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THIRTY VOLUMES

VOLUME FIFTEEN

THE DEVELOPMENT OF OBSERVATION AS A MEANS TO SUCCESS. DEFICIENCY IN OBSERVATION CURED BY PRACTICAL STUDY OF NATURE. THE IMPORTANCE OF THE POWER OF RELIABLE OBSERVATION IN FINDING THE MATERIAL FOR THE OTHER FACULTIES TO WORK INTO THE FABRIC OF SUCCESS. WHY THE OBSERVANT OUTSTRIPS THE UNOBSERVANT IN THE RACE FOR SUCCESS WHERE OTHER TALENTS ARE EQUAL. NATURE HERSELF A STIMULATING EXAMPLE OF PERFECT SUCCESS

"Come forth into the light of things,
Let Nature be your teacher."
WORDSWORTH

"To him who in the love of Nature holds
Communion with her visible forms, she speaks
A various language."
BRYANT: Thanatopsis

"Go forth under the open sky, and list
To Nature's teachings."
IBID

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THE PINE

Pinus

MANY peculiarities combine to make this one of the most interesting of trees. Not the least is the fact that it is a remnant of the Carboniferous Age, a surviving member of a great family that helped to furnish our coal beds. With its relatives, the other coniferæ, it forms a class widely different, botanically as well as in general appearance, from the other forest trees. They are known as gymnosperms, or naked seeded plants. The flowers, scarcely worthy the name, even scientifically, are borne in aments or catkins. They consist of little more than two exposed ovules borne on a scale which nestles in the axil of another scale or bract. The ovule-bearing scale quickly outgrows the bract, which in the developed cone is lost to sight. It may be seen on breaking the cone apart. In the firs this bract remains conspicuous. The cone does not ripen until the second or third year after flowering. It varies considerably in form and size in different species.

The leaves of the Pine are of two kinds,—primary and secondary. The latter are those which we commonly know as "needles," forming the foliage of the tree. In different species these vary in length and in form, some being perfectly round, some flattened or grooved. They spring in clusters from the axils of the primary leaves, which are usually mere scales, but occasionally take a linear form. All Pines are evergreens. In the spring the dainty, light green needles, coming out at the ends of the branches, form a striking contrast to the dark ones of longer growth.

The appearance of the tree itself is usually stately, although there are some dwarf species. The trunk is almost always tall, slender and tapering; the branches springing in umbel-like arrangement at intervals. From the resinous sap, which often exudes and trickles down the tree, are derived resin, pitch, tar, turpentine and many other similar valuable products.

Of the many species and varieties of Pine, we shall consider only those growing within the United States. Of these, perhaps none is of more importance than the Oregon Pine. This is a great tree, sometimes reaching to a height of three hundred feet. In Washington and Oregon, where for some reason it flourishes best, there are large forests of it. It is scattered northward to British Columbia, and southward as far as Mexico. Its wood, hard and durable, forms the most valuable timber of the Pacific region. Because of its great length and straightness, it is desirable for masts.

Another important Pine is the Georgia, or Long-leafed species (*Pinus palustris*). Vast forests of this are spread along the Atlantic and Gulf coasts, beginning at Virginia. This tree seems to love the salt water; it is seldom found more than one hundred and fifty miles inland. It grows to a height of from seventy to one hundred and twenty feet, and is sometimes three feet in diameter. It is a tree of great dignity and beauty, with long, flexible leaves measuring nearly a foot in length, and handsome cones. The wood of this species, commonly called Yellow Pine, is very valuable commercially, its uses being mentioned elsewhere. The Giant, or Sugar Pine (*Pinus lambertiana*), found on the Pacific coast, yields a sweet sap which is sometimes used for sugar.

The Pitch Pine (*Pinus rigida*), is well known throughout the Atlantic states. As its Latin name would suggest, it is a stiff tree, scraggly yet not by any means ugly. It is prominent among the Pines of New Jersey and Long Island. It is a rapid grower, and can live in soil too poor for most trees. When cut down, shoots quickly spring from the roots and flourish. In this it is an exception to the rule of its kind. Among the Greeks, the Pine was the emblem of death because it did not spring up as other trees after cutting down. The timber is of little value, but it is rich in valuable resinous sap.

The Jersey, or Scrub Pine (*Pinus Virginiana*) is a small, ragged tree, which, nevertheless, helps to beautify the landscape by spreading itself over worn-out fields. Unlike nearly all other Pines, its branches are smooth, not scaly. It is of little commercial value.

The Canadian, or Red Pine (*Pinus resinosa*) extends into the northern part of the United States. The reddish-brown bark and red wood have given it one of its names, but why it should be called *resinosa* is not so clear, as many other Pines contain a greater abundance of resin. The Red Pine is especially beautiful while young. Its long, flexible needles grow in graceful clusters along the sides at the tips of the branches. As the tree ages these side clusters fall away.

SPRUCE FAMILY

The White Spruces — Picea Alba — Picea Canadensis

This variety of the Spruce or Fir family is a native of cold climates in the temperate zone. It is found abundant in Newfoundland, the Hudson Bay region, and Alaska, and southward to Maine, New York and Michigan. Its westward range is to South Dakota, Montana and British Columbia. It is a slender, conical tree, usually sixty to seventy feet high, but sometimes reaching one hun-

dred and fifty feet. Its foliage is spirally inclined, as is its whole outline; the narrow, spiral leaves crowd on the upper part of the branches by the twisting of those beneath, and point sharply forward to the extremity of the branchlets. At first they are a pale, bluish green, semi-hoary in effect, then become a dark-green bristling mass, three-fourths of an inch long. The leaves of the Spruce differ from those of the Pine in that they are much shorter and are placed singly on the branches, instead of being clustered together in close groups, like those of the Pine. When dry, they fall and leave bare twigs covered with rough projections.

The White Spruce sometimes reaches one hundred and fifty feet, with a trunk measuring three feet around. Although the foliage is beautiful in its prime, the odor of this tree is unpleasant; and this alone may serve to distinguish it from the Black Spruce, whose resinous gum is pleasant to smell and taste. The gum of this tree is white and soft. It flowers in April and May. The cones are also different from the Black Spruce, being of a lengthened oval form, about two inches long. The seeds are also smaller and ripen earlier.

The wood is light yellow, soft and weak, with straight-grained, satiny surface. It is used in making the cheaper grades of furniture, for interior finish of houses, and for wood pulp. When burned, it snaps more than the Black Spruce. The tree that has sometimes been designated Blue Spruce is practically the same tree as the White Spruce, both names coming from the bluish-white shadings of the foliage when young. Woodsmen have also called it Single Spruce, to distinguish it from the Black or Double Spruce.

