certain plant growths have been repeatedly designated as sacred, and even in the present day, untutored races have many plant superstitions. Tree worship was common among the Celts and Teutons. The present day Christmas tree is a relic of primitive tree veneration. Even the American Indians worshiped trees at times. Man has been groping for God all through the ages. His tendency has been to deify those elements and things which he did not understand or which contained mystery. As soon as he became acquainted with the causes of these mysteries, the supernatural collapsed into the natural and he went searching after new wonders to call God.

From the beginning of literature, the bards of every land have sung to and of the flowers; the prophets have used them as instruments for their sooth-saying; the believer in resurrection

has cited them to prove a final resurrection for the souls of men; the reincarnationists have claimed in them a great evidence of the reincarnation of the soul; the atheist has tried to show through them the validity of his belief; hero and conqueror have found in them their crowns of glory and the poet has made them the theme of his pen. Yet the flowers bloom today much as they did on the hillsides of Greece and Babylon, and man, with all his century-accumulated wisdom, seems but to have seen the outer edge of their real lives.

The superstitious veneration of various flowers is an ancient and peculiarly charming expression of man's innate appreciation of the beautiful. He who condemns as idolaters the flower-worshippers of ancient ages may well look upon himself with critical eyes. Which is the better: to pay tribute to the Creator through the adoration of his beautiful floral children or make cold, glittering gold the ultimate though unacknowledged goal of this earthly life?

It is interesting to notice, in reviewing the annals of flower-worship, that the most fervent

and frequent examples are found in tropical countries. This is due, no doubt, to the luxuriance of vegetation in the hot countries, and the fact that, in most cases, flowers are in bloom there all the year around. Even one trained in a more rigid faith is tempted to strange reverence when he suddenly comes upon a great, glowing Orchid, squatting like some beautiful animal on the shaggy trunk of an aged tree. A Hindu is quite excusable when he becomes raptly worshipful while paddling through a floating sea of Lotus-Flowers.

In heathen mythology, "every flower was the emblem of a god; every tree the abode of a nymph." Paradise, itself, was a kind of "nemorous temple or sacred grove" planted by God himself. The patriarchal groves which are prominent throughout Biblical history were probably planted as living memorials of the Garden of Eden, the first grove and man's first abode.

Sacred flowers were common among the Greeks. The Anemone, Poppy and Violet were dedicated to Venus. To Diana belonged "all flowers growing in untrodden dells and shady

nooks, uncontaminated by the tread of man." The Narcissus and Maiden-Hair Fern were under the special protection of Proserpina and to Ceres belonged the Willow. The Pink was Jove's flower, while Juno claimed the Lily, Crocus and Asphodel.

The life of Christ flings a bright and illuminating ray of light over the whole vegetable world. Trees and flowers which have heretofore been associated with various heathen rites now become connected with holier names and are frequently made a part of the crucifixion itself. Hosts of flowers are dedicated to the Virgin Mary, particularly white ones, which are taken to be emblematic of her purity. Christian worshippers even went to the classic Juno and Diana, to the Scandinavian Freyja and Bertha, to obtain flowers to dedicate to her. The Passion Flower was often taken to represent various incidents connected with the crucifixion.

Though the Rose and the Lily are the blossoms which are most frequently associated with the Virgin, particularly in paintings, there is an endless list of other flowers of low and high

degree which are either named after her or thought to be under her influence.

Orchids are called "Our Lady's Slipper." Maiden-Hair is "Virgin's Hair." The Thyme, Woodroof and Groundsel plants are reputed to have formed the Virgin's bed. Among fruits the Strawberry and the Molluka Bean have been set aside for her worship.

The "Rose of Jericho" is made famous by the Bible. Popular tradition states that it first blossomed at Christ's birth, closed at His crucifixion and reopened at His resurrection. The legend of the rose-coloured Sainfoin is especially interesting. One of the flowers happened to be among the grasses and herbs lodged in the manger of the Christ child. At the presence of that holy form, it suddenly opened its blossoms to form a wreath for His head.

A more gruesome tale relates that the Wood-Sorrel, Spotted Persicaria, Arum, Purple Orchis and Red Anemone owe their dark-stained blossoms to the blood which trickled from the Cross.

Among the many theories regarding the identity of the wood of the Cross, the one about the

Mistletoe is especially fanciful. The Mistletoe is alleged to have been originally a full-sized tree but because of its ignoble part in the great Christian tragedy, it was reduced to its present parasitical form.

Every saint in the Catholic calendar has his own particular flower, either because of some incident in his life with which it was connected or because of arbitrary dedication. Care has been taken to pick flowers which are in bloom at the time of the festival of the saint which they represent. In this way, the flowers of the field make a living, religious time-piece.

Among the individual sacred flowers, Orchids and Lotus-Blossoms have probably been known and reverenced as much as any. There is small wonder that sentiment approaching veneration should exist toward the Orchids. Their singular beauty and fragrance have compelled the admiration of all historic peoples. The primitive Mexicans hold them in very great esteem. The Lotus-Flower, portrayed through all the ages, on papyrus, paper, silk, stone, and wood, has a world-wide sanctity. The ancient Egyptians worshipped the Lotus in connection with the

mysteries of Isis and Osiris. The sculptural remains of the Nile abound with the sacred plant in every stage of its development, the flowers and fruit being represented with utmost accuracy. The Brahmans regarded it as divine and the Hindus used it to decorate their temples and lay on their religious altars. The Chinese also called it sacred. Brahma, at his birth, is said to have come forth from the Lotus. Buddha and other eastern deities, including the Chinese god Pazza, are reported to have first appeared floating on its leaves.

Sir William Jones was one time dining on the banks of the Ganges. Desiring to examine the sacred Lotus-Flower, he despatched some of his people to procure a specimen. When it was brought, his Indian attendants immediately fell on their faces in adoration.

The Yellow Narcissus is a famous fabled flower which originally came from Palestine. Mahomet once said: "Whoever posseses two loaves of bread, let him trade one for a blossom of Narcissus, for bread is nourishment for the body, but the Narcissus for the soul." The birth of the Narcissus is narrated thus: In Sussex-

shire, England, the good St. Leonhard once battled with a dragon for three whole days. Before he was able to slay the monster, the doughty warrior was wounded with consequent loss of blood. God could not bear to see the life fluid of this holy man spilled heedlessly, so transformed each drop, as it fell, into a Narcissus.

"Consider the Lilies of the field, how they grow; they toil not, neither do they spin; and yet I say unto you that even Solomon in all his glory was not arrayed like one of these." This is a great tribute to the Lily and it has been similarly praised throughout all literature. About this lovely flower hang myriads of sacred legends and such titles as the "symbol of purity," the "soul of beauty" and "the symbol of peace." In the lore of the Greeks and the Orientals, this matchless flower was hailed with the Rose as the "Queen of Heaven." The Venerable Bede called it the most worthy symbol of the Virgin. He said that its pure white petals represent her undefiled body and the golden stamens her radiant soul shining with god-like light. Many old paintings of the Virgin show her with a vase of Lilies by her side.

The Rose is the universal symbol of royalty. In Greek mythology, it was the favourite flower of Aphrodite and was represented as springing from the blood of Adonis. Through all Norse and German mythology is repeated reference to the "regal beauty" and "queenly mien" of the Rose. In northern lands, the Rose was under the special protection of the fairies, dwarves, and elves.

The "Balm of Gilead" is a well-known sacred plant (*Balsamum Judaicum*) written of by Pliny, Strabo and Justin and grown in many parts of the East. It is said to have been first brought from Arabia by the Queen of Sheba as a gift to Solomon.

St. John's Wort (*Hypericum Perforatum*) was dedicated to St. John because its phosphorescent glow was remindful of the Biblical reference to him as a "bright and shining light." Some European peasants still believe that, if gathered and worn on St. John's Eve, it has the power of bringing good luck and success.

The Greeks and Romans used Verbena extensively in their religious ceremonies, principally because of its wonderful perfume. The

Romans called it "the sacred herb" and regarded it as an aid in divinations and omens. On New Year's Day, it was sent to friends as a token of greeting. The Roman generals wore a sprig in their pockets as a protection against bodily injury.

The Soma or Moon-Plant of India (*Asclepias Acida*) is a climbing vine with milky juice which is said to confer immortality upon its admirers.

Pomegranate was long reverenced by the Persians and Jews as the forbidden fruit of the Garden of Eden.

The Indian plant Basil for many centuries has been held in good repute by the Hindus, having been made sacred to Vishnu.

Mahomet pronounced Henna, the Egyptian Privet, "chief of the flowers of this world and the next." Wormwood was dedicated to the goddess Iris.

If there are many plants which man's adoration has made religious, there are almost an equal number which his suspicion and perversity have branded irreligious. A famous plant of this kind is the Enchanter's Nightshade which

has long been celebrated in the mysteries of witchcraft. Perhaps its usual place of growth in old graveyards among decaying bones and mouldering coffins has much to do with the sinister superstitions and legends connected with it.