Black Spruce — Picea Nigra

This evergreen is also of pyramidal outline, and distributes itself over much the same region as the White Spruce, but grows well in somewhat colder latitudes. It is very abundant in Lower Canada, Newfoundland, New Brunswick, Nova Scotia and Maine, also in Vermont and the upper part of New Hampshire. Farther south it is not seen at its best, except in cold and humid situations on the top of the Alleghanies and the mountains of the Carolinas. It is found in Michigan, Wisconsin and Minnesota. The finest forests of it are found where the soil is black and covered with mossy beds. The branches are pendulous, rather slender, with an upward curve, the roots thick, widespreading and the rootlets long, flexible and tough.

The bark is grayish-brown, scaly when old, and has no commercial value. The leaves are spiral, thick, and spread in all directions, and are of lustrous green. The cones are somewhat thicker and shorter than those of the White Spruce.

The tree does not retain its beauty after youth, and in old age sometimes becomes misshapen and unsightly. It derives its name from the dark green of its foliage, which, when massed on a mountain side, produces very sombre shadows. The cones of the Black Spruce cling to the tree during flowering time, and even persist in clinging to it sometimes for years; while the cones of the White Spruce fall off during flowering time. Resin flows freely from cuts or wounds in the tree, and thus hardens into the chewing gum that has so long been a marketable commodity. The odor from leaves and bark is pleasant and aromatic.

A favorite drink called spruce beer is made from boiling the young branches of this tree and adding to the liquid, molasses and yeast in certain proportions. This drink is not now so popular as of yore, but it played a prominent part in entertainments among the early settlers, and Cooper has immortalized it in his "Leather Stocking Tales." The wood of the Black Spruce has had a great maritime history; for generations it was manufactured into masts and knees for vessels built in Massachusetts and Maine. It is now used most largely in housebuilding, for the sounding-boards of pianos, for pulp and for fuel; and it is still one of the chief articles of commerce in the extreme West. In the East and North the oldest trees have been largely cut down. In the soil it loves, it grows to a great height. The distinguishing properties of its wood are strength, lightness and elasticity.

Red Spruce — Picea Rubens

The Red Spruce grows best from Nova Scotia to North Carolina and Tennessee. It reaches one hundred feet or more, but its common height is from seventy to eighty feet. It grows slowly and has thick resinous roots. The Red Spruce was for many years confounded with the Black Spruce; but Professor Sargent has shown wide distinctions between the two. The cones of the Red Spruce are large and fall during the first winter; while those of the Black Spruce remain on the tree for years. The Black Spruce is a tree of the far North, having but a precarious existence south of the very northern borders of the United States. The Red Spruce, on the contrary, is an Appalachian tree, and attains its greatest size in northern New Hampshire and Pennsylvania. Spruce beer is also made from this tree; and from it is obtained the pinkish chewing gum of commerce. It flowers in April and May. The anthers have bright red crests; the flowers are oblong and greenish. The wood is converted to the same uses as that of the Black Spruce.

WHITE ASH

Fraxinus Americana

This is one of the most interesting of American trees, by reason of its rapid growth and its beautiful foliage. The common name refers to the silvery-white surface of the under leaf. This tree sometimes grows to a height of eighty feet, the trunk retaining its distinct central shaft after the division into branches, though when these are covered with the dense foliage, it is hidden from sight. The easy sway of its branches, with the somewhat drooping leaves, gives it a very pleasing appearance.

The bark is deeply furrowed, the ridges crossing each other in diamond shape. The branches spread from the central stem, diminishing in length as they proceed upward, with a regularity that gives the tree a beautiful form. The buds are large and broad, of a pale brown color, differing in this respect from those of the European species, which are short and often black. The leaves are from twelve to fourteen inches long, and composed of three or four pairs of leaflets, smooth and of a light green.

This variety of the Ash is native to North America, from Labrador to the Carolinas, and a cold climate seems more congenial to it than a milder one, as it flourishes abundantly north of the Hudson River. The White Ash was introduced into England in 1723, by Mark Catesby, and several large plantations of it were started in different parts of that country, in 1826. The wood of the Ash is light, strong and elastic, and was used by the Indians for making bows and paddles. Two ancient traditions of the Ash are that no serpent will go near it and that it is more liable to be struck by lightning than other trees.

BLACK ASH

Fraxinus Nigra — Fraxinus Sambucifolia

The Black Ash is of slower growth and not as long-lived as some of its sisters. It is the most slender of the forest trees; when growing to a height of sixty or more feet, its diameter will be scarcely more than a foot. Its bark is dark and tinged with gray. It seems to love cold, growing in damp swamps, and putting out its blue-black buds as early as March. It grows farther north than any other of the Ashes, ranging from Newfoundland west, and south to Florida and Arkansas. It does not endure transplanting well, nor will it grow in dry soil.

The wood is of a light brown and has a beautiful grain that shows well under a polish, making it useful in cabinet work; it is also tough and pliable and is valuable for many purposes. The Indians used the young saplings, preferring them to any other wood for making baskets.

RED ASH

Fraxinus Pennsylvanica — Fraxinus Pubescens

Both the Red and the Green Ash, like the Black, prefer rich, moist soil, such as the banks of streams, but, unlike the latter, will grow where it is dryer. The Red Ash strongly resembles the White in general appearance, but the Red is downy on its branches and leaves, whereas the White is generally smooth. This down is of a reddish hue, and the inner surface of the outer bark of the branches is of a red or cinnamon color. This is also true of the White Ash.

The Red Ash is a rather small tree, averaging only about forty feet in height; the branches are short and upright, and its head is irregular. Its dry, wing-like fruit, similar to that of the White Ash but more spatulate, remains on the branches throughout the winter. The wood is light brown, brittle instead of elastic, and not as valuable, commercially, as that of the White Ash.

BLUE ASH

Fraxinus Quadrandulata

This is a native of the Mississippi Valley. It does not grow abundantly in any locality, but prefers a limestone soil. It extends from southern Michigan to central Missouri, and south to eastern Tennessee and northern Alabama, and through Iowa. It grows very tall, sometimes attaining a height of one hundred and twenty feet, and its trunk is occasionally two or three feet in diameter, though usually smaller.

Its distinguishing feature is its quadrangular shaped branchlets. It thrives in fertile bottom lands. It is hardy and grows rapidly, and its rich, shining foliage, free from insects, makes it well adapted for cultivation. The wood is dark yellowish and has much the same qualities as the other Ashes; it is used for flooring and for some parts of carriages. A blue dye is made from the inner bark and it is from this that it gets its name.

GREEN ASH

Fraxinus Lanceolata

THE Green Ash very closely resembles the Red Ash; the flowers are nearly alike, and from other points of resemblance it is believed by some to be a variety of the Red Ash. It has darker and more lustrous foliage, and its leaves are shorter and narrower, and smooth, and both upper and under surface are a light green and always shiny. In New England the difference is more strongly marked than in the West, where they seem almost identical. The Green Ash is the most beautiful of all Ashes for ornament, and it easily adapts itself to new surroundings, though liking plenty of sunlight.

It is suitable for planting in cities, and for shelter, because of its ability to flourish where the rainfall is small or uncertain.

The wood is not as valuable commercially as some of the other Ashes, though it is sometimes substituted for the White Ash.

THE INDIAN BEAN

Catalpa

THE Indian Bean (*Catalpa bignonioidas*) or, as it is also called, the Southern Catalpa, is a native of the United States, throughout which it is common in cultivation as an ornamental tree. It has large heart-shaped leaves, downy underneath and, when young, from six to twelve inches long. The flowers are white, spotted with yellow and purple, and give forth a delicate fragrance. The tree grows to a height of from twenty to forty feet; its spreading branches support flowers in thick clusters, and it makes a pleasant and refreshing background for house or garden. In the southern states it is found wild, but in the North, where it is not indigenous, it is successfully cultivated and flourishes as far north as mid New York. The wood is soft and light and is principally used for railroad ties. It is popularly supposed that the honey secured by bees from the Indian Bean flower has poisonous properties. Sometimes the Catalpa is called the cigar tree, and the bean is even now surreptitiously smoked by reckless small boys. The first Catalpa planted in New England still stands on Washington Street, Hartford.

The Western Catalpa (*Catalpa speciosa*) is a much larger species, being almost twice as tall as the Indian Bean. Its flowers are long and white, faintly spotted, and the seed pod is thick and coarse. It grows wild in the low rich woodlands of southern Indiana and in the country lying immediately to the south and west of that state.

WHITE THORN

Cratægus Coccinea

The Rose family, of which the White Thorn is a member, is a very large one, said to include more than sixty species of thorn-bearing plants. The genus Thorn belongs to the same division of the family as the Apple, Pear, etc., the structure of the fruit being the chief point of difference, but both in cultivation and in its wild state the species are disposed to vary.

The White Thorn is a small tree, growing from ten to twenty feet in height, with spreading, crooked branches, and silver-green, glimmering branchlets. Its stout thorns are one or two inches long and are curved. The leaves alternate, are simple, often lobed, dark green, tinged with red. The abundant flowers, though smaller, closely resemble in structure those of the apple: they grow in clusters, and are generally white, though sometimes a delicate rose color, and have an unpleasant odor. The blossom keeps company with the dogwoods in early spring. The fruit of this variety is a bright scarlet, and on this account, is sometimes called Scarlet-fruited Thorn. The fruit remains on the branches until late in autumn.

COCKSPUR THORN

Cratægus Crus-galli

This is one of the finest of the dozen varieties of Thorn native to the United States; it is found from Canada to Florida, and west of the Mississippi. In its wild state it produces varieties differing much in foliage. When well-developed by cultivation, it frequently reaches a height of twenty or more feet. There are also some garden varieties, one of which is a remarkable dwarf, much used as a hedge plant, for which its thick, compact habit of growth renders it especially well fitted. It is a conspicuous tree or shrub throughout the year, with its numerous, fragrant white flowers bursting into bloom in June, its thick leaves, dark green and shining in summer and turning to scarlet or dull orange in autumn, and its red fruit somewhat similar to the crab-apple, untouched by the birds, and remaining on the branches during the winter. It has numerous straight, slender, smooth thorns, from two to four inches long.

The wood of the Cockspur Thorn is close-grained and takes a fine polish, but, on account of its small size, its usefulness is limited. It is used in making handles of small tools where toughness is required.

SCARLET HAW HAWTHORN

Cratægus Mollis

This is the most beautiful of the American thorns. It is a small tree with straight trunk and is very ornamental as a lawn tree, as it may be grown in a close pyramid, with its branches nearly touching the ground. It blossoms abundantly and insects do not attack its foliage. Its roots are fibrous; it grows wild along the margins of swamps, on river banks, or in rich prairie soil. This species has been confounded with *Cratægus coccinea*, but it differs in having larger and broader leaves, less deeply cut, and fruit that is large and edible—the only Haws that can really be called so, for though slightly acid, the yellow flesh has an agreeable taste.

It blossoms in May. The flowers are white and perfect; an inch or more across and grow in stout, broad clusters. The fruit is a light scarlet with a slight bloom.

ENGLISH HAWTHORN

Cratægus Oxyacantha

This thorn tree, native to Europe, does not flourish as well in America as do some others of the species. It is a small tree or shrub, fine for the lawn, and is used largely in England for hedges.

The leaves are smooth, wedge-shaped at the base, and are lobed and toothed above the middle. The flowers are of medium size, single or double, white, rose color, or pinkish, and grow in numerous corymbs. It blossoms in common with most of the Hawthorns in May, the time when

> " . . . every shepherd tells his tale
> Under the Hawthorn in the dale."

The fruit is a coral red, and is about one-third of an inch across. Though said to be edible, the fruit of the Hawthorn is not alluring to either bird or human; the proportion of seed to flesh making it undesirable as food. The wood of all the Thorn family is hard and strong.

DOTTED-FRUITED THORN

Cratægus Punctata

This species of Thorn is found in New England, west and south to Georgia, and is particularly abundant in Virginia and Carolina. It is a compact tree, growing from twelve to thirty feet high, exceedingly effective as an ornamental tree, and when cultivated grows in a quaint fashion, broad and flat.

The bark is a reddish brown, the thorns light brown, sharp, sometimes three inches long. The foliage is smaller than some of the other species, the leaves wedge-shaped at base, tapering above, slightly pointed at apex and unevenly serrate, thick, light green and downy; when young, gray green, and at maturity, dull. It blossoms in May and June; the flowers are white, from eight to fifteen usually growing in a leafy corymb. The fruit is a drupe-like pome with bony seeds, round or slightly elongated, a dull red or yellow, marked with many white spots. In autumn the leaves turn to bright orange, or orange and scarlet.

BLACK THORN

Cratægus Tomentosa

The Black Thorn, also called Pear Thorn, from its pear-shaped fruit, is variable in its habit, producing several varieties, sometimes growing to a height of twenty-five feet, and again appearing as a shrub. Whether this variableness is simply an adaptation to different soils and climates is uncertain, but it is found in more localities than are any other of the American Thorns. One of the varieties has leaves dotted with white.

The bark is ashy gray in color, broken into thin scales; the young twigs are a bronze green, later becoming a dark orange, and finally an ashy gray. The leaves are simple, apex pointed, unevenly toothed, the upper surface a grayish green. The white flowers are abundant, grow in clusters at the ends of the branches, and have a disagreeable odor. The tree blooms in May; the fruit ripens in October. The thorns are stout, from one to two inches long. The bright scarlet or orange fruit, nearly an inch in diameter, remains on the branches all winter, and may still be seen when the flower buds begin to unfold in spring.