The Belladona is another plant whose name is often associated with black magic.

To this day many Danes believe that the Elder is eternally cursed. Children who sleep in beds containing Elder wood continually complain of having their feet tickled and their legs pulled. To carry a cane of Elder is to invite attacks of slander. Women who have Elder wood in their houses will never be married. It is the elves who dwell in the Elder who are supposed to work all this mischief.

Plants often rise superior to the curse which men place upon them. Probably every well-known plant, sometime in its history, has had attributed to it both good and evil. The deity of one nation may become the demon of another.

Plant worship holds a more prominent place in the world today than one would at first thought imagine, and it is not altogether confined to uncultured peoples. Dr. George Bird-

wood tells of remarkable instances of modern flower worship he saw in Bombay. In describing the Victoria Gardens, he says: "Presently, a true Persian, in flowing robes of blue, and on his head his sheep-skin hat, 'black, glossy, curl'd, the fleece of Kar-kal', would saunter in, and stand and meditate over every flower he saw, and always, as if half in vision. And when the vision was fulfilled, and the flower he was seeking found, he would spread his mat and sit before it until the setting of the sun, then fold up his mat again and night after night, until that particular flower faded away, he would return to it, and bring his friends in ever-increasing troupes to it, and sit and play the guitar or lute before it, and they would altogether pray there, and after praying still sit before it, sipping sherbet, and talking the most hilarious and shocking scandal late into the moonlight; and so again and again every evening until the flower died. Sometimes, by way of grand finalé the whole company would suddenly rise before the flower and serenade it together, with an ode from Hafiz, and then depart."

CHAPTER XI

Plant Mythology

"I'll seek a four-leaved clover
In all the fairy dells,
And if I find the charmed leaf,
Oh, how I'll weave my spells."

EVERY Plant is surrounded by a halo of human thought. If one is able to discern that halo, he finds a new and fascinating interest attaching itself to each herb and flower. The most humble of them become fortune-tellers, luck-bringers, and talismen against evil, as well as dwelling-places of fairies, elves, imps, and other ethereal mischief-makers.

In the childhood of humanity, the earth was a very romantic place. In addition to the familiar human inhabitants, there were whole races of supernatural and invisible beings which wielded great influence over the every-day world of affairs. Every plant was considered good or evil, according to the character of the spirits which it was believed to harbour.

People of this practical age are inclined to look upon these stories with contemptuous intolerance. "We have outgrown such baby-talk," they say, and forthwith relegate whole kingdoms of elfin hosts to their children's nurseries, or possibly refuse them their homes entirely. But to a few discerning minds, these idle dreams of a romantic past offer a most refreshing contrast to present-day utilitarianism.

The airy fancies of our forefathers should have a larger share in our thought today. A single flower myth contains more beauty and enduring appeal than a hundred steel mills. We must go back to the youth of the race,—to the time of Shakespeare, Milton, and gentle Ben Jonson,—for our noblest literature. In those days, men actually believed in fairies, goblins, and all the rest, and were probably better for having done so. We, with our broader intellectual outlook, can congratulate ourselves that we have advanced beyond such things, but still appreciate their spirit and their beauty.

In studying plant mythology, it is interesting to notice that certain traditions and legends are to be found in all parts of the world and in

many widely separated localities, forming, as it were, the ground-work of a great universal system of folklore. This would suggest that plant myths are founded mainly on true and inherent facts rather than on passing fancies. Almost all the nations have chosen the Rose for the queen of the floral court, and therefore the most fitting symbol of love. The White Lily has purity written on its spotless petals, and could never stand for anything else, anywhere. The Poppy is a brilliant, sensuous flower, quite suggestive of the narcotic excesses which its opium induces. Many extravagant plant beliefs of the past had their foundation in medicine. In the Middle Ages, quacks and charlatans used herbs having curative powers to exhort money from the masses. A few of the correctives were of real value, but there were thousands of out-and-out deceptions. Even so redolent and simple a thing as the common Onion was sometimes suspended in a room in the belief that it would draw all troublesome maladies out of the inmates. The first herbalists were priests, but gradually their art passed into the hands of professional outsiders, where it suffered greater and greater abuse.

One ancient dogma taught that each plant possessed the power of healing one particular disease, made known by some outward sign or similiarity. Thus bright-eyed flowers were good for those with failing sight; red blossoms of all kinds would arrest nose-bleed; Tumeric, a very yellow dye, cured jaundice; plants with long, tubular flowers were excellent specifics for throat troubles.

Many of these medicinal superstitions linger among the more simple of the earth's inhabitants today. Dutch and English countrymen still believe that a Potato carried in the pocket is a sort of protective charm against rheumatism. In Ohio, the farmers sometimes wear a string of Job's Tears seeds in an effort to cure goitre. In New England, the same magic charm is used to help babies through the troublesome period of teething.

The devil and his evil spirits have always wielded a large influence over certain members of the plant kingdom. In Scotland, up until the seventeenth century, it was customary to allow a small section of each farm to lie untilled and uncropped as a peace offering to Satan. In cer-

tain English counties, children of today will not pick Blackberries after a certain date, believing that the Evil One has trampled them and made them poisonous to humans. German peasants, without batting an eye, will tell you that the devil, in one form or another, has the regular habit of stealing portions of their crops.

Of plants that are dedicated to Satan, or more properly, which he has appropriated, there are many hundreds. Toadstools, because of their miraculously fast growth and fantastic shape, have always been associated with the kingdom of evil. It is not quite so apparent why other more beautiful plants are also handed over to Satan, though a reason can usually be found. The most alluring and gorgeous flowers are quite apt to be poisonous.

In old Bohemia, the Belladonna was a favourite of the devil. He could be enticed from it on Walpurgis Night by letting loose a black hen, after which he ran. In Russia, people shun the Sow-Thistle as a devil-plant. Some Germans believe that evil spirits lurk in Lettuce beds. To the same people, the Herban is the "Devil's Eye." Many nationalities are quite

sure that the Herb-Bennett, when kept in a house, takes its owners out from under the devil's influence. Thistle is often used for the same purpose. The Greeks used to place a Laurel bough over their doors to ward off evil. There is an English Fungus called Lycoperdon, or Puff-Ball, which produces a mass of dusty spores not unlike snuff. The annoyance experienced by people in the vicinity of the bursting pods has led to the plant being called "Devil's Snuff-Box." Children use it for various amusing pranks.

Closely allied to the devil-plants are the witch-plants, vegetable favourites of his human emissaries. The Elder is supposed to be a frequent meeting-place of these sinister hags; under its branches they bury their satanic offspring.

The witches employ the deadly Night-Shade in their vile concoctions. It is reputed to spring from the foam of the vicious, many-headed dog which guards the infernal regions. The Vervain and the Rue are also ingredients. The fact that the former was at one time sacred to Thor, and was also used in the rituals of the Druids, is a

possible explanation of its evil name. Rue as a narcotic capable of producing hallucinations, is most naturally a witch's plant. Strange to say, both of these plants are sometimes used as charms *against* witches. The Romans used the Vervain in casting lots, telling fortunes, and foreshadowing national events. Many other plants, ordinarily harmless, become the possessors of evil charms when gathered under certain circumstances. Thus, Shakespeare speaks of "root of hemlock digg'd i' the dark," and "slips of yew sliver'd in the moon's eclipse," as being cast into the bubbling pot.

The Fox Glove is "Witches' Bell," and is used by them to decorate their fingers. They employ the large Ragwort as a steed for their midnight journeys. In Ireland it is known as "Fairies' Horse." It is said that witches use Fern seed to make themselves invisible. In Germany they employ the Luck Flower for the same purpose. The Sea Poppy and the Moonwart (*Botrychium Lunaria*) are also numbered among the witch-plants. To the latter is also given the power of opening locks.

In England, Pimpernel, Herb-Paris and

Cyclamen are protections against witches. In Germany and many other continental countries, the St. John's Wort is their enemy and exposer.

The fairies have appropriated many flowers for their especial use. Despite the disbelief of latter days, to some people elfland still extends around the globe, and defies all the laws of chemistry and physics. It is still fairy midnight trippings which form those mysterious circles or depressions often to be noticed on the dewy sward of early morning. When the peasant girls of England go out into the meadows to beautify their complexions with applications of May dew, they always leave these mystic circles severely alone, for fear of offending the fays.

Midnight is the fairy magic hour. At the trumpet call of the Harebell, they gallop to their meeting-places mounted on blades of Grass or on Cabbage leaves. Sometimes they assemble to the tolling of the Wood-Sorrel or "Fairy Bell". For more extended migrations, they travel in Nuts. They usually dress in green and provide themselves with mantles of Gossamer. The Irish ones use Fox-Glove blossoms

to cover their hands. In infancy, the fays are cradled in Tulips and throughout life, they use the Cowslip as a drinking cup, and seek shelter of the Wood-Anemone in wet weather.

In some localities, it is believed that the fairies create the Toad-Stools. They are also reputed to gather colours from the sunset clouds, and with tiny but accurate brushes cover flower petals with their delicate tints. Fairies seldom reveal themselves to men, but the lucky possessor of a four-leafed Clover is sometimes privileged to see them.

From time immemorial, men and maidens in love have sought the aid of their floral friends. Which of us is there who has not gone to the Daisy in some heart perplexity of youth, and made its petals say, "She loves me; She loves me not," as we pulled them off one by one? An older and less known superstition says that an Apple seed placed on a hot stove will hop towards one's future mate.

In England, the Marigold is used for various love divinations, but in Germany it is carefully excluded from affairs of the heart. In that latter country the Star-Flower and the Dandelion

are popular in such cases. There was a time when Peas were much in demand for sentimental forecasts. On opening a pod, the number of green spheres discovered had a special significance. The dwarves were supposed to be especially fond of Peas. Even the prosaic Onion has at times been used to explain the mysteries of the divine emotion.

The Rose, most superb of flowers, has been extolled through all ages as the symbol of love. Incidentally, it is the national flower of England. The Scotch have a pretty ballad legend about Fair Margaret and Sweet William. The beautiful love of these two young people never realized itself in marriage. They both met an untimely death and were buried on either side of the neighbouring church. Soon there sprang up a climbing Rose vine from the grave of each, and meeting on the gable of the church, the lovers entwined in the lasting embrace which had been denied in life. Red Roses, because of their colour, have sometimes been supposed to have a relation to human blood. The medieval girl used to bury a few drops of her blood under a Rosebush in the hope that this action would

bring her ruddy cheeks. The Romans used the Rose as the symbol of love for the dead. They placed it extensively on their tombs.

In the past, there have arisen rumours of plants of wondrous properties which have been the mere inventions of glory-seeking travelers. Sir John Mandeville was a famous offender who even issued reports of trees which produced live animals in their fruits.

The old Greeks used to decorate their tombs with Parsley. When a person was dangerously ill, it was often said, "He has need now of nothing but Parsley."

The humble Bean has at times been afforded superstitious reverence. It is said that Pythagoras forbade his disciples to eat it.

The anxiety to secure good crops has led to many superstitious practices. In the pagan days of Germany and likewise in Rome, an image was carried around each field in order to insure its fertility. After the introduction of Christianity, the image of a saint was substituted for the heathen deity, and the practice continued.

Again and again, the Onion, whose name today is only mentioned with bated breath,

crops up among old plant superstitions. Because of its structure of enveloping sheaths, the Egyptians rightly considered it a splendid symbol of the universe. In Christian days, St. Thomas patronized it. Its cousin, the Leek, bears the blossom which Welshmen still hail as their national flower. It is worn by all loyal patriots on March first, St. David's Day.

The Thistle, Scotland's national flower, was once sacred to Thor. In those days it was regarded as a safeguard against lightning, from which it got its colour. Ireland's Shamrock belongs to the Trefoil family, and is sometimes called Dutch Clover, though the Wood-Sorrel is claimed by some to be the true Shamrock. St. Patrick once used it as a natural symbol of the trinity, through which it became nationalized.

Superstitions of the four-leafed Clover have lingered in the imaginations of men almost more than those of any other plant. To be efficacious in bringing good luck, the little talisman must be found unawares. If slipped into the shoe of a lover, it will insure his safe return. The finding of a five-leaved Clover brings bad luck.

Superstition plays its part in the evolution

of knowledge, and speculation is the parent of modern science. Astrologers, reading the fortunes of nations and individuals in the stars, paved the way for the great and exact science of astronomy. Studious alchemists in searching for a cheap way to make gold, laid the foundations of the profound science of chemistry. In a similar way, the old herbalists, with their secret potions and mysterious compounds, were the instigators of the accurate study of medicine, and most important from our standpoint, were instruments which greatly advanced the love and growing appreciation of plants and flowers.

CHAPTER XII

Mysticism in the Plant World

"Who passeth by the Rosemarie
And careth not to take the spraye,
For woman's love no care has he,
Nor shall he though he live for aye."

ONE day John G. Allen of Cherry, Arizona, went fishing along a small tributary of the River Verde. His skill with the rod seeming to fail him, he decided to make his outing profitable in other directions by hunting through some neighbouring cliff-dwellings for pottery. While wandering through those ancient and curious abodes, he accidentally discovered a section of wall which looked as though it might have been built to close a former opening. Careful investigation revealed the truth of this surmise, for, with a little perseverance, he broke through and removed enough stone to admit his body into a small room or recess, which contained some pottery and household utensils of extreme age.

In one corner of this prehistoric place, Mr. Allen discovered a few Corn cobs and about a dozen Squash seeds. More as a joke than anything else, he planted twelve of the seeds the next spring.

Eleven of them remained insensate to the revivifying influence of earth, sun and water, but the twelfth took courage and, bursting the walls which had imprisoned it for hundreds and possibly thousands of years, sprang up into a hardy, healthy vine, which eventually bore a huge, green, extremely warty Squash weighing nearly twenty-five pounds. This vegetable visitor from a shadowy age was named the "Aztec," and attained great fame.

There have been other and more striking instances of the suspended animation which permits plant life to lie quiescent for countless centuries, ready for an opportune time to resume the regular cycle of its existence. There are those who are always ready to cry "fraud," and conclusively prove these marvels false, but there is abundant evidence to show that plant embryos can and, in some cases, do survive long periods of time.

What a lesson lies in such phenomena! The power that can keep alive and unchanged the cells of a vegetable seed so many centuries is not likely to allow the soul of a man to perish. What an argument for immortality! What a breeder of strange and mysterious thoughts!

There is much mysticism in the plant world. What man does not understand, he either holds in awe or contempt. The plants are too often treated with good-humoured derision, but among higher minds, their unintelligible factors give them a greater fascination—a mystery and a psychic interest which is very alluring.

The plants seem to be closer in tune with Nature than man. They place themselves under her direct tutelage, and are extremely sensitive to her various moods and fancies. They respond to influences of weather and time with remarkable alacrity. The scarlet Pimpernel in particular, is an excellent barometer. At the least indication of rain, it folds its petals together in snug security, and, contrary to human beings, closes instead of opens the umbrella of its body. On a rainy day, it never unfolds at all, so eager is it to keep its petals dry.

"No heart can think, no tongue can tell,
The virtues of the Pimpernell."

The greatest of all floral barometers is the Weather-Plant or Indian Licorice (*Abrus Precatorius*). So keenly sensitive to all atmospheric conditions is this plant that it may be used to foretell cyclones, hurricanes, earthquakes, and even volcanic eruptions. Its small, rose-like leaves are in continual motion, which varies noticeably under different electrical and magnetic influences. The Austrian Professor Norwack, working at his Weather-Plant Observatory at Kew Gardens, London, once used it to predict a disastrous fire-damp explosion.

Many flowers show a remarkable appreciation of the passage of time and open and close at regular hours each day. In fact, a close student of floral habits can actually tell the time of day by watching the actions of the flowers around him. It is said that the Swedish botanist Linnaeus once built himself a flower clock, arranged to count the passing hours by the folding and unfolding of different blossoms. One does not really need to go to this trouble. The common flowers of the field and garden

are all accurate time-pieces. Long before the rising of the sun their activity begins; in fact even the night hours are all noticed by certain more obscure plants. Along about three in the morning, the dainty Goat's-Beard wakes from sleep and spreads its petals. Promptly at four o'clock the Dandelion begins its day's work. The Naked Stalked Poppy, the copper-coloured Day-Lily and the smooth Sow-Thistle are five o'clock risers. The Field Marigold is a slug-a-bed, and does not blink its sleepy eyes at the sun until ten o'clock. The Ice-Plant throws back its downy coverlets exactly at noon.

Shortly after mid-day, the early risers begin to get tired, and prepare to sleep through the heat of the afternoon. Beginning with the Hawkweed Picris shortly after noon, and extending to the bed-time of the Chickweed at ten at night, every quarter hour sees the retirement of some particular flower. After sundown, the night owls make their appearance, and such plants as the Night-Blooming Cereus, the Moonflower, and the Datura check off the fleeting minutes. How can this marvelous aquain-

tance with the passage of time be explained in terms of cold materialism?

Among plants which show a well-developed sense of direction, the Compass-Plant is probably the most remarkable. Its flowers, and sometimes the edges of its leaves, always point toward the north with the certainty of a magnet. Travelers have been known to use it as a natural guide.

A great many plants perform remarkable acts which can only be explained by the possession of some measure of psychic sense or quality. Thus, a climbing plant in need of a prop will creep along the ground toward the nearest vertical support. If the support is shifted, the vine will promptly change the direction of its progress, and eventually reach the object of its desires.