THE LINDEN OR LIME

Tilia

THE Linden or Basswood is well known as a favorite ornamental shade tree. It is frequently and effectively grown along the streets of towns and cities, as well as on lawns. "Unter-den-Linden," in Berlin, is famed as one of the most beautiful streets of the world; and not the least part of its beauty is due to the trees from which it takes its name. There are several varieties, differing but slightly. Their general appearance is graceful and pleasing. Although these trees sometimes attain a height of one hundred and twenty feet, they are oftener from about sixty to eighty feet high; well-rounded below, but tapering somewhat toward the top. The trunk is usually straight, with dark brown bark, conspicuous for its deep, vertical ridges. Lindens sometimes attain a great diameter. The famous tree from which Neustadt in Würtemberg took its name, "Neuberg-an-der-grossen Linden," measured nine feet across at the base.

The branches, starting at no great distance from the ground, light gray or brown near the trunk, are decidedly green at the end, which produces a pleasing effect. The leaves are handsome. They are dark green, smooth, and glossy above, but grayish and downy beneath. They vary in different species from two or three inches to seven inches in length, with a width nearly as great. The sides are rounded into almost a semicircle, irregularly toothed, and ending rather abruptly in a sharp point. Prominent veining also helps to give them character. Long bracts of a much lighter green show prominently among the leaves, giving the tree a variegated appearance. The dainty little cream-colored flowers spring curiously from the center of the midrib of these apple-green, leaf-like bracts. They look like little stars, the five slender petals standing out separately and being set off by a cluster of many stamens in the center. The five sepals are downy. These flowers are fragrant as well as pretty.

Because of the abundance and delicious flavor of the nectar secreted, the best of honey is said to come from apiaries situated near a Linden grove. The amount of honey produced by bees so situated is astonishing. "Bee-tree" is one of the names given to the Linden, and the celebrated Lithuanian honey is made from the nectar of this tree. Not less interesting is the tree when the little, hard, rough, ball-like fruits have replaced the flower-clusters. These are of a greenish gray, about the size of a small pea or an ordinary bullet. The children love to put pins through them, to make them dance at the end of a

pipestem, by inserting the pin into this, and then blowing into the other end of the pipe. These little balls nod on the trees for a long time before falling.

The American Linden, also called Basswood, Whitewood, and Whistle-wood (*Tilia Americana*), is widespread throughout North America, as far south as Virginia. It sometimes obtains the maximum height given above. The leaves are from four to five inches long. In the flower of this species are little petal-like bracts surrounding the stamens at their base. These are lacking in the European species.

The European Linden (*Tilia Europæa*) is distinguished from the American Linden by its blossom, as stated above; there are also several superficial differences in the general appearance of the trees. The European species is considerably smaller, seldom attaining a height greater than thirty-five or forty feet. It is also more slender, not so rounded in growth. The branches are lighter and higher from the ground, and the leaves are not so large. These trees are often planted about country houses.

The Downy Linden (*Tilia pubescens*) is more like the European Linden just described. It grows to about the same height, is slender and small-leaved. The bracts bearing the blossoms are sessile, and rounded at the base, instead of pointed, as in the other species. Much of the pubescence disappears when the tree reaches its full growth. The Downy Linden is common throughout the United States, south and west of New York.

And now we come to perhaps the handsomest of all the Lindens, namely, the so-called White Basswood (*Tilia Heterophylla*). This tree, which is found plentifully in the mountains of Pennsylvania, and through the South and Southwest as far as Tennessee, is usually about fifty or sixty feet high. The leaves are even larger than those of the American Linden, sometimes measuring seven inches. They are of a dark, rich green above, smooth and shining; below they are silvery and of velvety softness, with purple veins showing through. A certain irregularity, or lop-sided appearance, in the leaf, common to all Lindens, is particularly noticeable in this species. It is found in the southern states, and as far west as Illinois. Unfortunately, it is not often seen in the North, even in cultivation.

The wood of the Linden is light, close-grained, and will not warp easily. That of the American Linden is soft and brownish red in color; in other species it is white. It is used largely for toys and other small objects, turned or carved; also for the sounding boards of pianos, for the seats of chairs, and for many other purposes where a non-warping wood is required. The reddish wood of the American Linden is principally in demand for carriage panels, because it is

particularly free from blemishes, but it cracks easily in the working. The inner bark, or "bast," is as valuable as the wood. It was used by the ancients for the making of paper, mats, and twine. Bast mats are now made in Russia and exported.

THE PECAN

Carya Olivæformis also known as Hicoria Pecan

THE Pecan, *Carya olivæformis*, or *Hicoria pecan*—for it rejoices in two botanical names—is one of the Hickories. Its habitat is in rich, moist soil, especially along the banks of streams, in the middle-west. It flourishes from Indiana and Illinois southward to the Gulf, and southwest, especially in Arkansas and the Indian Territory. It is a large, handsome tree, the largest of the Hickories, sometimes reaching a height of one hundred and seventy feet, with a diameter of six feet or more. In common with other Hickories, it has a rough bark and compound leaves of from nine to fifteen slender, sharply pointed leaflets. The young twigs are downy. The flowers are borne in aments, usually in the axils of leaf-scars on last year's twigs, sometimes in those of this year's leaves. One of the four lobes of the calyx—there is no corolla—is long and linear, the other three short and broad. The fruit, well known as the Pecan nut, is olive shaped, hence its name *Olivæformis*. It is encased in a thin, four-valved husk, which often splits open, allowing the nut to fall out, itself remaining on the branch all winter. The inner shell is hard and smooth, but thin. The kernel, unlike that of the hickory nut, is divided but once, and that by a thin membrane. This cell-wall is very bitter and astringent, but the kernel is sweet, oily, and delicious. The nuts ripen in September and October. They are well known as nuts of commerce. The wood of this tree is of little value.

THE HORNBEAM

Carpinus

THE Hornbeam (*Carpinus Caroliniana*), also called the Blue or Water Beech, belongs to the Oak family. It is to be found from New England to Minnesota, growing principally along the banks of streams. It can be distinguished from the Hop Hornbeam by its three-pointed leaflets, placed in pairs, base to base, with the small nuts. The leaves are ovate-oblong, pointed, fuzzy when young, but growing smooth. The fruit is about three-fourths of an inch long,

the nut being about one-eighth of an inch. The tree, which is really little more than a tall shrub, grows to a height of from ten to twenty feet. It has a close, smooth bark, like that of the beech. The wood is white and hard.

THE POPLAR TREE

The Aspen or White Poplar — Populus Tremuloides

THE Poplar is a tree of wide range; it grows naturally in both temperate and arctic regions, forming extensive forests in the extreme North. Nine species are found in the United States; five of these are native to the eastern part of the continent, the others are indigenous to the Rocky Mountain region. Besides the native growths, three European varieties have been naturalized here, *viz.*, the White (*P. alba*), the Lombardy (*P. Italica*), and the Black, (*P. nigra*).

The Aspen takes naturally to moist, sandy soil and gravelly hillsides. It is small and slender, but occasionally reaches fifty feet in height, though generally it is not so tall, except in northern Arizona, where it grows one hundred feet in height, at an elevation of eight thousand feet above the sea. It grows rapidly, forming a narrow, round-topped head. The base is slightly heart-shaped; the roots are large and vigorous. On old trees, the bark near the base is nearly black; higher up, on the younger stems, it is a pale greenish or yellowish brown, running sometimes to whitish, and roughened with horizontal bars or wart-like excrescences or scars.

The branchlets, at first reddish brown and shining, change first to a light gray, afterward to a dark gray. In the early spring, the sweet inner bark is used as food by the Indians of the North. The leaves are alternate, simple, and one to two inches long. They are feather-veined, with the midrib conspicuous, and they come out of the bud a smooth light green; when full-grown they are dark green, shining above, a pale, dull, yellow green beneath. In autumn, they turn a bright yellow.

The inner buds are slightly resinous, reddish brown, conical, acute, incurved, and a quarter of an inch long. The Aspen flowers in April. The fruit is borne in oblong capsules, and the seeds within are light brown, surrounded with long, soft, snowy white hairs. It ripens in June. The entire Poplar family is the most restless of the forest inhabitants. The quivering of their leaves is owing to the compressed, pinched formation of their leaf stalks. Of course, fable and superstition have busied themselves weaving stories to account

for this peculiarity. According to an old tradition, the wood of this tree was taken for the Saviour's cross, and ever since, the tree has shuddered. Another old tradition says that when Christ went on his way to Calvary all the trees sympathized and mourned, except the Aspen; when he died, there fell upon the Aspen such remorse that it took on a fearful trembling, which has never since passed away.

The Aspen is very useful in forming an undergrowth that shelters longer-lived trees, and in late years it has spread over vast areas of the slopes of the Rocky Mountains, from which fire had swept the older native growths. The wood is light brown, close-grained, and is now largely used for flooring and for turnery. It burns freely, even when green. It has been little esteemed for cabinet work on account of its softness.

The Aspen is very tough and closes its wounds rapidly if hurt. Owing to this toughness it cannot be easily pierced or splintered by a blow; hence the ancients used it for bucklers, believing it invulnerable. It has been proved durable when not exposed to changes of atmosphere or to water. An ancient plank of Aspen was once found on which was cut this couplet:

"Though heart of oak be ne'er so stout,
Keep me dry and I'll see him out."

Large-toothed Aspen — Populus Grandidentata

This tree is common in the north, but rare in the south, of the North American Continent. It loves a rich, moist, sandy soil, near the borders of streams, where it reaches a height of sixty feet. Slender, spreading branches spring from a trunk two feet in diameter, forming a narrow, round-topped head. Its sounding Latin title, *Grandidentata*, means simply that the teeth of the leaf margin are a little larger than those of the quivering Aspen described above. This species also flowers in April. It is gregarious and loves to form thickets of its own species. It looks very attractive as its leaves twinkle on the gravelly hillside, or hang over river banks; and as its leaves unfold around its long, drooping catkins, in May, it proclaims itself a Poplar, from whatever distance seen.

The wood of this species is also light brown,— the sapwood nearly white — soft, close-grained, but not strong. It is used sometimes for woodenware, but more largely for wood pulp, in paper manufacture.

Swamp Cotton — Populus Heterophylla

This member of the family is also called Downy-leaved Poplar. It is very rare in New England, but is seen occasionally on Long

Island and southward to Georgia, becoming abundant in the Gulf states, the Lower Mississippi Valley and northward to southern Illinois and Indiana. It loves low, rich land. It averages from sixty to eighty feet in height and never exceeds ninety.

The wood is dull brown, with lighter brown sapwood; it is of light weight, soft and close grained. It is used in the interior finish of buildings, and is manufactured into lumber for this purpose in the South and West.

The flowering catkins of Swamp Cotton are very graceful; broad, densely flowered, erect at first but finally pendulous; two to two and a-half inches long, with stout, brittle, hairy stems. The leaves of this Poplar flutter less than those of the other members of the family, owing to the leaf stems not being so much compressed laterally. The leaf retains its down more fully than any of the others, owing to which it is often called the Downy Poplar. In the Southwest, the wood is used largely for manufacturing purposes, and is called Black Poplar. It is darker than the wood of the Aspen.

Cottonwood Poplar

Another variety is the Cottonwood Poplar, called also *Populus Monilifera* and *Populus Angulata*, and in common speech Necklace Poplar and River Poplar. *Monilifera* refers to the necklace-like catkins, *Angulata* to the angular stem of the shoots — all big names for little differences.

Comparatively rare in the eastern states, and small when found there, this variety of the Cottonwood forms the largest and most abundant tree along the streams between the Appalachian and the Rocky Mountains. In these regions it reaches a height of one hundred feet. The leaf is egg shaped, with outline approaching the triangular; long, tapering apex, and square, somewhat hollow base. The leaf stem is long, slender and much compressed sidewise. Full grown leaves are from two to four inches long (young leaves much longer), the width nearly the same. The buds and leaves are balsamic in fragrance. The seeds are covered with a white, cotton-like fiber. The flowers come in March and April before the leaves. The trunk is light granite-gray and roughens and furrows with age.

The wood is brown, light, soft, close-grained, but not strong. It is now used mostly in making paper pulp, packing cases and for fuel. Under the name of Carolina Poplar, this tree has been much planted in cities and parks. It makes an excellent shade tree. Professor Charles S. Sargent says, "With its massive, pale green stem, its great, spreading limbs, and broad head of pendulous branches covered with

fluttering leaves of the most brilliant green, *Populus Deltoides* is one of the most stately and beautiful inhabitants of eastern America." Experiments have been made in weaving the cotton fiber of these trees into cloth, but it has not been found a paying industry.

Balsam Poplar — Populus Balsamifera

The Balsam Poplar is also known as the Tacmahack. It is found in the far North, in New England, central Michigan and other western sections. In New England and the middle states it usually reaches a height of about sixty feet, but in the valley of the Mackenzie River, in Canada, it grows one hundred feet high, with a trunk six or seven feet in diameter. It prefers the bottom lands of rivers and the borders of swamps.