Inasmuch as it is positively known that plants are sensitive to light, it may be that, in this case, the vine actually perceives the support through a process akin to animal sight; but if a climbing plant finds itself growing between two mounds or ridges, and behind one there is a wall or some other means of support, and be-

hind the other none, it will invariably bend its creeping steps over the ridge hiding the wall. The wall was invisible from the plant's starting-point, and certainly betrayed its presence through no odour or other manifestation. In some mysterious way, the creeper simply knew that a vital necessity of its life lay in a certain direction. Ordinarily, we associate such phenomena with psychic influences. It is quite evident, that in certain ways, the plants display a very practical knowledge of such mysteries.

For many years, man has instinctively been aware of this psychic superiority of the members of the vegetable kingdom, and has gone to them for advice in various troubles and difficulties, even sometimes believing the plants to have a direct control over the affairs and lives of men. While the great mass of such alleged influence is classed by modern thought as merest superstition, who can say that the wildest of these fancies does not contain certain germs of truth? At any rate, a brief investigation of some of the more popular beliefs of former years is very illuminating.

In ancient days, many flowers and plants were

supposed to possess the power of discovering the location of lost or hidden riches and conducting a human searcher to them. The Germans named the Primose Schlűsselblume, or key-flower, in the belief that, if held in the hand, it would unlock to its possessor the location of buried treasure by some movement or other manifestation. To this day, many country people in Europe and America have implicit faith in the ability of the divining rod to seek out underground water. There are many enlightened folk who claim that reported successes of this method of picking well-sites are mere coincidences, but in view of the wide-spread reliance on this theory which is constantly meeting the most practical tests, would it not be open-minded to suggest that possibly the branches of the rod do make some slight movement toward the hidden water with which they have a natural affinity?

As mentioned in a previous chapter, young people through all ages have gone to flowers for counsel when in love. The most frequent masculine question has been "Does she love me?" The flowers have given the answer in a variety

of ways, most often by the number of their petals. The query of the very young girl usually has been "Will I be married?" and she has been sure to see that the reply is most often in the affirmative. In *A Midsummer Night's Dream,* Oberon tells Puck to lay Pansies on Titania's eyes in order that she may fall in love with the first person she sees upon awakening.

There was a time when people placed great reliance upon the efficacy of dreams. Plants seen in dreams always had special significance. Among the various omens, general good fortune was indicated by Palms, Olives, Jasamines, Lilies, Laurels, Thistles, Currants and Roses. When flowers or fruit of the Plum, Cherry, Cypress and Dandelion appeared, misfortune was indicated. Withered Roses foretold especially dire events. "Nobody is fond of fading flowers." A four-leaved Clover put under a pillow induced dreams of one's lover. In parts of South America, the natives are said to smoke and eat certain intoxicating plants in the hope that they may see visions in the resulting narcotic dreams.

Plants have not been the cause of very many

ghost stories, but occasionally one hears of some mysterious night adventure of which some plant is the central figure.

The Reverend S. H. Wainright of Japan tells a somewhat amusing tale of a ghost scare he and his family had while living at Tsukiji, Tokio. One evening, while sitting around the fire, they were considerably disturbed by a weird and recurring sound which seemed to come from the front yard. At first they took it for the creaking of a bamboo gate, then for boys throwing pebbles, but neither of these explanations seemed adequate. Finally, continual repetitions led to a search which located the noises in a Wistaria arbour near the front fence. On near approach, the loud taps sounded so much like stones striking the leaves, that it was decided to take no further notice of the matter. However, the problem weighed on Mr. Wainright's mind, and he and his son at length sallied forth a third time, determined with Aristotle that the main thing was to know the causes.

"We entered the side yard through the bamboo gate and approached the Wistaria. Under-

neath the Trellis arbour there were dark shadows and outlines were indistinct. A Palmyra Palm was growing in the corner of the fence under the arbour, and the fingers of one of the leaves pointing downward seemed to be the hand of a man. When expectation is running high, a fingered palm leaf may easily become the hand of a human being or of a shadowy ghost. We had the electric burners brought to the windows upstairs and the light thrown toward the arbour, and the shadows cast by the electric rays rendered the situation all the more mysterious.

"The noises were plainly among the Wistaria vines. But, strange to say, the stones which seemed to be striking the vines came from no particular direction. They seemed to burst like shells the minute they struck and the pieces were heard to fall or strike in different directions. By this time the thought of ghosts had not only occurred to us but was gaining force in our minds. Indeed, a first-rate romance was developing — subjectively, I should no doubt add."

Again the party abandoned the quest, re-

turned to their fireside, but could not rest content. "With a heroic determination of will, I declared that I would again go in search of the causes and not return until the secret had been found out. The lights were held by those who remained indoors at the upstairs windows. Two of us approached through the side yard the place of mystery. Step by step we advanced, stopping at intervals to listen. We could see nothing, but the noises we heard were unmistakable. There could be no deception as to their reality. Step by step, we drew nearer, peering in the meanwhile into the dark shadows beneath the Wistaria. The nearer we came to the arbour, the greater was the sense of mystery which possessed us. The noises were weird and inexplicable. As we came near, a discovery was made which excited us still more. After the explosion of the shells, white sabers seemed to fall upon the ground. Were the ghosts in battle? What could it all mean?

"Loyal to the heroic determination to go straight to the seat of the trouble, I walked beneath the Wistaria arbour feeling an atmosphere charged with electricity as I went. We

stood side by side looking about and waiting, when suddenly a Fuji pod exploded before our eyes. The seeds flew in different directions and the divided halves of the pod fell to the ground and lay like sabers dropped in the attack of battle. When the discovery was made, one of us called out to the upstairs window that it was the explosion of the Wistaria pods that caused the noises. There was a general laugh and the ghosts disappeared. Not affected by rain or darkness, by heat or cold, by human foot-steps or voice, there is one thing ghosts cannot endure; to be laughed at literally slays them."

In the Middle Ages, the Mandrake was a magical plant which was reputed to shine like a candle at night and thrive particularly well near the gallows. When pulled from the earth, it uttered uncanny shrieks, and according to Shakespeare "living mortals hearing them ran mad."

Two centuries ago it was believed that every plant, as well as every human being, was under the influence of some particular planet. The plants over which Saturn claimed an ascendency were characterized by ill-favoured leaves,

ugly flowers and repellent odours. On the other hand the plants of Jupiter displayed smooth leaves and graceful, fragrant flowers. Today we believe that all plants belong to only one planet, and that is the planet earth.

In the minds of agricultural folk, the moon has always had great influence over vegetation. There are many rules still extant regarding the proper time of that satellite's phases in which to plant, reap and perform a hundred other rustic acts. A medieval superstition stated that when the moon was on the increase it imparted healing and medicinal qualities to all herbs. During its decline, the same plants generated poisons.

The mystic qualities of the flowers have been responsible for their extensive ceremonial use throughout all history. Man attempts to express all his more subtle emotions by their sweetness and purity. He carries them alike to christenings, weddings and funerals, and invariably sends them to his best girl. It is recorded that a certain eastern king of antiquity was in the habit of offering a hundred thousand flowers each day before the idol of a favourite god.

Flowers are still extensively used as signs and symbols. There are ponderous volumes written on the "Language of Flowers." All the garden beauties have a natural symbolism written on their faces. Rosemary, with its lingering colour, is an eternal emblem of remembrance. "Violets dim but sweeter than the lids of Juno's eyes or Cytherea's breath" speak of modesty in quiet tones. The spotless Lily must always stand for purity.

Other floral symbols have been chosen for more remote but quite apparent characteristics. Impatience is indicated by the Balsam seed-pods, which, when ripe, curl up at the slightest touch, and shoot forth their seeds with great violence. A popular name for the plant is "Touch-Me-Not." The very name of Heliotrope tells of its constant turning toward the sun. It is often referred to as a symbol of devoted attachment. Aspen, because of its tremulous motion has been made a sign of fear. When people think of the Poppy and its narcotic product, they likewise think of sleep and oblivion. A less apparent symbol is found in the Wild Anemone, which is taken to denote brevity be-

cause its frail petals are soon scattered by the boisterous wind. The Snow-Drop, first flower of spring, peeping from its immaculate snow bank, is an unmistakable emblem of purity .

The ancients were very liberal users of floral tokens; the Chinese, Assyrians and Egyptians had many identical beliefs on the subject. The Olive was and still is the universal badge of peace. Laurel was the classic sign of renown with which the brows of prominent athletes and statesmen were crowned. The Cypress was often an index of mourning. The Rose and the Myrtle, having been dedicated to Venus, were insignias of love. The Palm was a wide-spread representation of victory. Bible students will recall that Palms were scattered before Jesus Christ on the occasion of his triumphant entry into Jerusalem.