The leaf is egg shaped in outline, with taper pointed apex and rounded base. The buds in spring are large and yellow and covered with a fragrant gum. The leaf stem is nearly smooth, the lower half rounded, the upper part only slightly flattened. The leaves are simple, alternate, finely edged, rather sharply toothed, and from four to six inches long. This tree blooms in March and April, before it leaves.

This is the largest tree in extreme northern America. It possesses all the Poplar characteristics of drooping catkins, whitish trunk, shimmering leaves and cotton seeds. Its wood is light brown, of light weight, close grained in texture, but not strong. It is used extensively in the manufacture of paper and for fuel.

The other variety of this species is the *Balsamifera Candicans* or Balm of Gilead. It grows abundantly in the northern United States and in Canada, where it has been much cultivated as a shade tree. The leaves are simple, alternate and edge toothed. The leaf buds in spring are large, varnished and very fragrant. The leaves are from four to six inches long and nearly as broad. When young they are yellow, but with maturity, turn to a dark, rich green above, and whitish underneath. The bark is smooth, greenish and often dark spotted. The whole outline of the tree is egg shaped, tapering to a point above. It is a handsome tree, growing to a height of sixty or seventy feet, even on poor soil. It is deemed very desirable on account of its fragrance in spring, although there are people who do not like its odor.

White Poplar — Populus Alba

This Poplar, which is now found in most of the older settlements of this country, is not a native of our forests. It came in with the colonists by way of New England, and is believed to have

reached England itself through Holland. It is a native of both Europe and Asia. In favorable situations, it has been known to reach from eighty to one hundred feet, with sturdy trunk and spreading head.

Its leaf outline is a broad oval, approaching diamond shape, with pointed base. The leaves are usually about two inches long, and width about the same; the leaf stem flattened sidewise. Its branches are crowded and perpendicular. Low on the trunk the bark is dark and furrowed, above and on the branches it is greenish gray, with dark markings. The young shoots are covered with a white down, which continues to come out far into the summer, increasing the white aspect of the trees. The leaves are coarsely and sparingly toothed, dark green and smooth above and covered with a thick down beneath.

The Lombardy Poplar — Populus Nigra Italica

This is the last of the Poplars of which we shall speak. It is botanically called *Dilatata Nigra*. It is not a native of our country, but was introduced from Italy more than a hundred years ago and rapidly took to the soil. It is more scarce now than formerly, when its tall form, rising like a church spire, formed a landmark on many a hillside in New England and the middle states. In the latter, and in many parts of Massachusetts, it still flourishes, but the climate of New Hampshire and Maine has often proved too severe. In some localities it may be noticed standing in gray and withered nakedness like a sentinel frozen at his post. Nor is it the climate alone that does battle with it. Unfortunately, it is one of the trees on which insects love to feast, and if left unattended they often succeed in killing it; so that between climate in some quarters and insects in others, this distinguished looking tree is more rare now than it was two generations ago. It, however, continues to flourish where care is bestowed on it. The Lombardy Poplar grows very tall — eighty feet and upward — with oval base and very pointed top. The bark is roughish, the branches growing close together and upright. The leaves are simple, alternate, with leaf stems fastened sidewise; the color, a deep, clear green. Its flowers grow in catkins resembling in shape those of the White Poplar, and when in full bloom the branches and catkins appear to cover the trunk from the ground upward. The wood is darker and somewhat harder than that of the Aspen, or Cottonwood Poplar.

THE DOGWOOD

Cornus

CORNACEÆ, the Dogwood family, comprising twenty-five or more species, are natives of Europe, Asia and North America, and are among the most beautiful of the trees or shrubs that adorn the landscape, from the time they put forth their snowy or pinkish blossoms in early spring, until their bright berries ripen in the autumn, and the foliage takes on a brilliant scarlet crimson and gold; and, even before the leaves have fallen, the forming of the little round buds gives assurance of the next year's bloom.

Many of the family closely resemble one another, the blossoms of each variety growing in spreading clusters. Their chief difference is in their leaves and fruit and in their size, which ranges from the dwarf shrub of the Bunch Berry, the smallest of the family, to the Flowering Dogwood, which is the largest of all.

The inner bark of the tree is very bitter, and has medicinal properties of a tonic nature, similar to Peruvian bark, for which it is sometimes substituted. The Indians used the bark of the roots for making a scarlet dye. The wood of the Dogwood is hard, fine grained and susceptible of a high polish. It is used in the manufacture of many small articles, both useful and ornamental, its close grain rendering it capable of a beautiful satiny finish. The earliest description of Dogwood was given in Ray's "Historia Plantarum" (1686-1704).

Alternate-leaved Dogwood — Cornus Alternifolia

THIS species produces a vigorous growing tree, reaching a height of from eight to twenty-five feet. It is indigenous to North America, and is found in every latitude, growing along country lanes and along river banks and borders of woodland. The reddish-brown bark is smooth or somewhat broken in irregular ridges; the yellowish-green branches are streaked with white or light green; the leaves, alternate, are clustered at the ends of the branches, and are ovate, entire, and long-pointed. It blooms in early May and June.

The odd little flower, with cream-white spreading petals surrounding its four stamens, grows in broad, open clusters of many tiny flowers crowded together. In October, when the fruit ripens, the bunches of dark blue berries, drooping from their reddish stalks, present a most pleasing contrast to the other varieties of fruit and the

brilliant foliage of the autumn glory. An old-time legend credits the farmer with watching the Dogwood tree, in the belief that the unfolding of the leaves was a sure sign that the time had come for planting corn.

Flowering Dogwood— Cornus Florida

This is the most beautiful of all the Dogwood family. In its native soil, and with the favorable surroundings of a southern climate, it will attain a height of thirty-five or forty feet; in the colder North it frequently appears as a shrub. The profusion of its flowers gives it its specific name, *Florida*. It grows in woodlands and rocky thickets and by woody roadsides, from Maine to Florida. It particularly abounds in New Jersey and Pennsylvania, and in Maryland and Virginia where the soil is moist. In Florida and the Carolinas, it is found only where the soil is gravelly. Its special characteristics are: dark reddish-brown bark; shining branches; leaves opposite, ovate, entire-edged, a bright green above, paler underneath and pubescent; flowers large, white or pinkish. A large white involucre, divided into four distinct parts, rounded and notched at the tops, somewhat heart-shaped, simulating a corolla, surrounds the clusters of small greenish-white flowers.

A nectar, hidden in a disk on each little ovary, attracts numberless small flies, bees and butterflies; later in the season, the flowers are replaced with oval bunches of egg-shaped, scarlet berries, which remain on the trees until the winter birds, finding little else to satisfy their hunger, devour the fruit and scatter the seeds far and wide.