In their enthusiasm, flower-lovers have sometimes allowed their imagination to carry them into unnatural and artificial symbolism. It is not difficult to associate the White Lily with purity but when we are told that the Flowering Almond represents hope, the Common Almond indiscretion and stupidity, and the Floral Al-

mond perfidity, one is reduced to looking up this curious code in an indexed book. When each variety of the Rose family has different and fluctuating significance, a swain hesitates to summon the floral language of love to his aid.

Many people believe that peculiar mystic attachments exist between certain birds and flowers. The Persians claim that whenever a Rose is plucked, the nightingale utters a plaintive cry as if to protest against the wounding of the object of its love. Many other birds show marked affection for various plants.

In the same manner, almost every man and woman has his or her favourite flower. Certain persons of a temperamental type are often emotionally affected by the presence of flowers with which they appear to have a mysterious psychic connection. Certain people claim to be able to discern such marked similiarity between human beings and various flower affinities that they undertake to liken various prominent people to different blossoms. There is much chance for scientific investigation in this field. With Perdita we at least know that "flowers of middle summer should be given to men of

middle age, but for our young prince we want flowers of the spring that may become his time of day."

Sometimes, through sentimental attachment, whole peoples elect certain flowers to represent them before the world. Thus the United States has chosen the Goldenrod for its national floral emblem, while the Rose of England, the Thistle of Scotland, the Shamrock of Ireland, and the Leek of Wales act in the same capacity for the British Isles.

Man paid a high compliment to the mystic veneration in which he holds the plant world when he, in his primitive beliefs, invariably conceived of heaven as some terrestrial paradise of luxurious vegetation. The Persians had their Mount Caucasus; the Arabians dreamed about an Elysium in the Desert of Arden; the Greeks and Romans had bright mental pictures of the Gardens of Hesperides; and the Celts hoped to spend their postmortem existence on an enchanted isle of wondrous beauty.

Such beliefs have fallen into disuse, but man is still a long way off from a solution of the various mystic phenomena of the plant world.

Botanists should leave off indexing and classifying plants for a while and endeavour to discover the subtle and fascinating laws of their psychic existence.

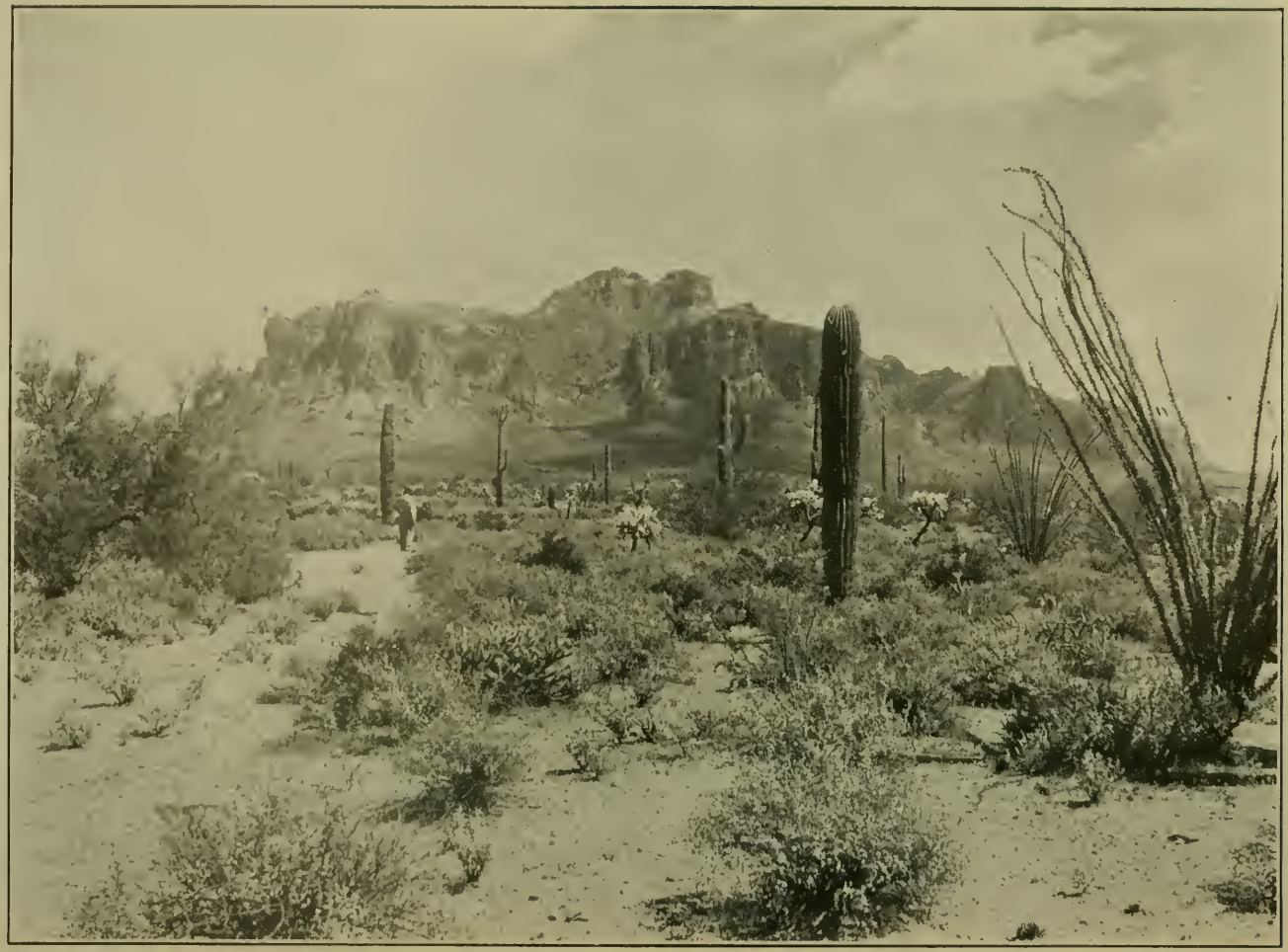
CHAPTER XIII

Plant Intelligence

"The Marigold goes to bed with the sun,
And with him rises weeping." —Shakespeare

IT is no new thing to believe in the existence of intelligence among plants. As far back as Aristotle, various great minds in the earth's history have ascribed definite, thinking acts to our floral and vegetable friends. Not a few have seen unmistakable evidences of soul in plantdom. Even the most skeptical have become aware of many things they cannot explain in purely mechanistic terms.

We are still living in an age which has deified human wisdom. Man has built up vast systems of knowledge and law, all based on his own deep-rooted convictions. He approaches every subject with apriori beliefs and presumptions. He is slow to acknowledge thinking powers to his companion creatures of a terrestrial universe.



ALLIES OF THE DESERT ARM THEMSELVES WITH PRICKLES AND THORNS
AGAINST THEIR ANIMAL ENEMIES

To a person on a country road, the wayside trees and flowers are too often mere happenings or creations. Their ways are so quiet and undemonstrative, that, if he has never been taught differently, he rarely thinks of classifying them as independent, free-acting beings. The fact that they are anchored to the soil seems to remove them from the realm of self-willed creation. Yet why should it? Are fishes not doomed to pass all their days in the chemical combination of hydrogen and oxygen we call water? Does not the delicate Canary die if the air surrounding it goes below a certain temperature?

The fact is that many plants exhibit all the elemental qualities of human intelligence and also have vague psychic expressions of their own which we only understand in a very limited way.

What causes the radicle or root of the smallest sprouting seedling always to grow down and the plumule or stem always to grow up? It cannot be gravity because that great earth pull would affect both parts equally. This same radicle, when it has developed into a full-

fledged root, feels and pushes its way through the earth in a marvellous fashion searching out water and traveling around obstructions with unerring exactness. The slightest pressure will serve to deflect it; aerial roots have been observed to avoid obstacles without actually coming in contact with them. The plants use their roots to feel their way to moisture and nourishment just as a man would feel his way with his hands. The great Darwin, himself, wrote many years ago: "It is hardly an exaggeration to say that the tip of the radicle thus endowed, and having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals."

In the same way, plant tendrils seek and search out the best supports, after the manner of animal tentacles. When fully wound around a prop, they drag the body of the plant up after them.

Practically all plants show a full knowledge of the importance of sunlight to their life processes. They usually strain all their energies and exert all their ingenuity in an effort to display as great a leaf surface as possible. That

this action is not always purely instinctive is indicated by the response of certain carniverous plants to light. Having learned that success in capturing their prey depends upon a static position of their leaves, they make no effort to adjust their parts to strong or concentrated light. This is clearly a case of intelligent adjustment to environment.

It is interesting to note that the plant cells which are sensitive to light often become tired or partially blinded just like the retina of an animal eye. Darwin found that plants kept in darkness were much more responsive to light than those which dwelt habitually in the sunshine.

Many plants are wonderful weather prophets and keepers of time. Their reactions to the coming of night, showers, heat, cold and other natural phenomena show much wisdom. That plants require the rest which accompanies sleep is indicated by the weakened and degenerate condition of individuals which are sometimes forced to exceptionally rapid development by continual exposure to electric light.

A human faculty which few people associate

with plants, is an acute sense of taste. How else do the plants know what elements to absorb out of the soil? Certain experiments have enabled investigators to discover marked taste preferences of a number of microscopic plants. Bacteria are exceptionally fond of kali salts. Though they thrive equally well on glycerine, they can be lured from it at any time by the toothsome kali solution.

A sense of taste plays a remarkable part in the fecundation of Moss. The male element is composed of swift-swimming cells equipped with vibratory hairs. When deposited by the wind or other means on the cups of the female flower, they swim about in the moisture until they are eventually enticed to the unfertilized eggs at the bottom by their taste for malic acid. That this is no idle theory can be proved in the laboratory. The seed-animalicules of some of the Ferns also are urged to the act of impregnation by their preference for the sugar in the seed cups.

All through the plant world we see actions and habits which are the reverse of automatism or mere instinctive response. Every plant con-

tinually has to meet new and trying conditions, and while its reactions, just like those of man, are frequently in the terms of racial and individual experience, it is constantly called upon to make new and novel decisions.

Consider the intelligence of a wild Service Tree described by Carpenter. As a seed, it sprouted in the crotch of an Oak, and at once sent a lusty root down toward the earth. As it descended the Oak trunk and neared the ground, its further progress was barred by a large stone slab. It is authentically recorded, that, when still one and one-half feet away, the tip of the root, by direct perception or occult means, discovered the presence of the obstruction, and, at once splitting into two equal branches, passed on either side of the stone.

A more remarkable case is that of a tropical Monstera, which, coming into life on top of a greenhouse, sent canny and vigorous roots directly down to certain water tanks on the ground.

Isolated instances of plant intelligence might be mere coincidences if it were not for the fact that they multiply greatly the further one in-

vestigates. The common Potentillas and Brambles show remarkable sagacity in searching out hidden veins of soil among the rocks where they grow. Nothing is more ingenious than the way in which Hyacinths, Primroses and Irises smother competitive seedlings by putting forth large, low-lying leaves to cut off the light of neighbours.

Plants are great inventors, and by continual experimentation have perfected thousands of ingenious devices to help them in their life struggles. Many of these have to do with the all-important processes of reproduction and cross-fertilization. The elaborate organs which oftentimes force visiting insects to aid the flowers in their love-making are conclusive proofs of directing intelligence. If, as is generally believed, vegetable life preceded animal life on this planet, then the plants must have developed these special reproductive organs in which insects act as the fertilizing agents as direct attempts to benefit the race by cross-breeding.

While cross-fertilization is vitally necessary for the maintenance of a vigorous and hardy

stock, inbreeding either between flowers of the same plant or even between the organs of a single bi-sexual flower is often practiced. In the love-making of the Grass of Parnassus and the Love in the Mist (*Nigella*), we have a very pretty and intelligent act. The flowers are unisexual and, as the females usually grow on much longer stalks than the males, the latter would not have much chance of showering their pollen on their consorts, if it were not for the fact that, at the proper season, without outside stimulation, the "tall females bend down to their dwarf husbands." This surely is as intelligent and conscious as the mating of animals.

The carnivorous plants act with uncanny wisdom. The insect-devouring Sundews pay no attention to pebbles, bits of metal, or other foreign substances placed on their leaves, but are quick enough to sense the nourishment to be derived from a piece of meat. Laboratory specimens have been observed to actually reach out toward Flies pinned on cards near them. So highstrung are these sensitive organisms that

they can be partially paralyzed if certain spots on their leaves are pricked.

Many people have no hesitancy in ascribing considerable intelligence to the higher animals; why do they balk at making the same concession to plants? If you concede intelligence to a single animal, you concede *some measure* of brain-power to all animals down to the one-celled Amoeba, and so must grant the same favour to the plant world. Plants and animals, besides having many habits in common, in their simplest forms are often indistinguishable. Both reduce themselves to single-celled masses of protoplasm. The Myxomycetes are both so plant-like and at the same time so animal-like that their classification "depends rather on the general philosophical position of the observer than on facts." Possibly they are both animal and plant at the same time—a sort of "missing link" connecting the two kingdoms of life.

Anent the same question Edward Step says, "Modern thought denies consciousness to plants, though Huxley was bold enough to say that every plant is an animal enclosed in a wooden box; and science has demonstrated that there

is no distinction between the protoplasm of animals and plants, and that if we get down to the very simplest forms in which life manifests itself we can call them animals or plants indifferently."

When one considers the rooted, plant-like life of Mollusks and Hermit Crabs, and then the active, animal-like life of the free-swimming Moss spores and the wind-borne Fungi, he is tempted to wonder if, after all, this talk of plants and animals, is not just another of man's arbitrary classifications, which may be superceded in time by some other system of nomenclature.

Of only one thing are we sure, and that is that all life is one — an expression of the intelligence and power which pervades the universe.

Many readers may vaguely feel and believe these facts and yet not be certain that plants are individually and personally intelligent; long training makes them still feel that the many admittedly clever and ingenious acts recorded every day in plantdom are but the indications of some external mind or force working through

Nature. The plants act in certain ways because they have no choice in the matter; they are passive tools in the hands of such craftsmen as "instinct," "heredity," and "environment." The answer to this is that you can ascribe an exactly similar fatalistic interpretation to every human thought, word or deed. What you consider the freest decision of will you made today can be shown conclusively to be the result of a long train of acts and influences which stretches back to Adam. It would have been impossible for you to have acted differently.

Such blanket reasoning leads nowhere. If you believe that you are a free, independent, decision-making soul (and who does not?) logically you must grant the same rights to the humble Squash.

Even in the terms of man's own science, the plants can be shown to be intelligent. The psychologist Titchner classifies the three stages of mental processes as (1) Sensations (2) Images and (3) Affections. The term "affection" is here used in the special sense of a capacity for en-

tering into intellectual states of pleasure or pain.

In view of what has already been said, it hardly seems necessary to prove the existence of sensation in plants. The very fact that all life is a constant response to stimuli and the adjustment to environment presupposes the existence of plant sensation. Only a few hours passed in the investigation of plant habits will show our vegetable friends giving definite responses to heat, cold, moisture, light, and touch, while laboratory experiments show their sensitive powers of taste and hearing.

The touch sense of the Sundew is developed to such an extent that it can detect the pressure of a human hair one twenty-fifth of an inch long. The tendrils of the Passion Flower attempt to coil up at the slightest contact of the finger and as quickly flatten out upon its removal. The stamens of the Opuntia or Prickly Pear have specialized papillae of touch exactly similar to the papillae of the Hermione Worm. When rubbed by the body of an insect, they transmit an impulse which causes the anthers to let loose a shower of pollen on

the intruder. The animal world cannot exhibit a higher sensitiveness to touch than that displayed by the celebrated Venus Fly-Trap. On each side of the leaf midrib stand three sharp little bristles. They are the sense organs controlling the closing of the vegetable spring. Quick must an insect be to escape their vigilance.

Sensation and imagery are so closely connected in the human brain that the existence of one would seem to predicate the other. Fortunately, we have very good evidence to indicate the faculty of plant memory, which must necessarily be built up of images of one kind or another.

If a plant which is accustomed to folding its leaves together in sleep on the setting of the sun, be placed in a completely dark room, it will continue to decline and elevate its foliage at regular intervals, indicating that it remembers the necessity for rest even with the reminder of outside stimuli lacking.

By what faculty do plants become aware of the approach of spring? Only occasionally are they deceived by January thaws, and no matter how unseasonably cold a March may be, they

go right ahead with the preparation of April buds and leaves. So accurate is plant knowledge about the seasons that Alpine flowers often bore their way up through long-lingering snow, even developing heat with which to melt the obstruction, when they feel that spring has really come. What gives plants such courage in the face of contradicting elements, if not an accurate sense of the passage of time and therefore the memory of other seasons, which implies imagery?

Until we develop a workable system of thought communication with plants, we can never scientifically prove that plants are capable of psychological "affections" or emotions. Mental states are purely personal matters. We would never be sure that any other human being went through feelings of love, anger, hate and pity, similiar to our own, if he were not able to tell us of them. Until the plants can describe to us their inner emotions, we can never definitely know whether they have real feelings, and if they parallel the human variety in any degree. But just as we have become able to read a man's mental processes by his facial expres-

sions, tone of voice and bodily posture, so we can guess at plant emotion by external manifestations. When a flower greets the morning sun with expanded petals, uplifted head and a generally bright appearance, why should we not say it is happy and contented? When an approaching storm causes a plant to droop its body and contract its petals and leaves into the smallest compass possible, why is not fear, apprehension and melancholy indicated? When the jaws of the Venus Fly-Trap close on its hapless victim, they must do so with a savage joy akin to that of a Tiger springing on its prey.