The Flowering Dogwood well repays cultivation as an ornamental tree, the showy white blossoms, as well as the bright berries, producing a charming effect against the green foliage. Before the leaves are fully developed, the blossoms unfold, and, covering the tree in their profusion, may be seen from a long distance, as if reaching out their snowy hands in joyous welcome to returning spring.

THE SUMACH FAMILY

Rhus

The Sumachs stand apart from other trees and shrubs, and exhibit a distinct individuality. Everyone, observing or unobserving, knows the rich, red, velvety-looking trees and bushes scattered along the highway. The smooth, dark-brown bark has a soft look, as if it were not so compact as that of other trees; the branches are curiously blunted at the ends, instead of tapering to a point; the

branchlets and leaf-stalks, velvety, with a thick crimson down. The leaves are very showy. They are compound, oddly pinnate, with from eleven to thirty-one leaflets; alternately arranged, with stout, reddish petioles. In the autumn, the leaves assume the richest maroon tints, and the most brilliant crimsons and scarlets to be found in the foliage of trees. The flower clusters, too, are conspicuous. They occur in upright panicles, usually dense, but varying somewhat in different species. The panicles are more showy when the small, five-parted flowers have been replaced by crimson or purplish drupes. These drupes are almost dry, and contain one seed each.

Some of the Sumachs are poisonous; and those which are harmless are looked upon with suspicion by many persons who cannot distinguish between the species. The common Poison-sumach may be known by a little blade-like projection on each side along the petiole. This plant is a relative of the Poison-ivy, or Mercury-vine, which contains a similar poison. Both these plants, while highly poisonous to many, do not affect others at all; they will even affect a person at one time and not at another, as his general condition renders him more or less susceptible.

Species of Sumach are indigenous to each of the continents except Africa. The Smooth Sumach (*Rhus Glabra*) is a shrub common in the eastern part of the United States. It grows in rocky or barren soil. The smooth leaves are white underneath. So far from being poisonous, the crimson drupes of this species contain a refreshing acid.

The Venetian Sumach (*Rhus Cotinus*) unlike most of the genus, is simple leaved. These leaves are rounded at the end, and have long, thick petioles which do not leave the branch until severe frost kills them, long after other deciduous trees are bare. It is a native of southern Europe and western Asia, but some think it also indigenous in Arkansas, where it is found on the rocky bank of the Grand River.

The Canadian Sumach (*Rhus Canadensis* or *Rhus Aromatica*) is a straggling bush found in Canada and the United States, having sweet-scented leaves.

The Stag-horn Sumach (*Rhus Typhina*) is either a shrub or a small tree, picturesque on account of its irregular branching. It grows in eastern North America, sometimes attaining a height of forty feet. The little branches and stems are especially downy in this species. The drupes are bright crimson. Because of the acidity of these and the twigs, this species has been called the Vinegar Tree. The pith is easily removed from the young shoots, which are sometimes thus converted into pipes through which to draw maple

sap. The wood of this tree is valued for inlaying, because of its handsome, satiny appearance. In color it is yellow, streaked with green.

The Coral Sumach (*Rhus Metopium*) found in Florida and the West Indies, is known as the "poison tree." It gets the first name from its pretty scarlet berries.

An interesting species is the Laurel Sumach (*Rhus Laurina*) of California. This is a large, leafy shrub, with many and spreading branches, emitting a pleasant, aromatic odor. Both this and the *Rhus Integrifolia* form dense thickets along cliffs near the sea, in California. Both these and a few other species have simple leaves, as indicated in the Latin name of the second.

There are many other species which need not be mentioned here. Nearly all of them are useful for tanning leather, and for the making of dyes, of which both black and yellow are made from it. The *Rhus Vernicifera*, of Japan and Nepal, yields a juice which is used for varnish. The *Rhus Venenata*, a poison Sumach, has a similar juice which might be employed in the same way were it not for its harmful properties. This tree is so poisonous that its baneful properties are not eliminated even by burning the wood to charcoal. The *Rhus Radicans*, of North America, and some other species, are cultivated for medicinal properties.

THE LOCUST

Robinia Pseudacacia

This is one of our handsomest shade trees. Tall, slender, with upright branches, graceful foliage and beautiful blossoms, it is rarely passed unnoticed. The reddish-brown bark is rough and ridged. The young tree is protected by thorns until it attains a diameter of four or five inches, but these disappear later. The leaves are curiously pinnate, having from eleven to twenty-five oval leaflets, smooth, and very thin and fine in texture.

A glance at the *papilionaceous* blossoms will tell that this tree, fifty, sixty, perhaps eighty feet high, is a relative of the little pea-vine; they both belong to the order *Leguminosæ*, or Pulse Family. These flowers grow in long, loose racemes from the leaf-axils. They are pure white — except at the base of the standard, or largest petal, where they are yellow — and are extremely fragrant. Often the air for some distance about is laden with their perfume, and one looks for the tree long before one's eyes have espied it. The fruit is a legume or pod, narrower than that of the pea, containing similarly from four to six seeds, brown in this case.

The Locust was the first American tree introduced into Europe. Linnæus named the genus *Robinia*, in honor of J. Robin, the French botanist, who received and cultivated it about the year 1601. The wood is very valuable. It is hard, light, close-grained and durable; in fact, it hardens with age, instead of decaying. Because of these qualities it is valuable in shipbuilding, but is used in connection with other woods, as it is difficult to obtain Locust timbers of desirable size. The tree is found from Pennsylvania southward to Georgia, and westward.

The Clammy Locust (*Robinia viscosa*) is a smaller tree than the preceding, sometimes only a shrub, and is found from Virginia to Georgia. The branchlets and leaf stems are clammy, hence its name. The flowers are pink and showy, but they grow in more compact racemes, and less graceful than those of the False Acacia; neither have they the delightful fragrance of those flowers. It is not common growing wild, but is often cultivated.

The Rose Acacia, or Bristly Locust (*Robinia hispida*), is a showy shrub found in the South, and frequently seen in cultivation in the North. The flowers are large and of a deep rose color. The legumes are covered with bristles.

BEECH FAMILY

Fagaceæ

The Beech is thought by many to be the most beautiful of trees. Its leaves are rarely eaten by insects or spotted with disease. In early spring, when the half-opened leaves are a shining mass of soft green and white, it is no less charming than in midsummer, when the abundant foliage lies in shelving masses upon its branches, causing a dense shade. And in the autumn, even after the leaves, turned to a golden yellow touched with russet, have fallen to the ground, the tree is not shorn of all its beauty, for it then shows to advantage its beautiful silvery-white bark, its strong trunk, and the structure of its closely interwoven branches. In the Southern Hemisphere there are several evergreen species, and traces of *Fagus* in cretaceous rocks show it to have once existed in a large territory from which it has now wholly disappeared.