There are those who relegate a certain amount of intelligence to plants but deny them consciousness. They are unwilling to admit that plants are aware of their own physical and mental processes. This would seem to be the merest quibbling over terms and an entrance into that metaphysics which does away with all consciousness.

If plants were not conscious, at least under stimulation, they would have long since perished from the earth through inability to react to new conditions. Francis Darwin says: "We

must believe that in plants exists a faint copy of what we know as consciousness in ourselves." Many scientists believe that life and consciousness always precede and are superior to organization. It is urged that possibly many plants possess consciousness without self-consciousness or introspection.

After a thoughtful consideration of such facts as these, only the blindest prejudice can continue to laugh at plant intelligence. Why then has the world of human thought been so long and reluctant to acknowledge it? Simply because it always reasons along authentic and established lines. For many years it has been taught to associate animal movement with special groups of cells called muscles and intelligence with special groups of cells called nerve tissue. Failing to find any trace of nerve tissue in plants, it ignores a hundred convincing facts to the contrary, and declares that plant intelligence is a myth. Failing to detect a *mechanism* of sensibility, it denies the existence of sensibility, even though in the little Mimosa the sense of touch travels from leaf to leaf before our eyes.

It must be realized that the animal brain merely acts as the electrical motor for the life-power which drives the universe. This motor and all of its auxiliaries are absent in Protoza and other one-celled animals, but the power is not. In the same way, they are absent throughout all plantdom, but the eternal life principle manifests itself in many mighty acts.

What is a nervous system, anyhow? It is a group of cells, the specialized function of which is to transmit impulses from one to the other by certain obscure chemical reactions. Why cannot ordinary tissue cells do the same thing, possibly in a feebler, less efficient way? Plant cells are all joined together by fine connecting strands, forming a "continuity of protoplasm" through which such impulses could readily travel. Whether investigators agree to this or not, it is an indisputable fact that it is true.

Though science is now beginning to verify the fact of plant intelligence most conclusively great and independent thinkers of all times have long felt its truth. Certain minds are always in advance of their age. While science

laboriously proves every step of its way with painstaking and commendable exactness, they are soaring far ahead in new and fascinating fields. Sometimes they go astray, but quite as frequently they are the pioneers of great and progressive ideas.

CHAPTER XIV

The Higher Life of Plants

"I swear I think now that everything, without exception, has an immortal soul!
The trees have, rooted in the ground! the weeds of the sea have! the animals!
I swear I think there is nothing but immortality!"
—Walt Whitman

Maurice Maeterlinck, in one of his delightful essays, pays a remarkable tribute to the spiritual powers of plants.

"Though there be plants and flowers that are awkward or unlovely," he says, "there is none that is wholly devoid of wisdom and ingenuity. All exert themselves to accomplish their work, all have the magnificent ambition to overrun and conquer the surface of the globe by endlessly multiplying the form of existence which they represent. To attain this object, they have, because of the law which chains them to the soil, to overcome difficulties much greater than those opposed to the increase of animals. . . . If we had applied to the removal of the various

vicissitudes which crush us, such as pain, old age, and death, one-half the energy displayed by any little flower in our gardens, we may well believe that our lot would be very different from what it is."

No truer thought was ever set on paper. Though man prides himself upon his imagined superiority to non-human creation, and even denies the capacity for the higher things of life to animals and plants, he, in reality, nearly always shows himself vastly inferior to them in actual applications of moral and spiritual principles.

Have the plants souls and spirits? No man who has carefully and conscientiously studied them can wholly deny it. They exhibit a pluck, a determination, a moral perseverance which awaken all our admiration. Where we are weak, they are strong. Where men would lie down and die, they go steadily forward. When a plant perishes in the struggle for existence, it is because the odds have been too great. To make the most of heredity and environment is an axiomatic rule in plantdom.

Man's mind has developed at the expense of

man's body. The plants always maintain an admirable balance between the two. There are degenerates and unscrupulous individuals among them, but they never forget that their first duty is to themselves. Self-culture is with them a passion. Whoever heard of a plant over-eating or over-drinking or giving away to any of those indulgent vices which are the bane of the human world? They have their faults, but they are sources of strength rather than weakness.

In relation to its companions of the vegetable realm, the Murderer Liana is a double-dyed villian, yet it is only practicing in an open and frank way, the food-getting methods, which all life, by its very nature, is forced to adopt. To live by the destruction of others is the sad lot of both the smallest plant and the most highly developed animal.

Aside from the peculiarly human susceptibility to self-indulgence, it is hard to find a single spiritual trait not exhibited by some member of the plant kingdom.

Love? There is no higher devotion than that shown by the water plant called Vallisneria.

The female flowers reach the surface of the water at the end of long, tapering, spiral-like stalks, but the males are compelled to remain far down near the bottom. At the flowering season, the males, responding to the universal mating instinct, deliberately break themselves from their stalks and rise to the surface to be near their loves for a little while. All too soon, however, they are carried away by unruly currents to an untimely death, leaving behind them, in their pollen, the principle from which another generation of their species shall arise. They have presented themselves a living sacrifice on the altar of love.

Courage? Think of all the hardy trees which dwell in the high and cold places of the earth —places that are so exposed and desolate that the trees and plants find it necessary to contract themselves into the smallest possible compass, often living largely underground. On the other hand, think of the death-defying Cacti which live in infernos of the desert heat and dryness and yet put forth flowers of joy.

Faith? Hope? What sustains the perennials through long, bleak winters and makes them

sure of the promise of spring? When the Alpine flowers are so positive that spring has really come that they push their inquiring heads up through the snow which still covers the mountains, they are showing a superhuman faith, literally risking death in order that they may get a strong and early start in life.

Charity? When trees like the Oak and the Maple allow a whole multitude of lesser plants to dwell in the snugness of their shadows, they are showing forth some of the kindly qualities of plantdom. If they chose to they could discourage lowly neighbours after the manner of the monopolistic Beech or the aristocatic Pine.

Name a human sin or virtue, good quality or bad, and one does not have to search far in the plant world for its counterpart. Along with kindness, mercy, gratitude, submissiveness, and parental love we also find cruelty, hard-heartedness, ingratitude, arrogance and neglect of offspring. Even at that, the credit side always exceeds the debit and no plant is guilty of self-destruction. It must be borne in mind, that what we call sin and malignity are to them legitimate courses of action.

If plants have every property of the human soul, why have men been so slow to admit their kinship with the trees and the flowers? Life, law and love are divine and bind man to all creation. He is spiritually as well as physically related to the plants. In the past, he has endeavoured to set himself apart from Nature and look down upon her as upon another world. Because he has a brain, he has imagined that anything which has none cannot possibly possess an intelligence and an inner life. To uphold this theory he has shut his eyes to a thousand denying facts.

All plants and animals of whatever kind begin life on exactly the same level. The wayside Daisy and the Human Being both start their earthly careers as single cells. In both cases, there is no visible machinery of life and consciousness, yet we can say "Here is a potential Daisy. Here is a potential Man." The wonderful, all-pervading spirit of life belongs to both.

The language of the Bible classifies man with all life under the Hebrew term *Nephesh chayiah,* that is, living soul or creature. The Old Testament favours a rigorous protection of

animals and plants against wanton destruction. Is not the equality of the three kingdoms of life hinted at in the following passage from Jonah?

"Thou hast had pity on the Gourd, for the which thou hast not laboured, neither madest it grow; which came up in a night, and perished in a night."

"And I shall not spare Nineveh, that great city, wherein are more than six score thousand persons that cannot discern between their right hand and their left hand and also much cattle."

Some marvelous experiments carried on by Sir Jaghadish Chaundra Bose in Calcutta, India, offer interesting light on the higher life of plants. By exceptionally delicate and ingenious instruments, Sir Jaghadish has been able to measure the plant movements associated with growth, shock and response to stimuli in general. He has come to the conclusion that plants not only have a conscious intelligence, but have their good and bad days, their moods, their whims. He believes they react to slight or pleasurable stimuli by general expansion. Violent stimuli cause pain and contraction. A plant struck a blow quivers and shakes in

veritable agony. Plants about to die undergo a violent spasm and then by making no response at all to outside influences, show that they have actually given up the ghost.

Sir Jaghadish is satisfied that a plant pulled up by the roots experiences a shock comparable to that of a man being beaten into insensibility. Many trees and plants, as every gardener knows, fail to survive transplanting and die from pure shock, even if their tissue has been in no way injured. Sir Jaghadish has performed the interesting experiment of administering a powerful chemical to act as an anesthetic to trees about to be transplanted. Such specimens have stood the re-location well but in some cases have shown an apparent loss of memory and a general state of upset habit, exactly as would a man or animal coming out of a stupor.

All this strongly suggests a soul or driving spiritual force in every living creature. Regarding its exact nature there are many opinions. Maeterlinck believes that there is a general scattered intelligence, a sort of universal fluid, which penetrates all organisms in an amount proportionate to their conductivity. Man offers

the least resistance to the divine principle and so receives a generous share. The plants receive lesser amounts, but really belong to the same intellectual order. They exhibit the same ideas, the same hopes, the same logic and undergo the same trials in a lesser degree than their more educated brothers. The plants and man both grope, hesitate and correct themselves in their labourious evolutionary development.

Of course, this theory is only a conjecture, but is very appealing and much more modest than the traditional attitude which assumes that man is a miraculous and marvelously endowed being fallen from another world and therefore lacking any definite ties with the rest of terrestrial life.

If then we believe that a vital spiritual force dwells within every plant, what becomes of it after the death of its enclosing walls? Each cell of a tree in effect dies many times each season. Continual waste and renovation bring periodic transformation of cell structure. The abode is changed but not the inhabitant. There must be an animating, non-physical force which carries on the cycle. If it is superior to the

forces of bodily dissolution, must it not also be infinite, immortal?

With so many modern people doubting (or pretending to doubt) the immortality of man, it may seem presumptuous to claim immortality for the plants, yet that is the unescapable conclusion to which the writers of this book are driven. All life is one, indivisible and inseparable. There is a divine spark in every living creature and it is reasonable to expect it to live beyond death. Immortality by reproduction is not enough. If it were true that the eternal principle continually passes from parent to offspring, and that when the parent dies, he is dead spiritually as well as physically, then we should expect immediate degeneracy and death after reproduction takes place. That a portion of soul essence descends through countless generations we do not doubt, but each plant and animal is also a spiritual entity. Man and plants are both tools in the hands of Maeterlinck's all-prevailing intelligence. Yet man feels that he is a free agent. Why not the plants also?

Every plant has racial and family traits, and each one also has a marked personality. If im-

mortality is a fulfilling, a conserving continuance of the present earthly existence, then the plants deserve and have a right to expect a chance for infinite development.

The plants serve to make this earth a floral paradise. Why should they not be equally necessary in a world of spirit? It is to man's credit that he has always pictured heaven as a place made beautiful by great hosts of trees and flowers.

CHAPTER XV

Plants and Men

"Our human souls
Cling to the grass and water brooks."
—Athanase

THE average city man gives little thought or attention to his vegetable neighbours, yet their continued existence is quite as vital to him as the air he breathes. Directly or indirectly he is utterly dependent upon them.

Every time he sits down to a dinner table, he is paying an unconscious tribute to the food-producing abilities of plantdom. In a general way, plants are the world's food producers and the animals are the consumers. Plants are able to build up living tissue from inorganic material. Animals must prey upon that elaborated structure to keep themselves alive. Plants separate oxygen from carbon dioxide and water, thereby storing up sunshine as potential energy. Animals reverse the process, and, recombining oxygen with the plant tissue, liberate

heat and power. In a desert region, animals soon perish, because even carnivorous species live on herbivorous fellows which in turn are eaters of plants. This is why the distribution of men and animals is so greatly influenced by that of plants.

For clothing man depends partly upon such plant-products as Cotton and Flax and partly on plant-fed animals which yield him silk, wool and leather. The great plant structures of the forest give him the chief materials which go into the construction of his ships and houses, with all their appurtenances. The bodies of plants, recently alive or the bodies of plants long since dead furnish fuel for cooking, heating and power. Drugs are very largely of vegetable origin. In brief, the plants feed, clothe, shelter, and warm mankind.

Man has made many plants his servants. His first attention was naturally given to such species as he could use for food. Two thousand years ago, the ancients were growing practically all the food plants that are known today. Maize, Potatoes, Rice, Beans, Dates and Bananas have been cultivated for an even longer period.

Fodder plants, calculated to furnish food for man's domestic animals, were the next to receive attention, and following those, medical plants, edible fruits, garden vegetables and aromatic leaves and seeds, such as Tea and Coffee, came to the fore.

When we consider that plants display superior powers in so many directions and, as F. L. Sargent says, "do to perfection so many things we cannot do at all," it is really remarkable that man has so completely subjected them to his will. Because of their static condition, they are quite helpless in his hands. He levels their grandest forests and burns their widest prairies. Certain plants he makes his pets, fighting their enemies and nurturing them in the most careful way. The tender Wheat would never be able to occupy the vast stretches it does through its own strength. Under man's guidance and protection, its volume is increased a thousand fold.

The vast changes which human efforts make in the surface of the earth have a correspondingly important effect on vegetation. Every time a tract of woods is cut down, every time a

lake is drained, every time a field is plowed—whenever any alteration is made in the landscape—the vegetation is affected. Sometimes this disturbance of the natural order of things becomes a serious menace, as in the case of deforestation. The welfare of the world is bound up with the welfare of the plants.

About a hundred years ago, a certain section of forest in France was levelled. It contained Oak, Beech, and Ash. The new trees to spring up were Birch and Poplar. After thirty years they too were felled and young shoots of the same species immediately came up, with a few descendants of the original growth reappearing. It was not until the third clearing or ninety years after the original cutting that the Oaks and Beeches began to regain their lost prestige. This is a good example of the effect that human operations have on the plant world. Wholesale cuttings tend to change the chemical composition of the soil by withdrawing certain elements, thereby causing other species to flourish which do not need this material.

When it comes to plants grown in nurseries and conservatories, gardeners are often able to

make almost unbelievable changes in floral and vegetable form and structure. There has been much experimentation of recent years in connection with the effect of light, both natural and artificial, on plant processes. In general, it has been established that it is just as injurious for a plant to have too much light as too little. Steady exposure to light makes for accelerated growth of tissue. Lessening light speeds up flowering and reproduction. Control over a plant's light supply therefore means that the manipulator can produce at will either large, luxuriantly foliaged plants which flower late, or from the same seed develop small specimens blooming exceptionally early.

Man is not content with merely controlling the external conditions which affect vegetation but often steps into their internal processes and moulds their life-forces at their very fountain-head. By the simple methods of selection and cross-breeding, he is able to work miracles with the laws of heredity, and bridge in a few years gaps which a plant would have taken centuries to span by ordinary evolutionary processes.

Luther Burbank is the modern garden

wizard who has attained the greatest distinction in this field. He says: "There is no barrier to obtaining fruits of any size, form or flavour desired, and none to producing plants and flowers of any form, colour or fragrance; all that is needed is a knowledge to guide our efforts in the right direction, undeviating patience and cultivated eyes to detect variations of value."

Burbank has many times shown that he has the knowledge, patience and cultivated eye in a superlative degree. He claims to only apply old methods in a new way, but his results have been phenomenal. In fruits he has produced many new varieties of Apples, Pears, Peaches, Apricots, Plums, Prunes, Cherries and Quinces. His Plumcot is a delicious cross between a Plum and an Apricot. Out of the Dewberry and a Siberian Raspberry he compounded what he calls the Primus Berry. A Dewberry plus a Cuthbert Raspberry equals a Phenomenal Berry. One Lawton Blackberry and one Crystal White Blackberry make one Paradox Berry.

Among the Burbank floral creations the Shasta Daisy is notable. It combines strains from Europe, Japan, and America. A new giant

Amaryllis has twelve-inch blossoms. The Tigridias is suectacular, the blue Poppies are odd and there are many extraordinary Lilies.

The substitute for Grass developed by the California naturalist thrives through the most severe drought and so is of practical economic value. His improved Walnut Trees grow to a large size in a few years and his Chestnuts bear abundant crops when they are mere bushes. Spineless Cactus is a very valuable creation.

All these results are obtained in what seems to be a very simple way, yet their successful outcome is only made possible by the mind of genius working with infinite patience over long periods of years. To select out of a group of plants a few individuals which show exceptional quality of a desirable type; to save the seed of these favoured few and make further selections among their progeny; to couple with this the cross-pollenizing of different varieties or species showing a tendency to greater variation or accentuation of characteristics—all this may seem only high grade garden practice, but only one man in two or three generations has the exceptional and sympathetic perceptive

faculties which enable him to attain really striking results.

On his experimental farms near Santa Rosa, California, Luther Burbank has made many thousand distinct experiments involving a wide range of plant species. It is said that at times he has had as many as three thousand tests, calling for observations on a million plants and flowers, under way at once. Probably no similar area of the earth's surface has grown such a variety of vegetable products or had such infinite care lavished upon it.

These are the practical aspects of the relations of plants to men. On the esthetic and pleasurable side they are equally important.

The love of plants and flowers is a universal sentiment slumbering in the most prosaic breast. Plants are a perpetual source of joy. They are friends which never change. In youth, they give zest to our outdoor pleasures. In age, they bespeak the happiness of days gone by. In death, they strew our last resting place with fragrance. At all times, they stand for purity, beauty and peace.

THE END

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