American Beech — Fagus Ferruginea

This is the only one of the Beech trees native to America. Like all the family, it has alternate leaves, almost entire and feather-veined,

light green when young, later becoming a dark green, paler underneath, and in autumn turning to a clear golden yellow. The bark, as well as the leaves, is of a lighter color than the European varieties and is very smooth. It is a large tree, frequently reaching a height of from sixty to one hundred feet, and has firm, light-colored, close-grained wood.

The fruit of the Beech grows in a prickly bur inclosing two triangular, sharp-edged nuts, which are opened by the frost, the burs hanging on the trees the greater part of the winter. The meat of the nut is very sweet and pleasant to the taste; and a favorite autumn pastime of the young people in New England some years ago was to make up beech-nutting parties, as soon as the frost had sufficiently loosened the nuts, and, climbing into the branches, shake them until the little fruit came down in showers to be gathered for use in the long winter evenings.

Purple Beech — Fagus Atropunica

This variety of Beech is native to Europe. It has the darkest leaves of any deciduous tree; they are of a reddish or purple cast, are almost entire-margined and, having very short leaf stalks, sway but little with the moving of the branches. Individual trees of the Purple Beech have been found at different times in the forests of Europe, but it is believed that the most of those cultivated are derived from a tree discovered about two centuries ago in a forest in Thuringia, which is supposed to be more than two hundred years old and is still alive. Mention was made of Beech trees with red leaves, in a natural history published in 1680.

The belief of the Indians that Beech trees were never struck by lightning, evidently adopted by the early settlers of this country and handed down to the farmers of the present day, has been confirmed by scientific experiments. These have proved that the Beech is less affected by electric currents, or resists them more vigorously, than the oak, ash and some others.

THE HAWTHORN

There are several varieties of this well-known tree. It belongs to the apple family, bearing a small, not very palatable fruit. It is usually planted in hedges, its long thorns making it effective for the purpose. Given room and proper nourishment, it will attain a height of twenty or thirty feet, and is very long-lived. The

white-flowered variety is fragrant in bloom, but the red blossoms of another variety have a disagreeable odor. In southern Europe and western Asia there is a shrubby species bearing a red fruit larger than that of the ordinary haw, and used around Jerusalem for preserves.

THE APPLE FAMILY

Pyrus

THE Apple, that well-known and wholesome fruit, is included with the Pear, the Quince and the Mountain Ash, in the genus Pyrus. The common Wild Apple or Crab-tree, with its small and hard fruit, is the parent of all, or nearly all, of the varieties of the Apple. Cultivation has wonderfully improved the original fruit.

It is to the Romans that we owe the first systematic cultivation of the Apple. They produced at least twenty different varieties (Pliny mentions that number), and introduced it during their occupation of Britain. From Britain the early settlers brought the fruit to America. It found favor with the Indians and was spread by them all over the continent.

The varieties of the Apple are beyond accurate counting. The tree itself is not beautiful in comparison with some of those of the forest, but the wild Crab-apple, especially in the springtime, when it gracefully bears its burden of bloom, has a beauty peculiarly it own, and the fragrance of its white, rose-tinted flowers is most pleasing.

The Apple-tree usually has a diameter across its head greater than its height. The branches are rigid, irregular and low; when loaded with the ripe fruit they are borne almost to the ground, and frequently so great is the burden that whole branches break away from the trunk. Twenty to forty feet embraces the average height of the Apple-tree. The tree is usually long-lived, many specimens bearing fruit after they have passed their two-hundredth year. As a fruit tree, it requires a fertile soil and a sheltered situation. The countless ways in which the excellent fruit can be used are well known. The bark of the Crab-apple yields a yellow dye; it also has medicinal properties. The Apple itself is one of the most nutritive and agreeable of fruits. The wood of the Apple-tree is hard, durable, and fine-grained, light brown in color. It is much used by turners and is a favorite wood for shoemakers' lasts.

The Common Apple (*Pyrus malus*) includes all varieties of the cultivated orchard tree. It is a flat-topped tree, averaging thirty feet in height, and throws out its white blossoms, tinged with pink, in

May. The fruit ripens from August to October, according to the variety and the climate. It flourishes in temperate climates; extremes of cold and heat are unfavorable to its growth. In China and India it is cultivated, but not successfully, for the fruit is sparse and poor and the trees die quickly. The Apple has a large commercial value and in America its cultivation is an important industry. In one form or another, fresh, dried, or as preserves, American Apples are to be found in all parts of the habitable globe.

The Crab-Apple

The wild Crab-apple (*P. coronaria*) of North America is supposed to be the parent of all cultivated apples. The tree is always small, in fact it usually has a stunted appearance. The bloom is well known as the daintiest and most fragrant of all apple blossoms. Its petals are of an exquisite pink on the outside, and curve inward more than those of the ordinary apple. The fruit is small, very smooth and shining, green when wild, but highly colored in cultivation. It is somewhat acrid and has a peculiar flavor; nevertheless it is relished by many persons, and is considered good for preserving.

The Mountain Ash (*P. Americana*) is in no way connected with the Ash proper, but is a close relative to the Apple and the Pear. It is a graceful shrub, growing to a height of fifteen to thirty feet in swamps and mountain woods, in the northern parts of the United States. It has showy clusters of small, bright red berries, which ripen in autumn and remain on the branch into the winter. It is often cultivated for ornament.

The Pear

The Pear (*P. communis*) is half-sister to the Apple, and, like it, is largely cultivated for its fruit. It is usually a taller tree than the Apple, frequently growing under cultivation to a height of from forty to sixty feet. There are many varieties of the Pear, and the fruit differs greatly in size, form and substance, according to the variety, soil and climate.

"The man who plants a Pear is planting for his heirs," is an old saw relative to the slow growth of the tree, but it is a much exaggerated one. This tree bears fruit in a few years, and its ultimate life may run into the hundreds. We have on record Pear trees over four hundred years old.

The Pear-tree is pyramidal in shape and grows upstanding or as a wall fruit, according to the manner in which it is planted. The bark is smooth and the branches are often thorny. The thorns, however, generally disappear under careful cultivation.

California, Georgia and Florida supply the best American Pears. The Sickel is a distinctively American variety and, although somewhat small, is unsurpassed for sweetness and flavor. The Bartlett is also much grown in the United States.

THE WILLOW

Salix

The Willows as a family are known in science by the name of *Salix*. There are one hundred and sixty varieties of this tree, of which not more than half a dozen thrive in the United States, although local customs have given single species many names.

The Willow varies in height. Sometimes it towers ninety or one hundred feet high, and sometimes it is a pretty shrub. The Pussy Willow and the White Willow illustrate the peculiarities of this plant. The whole family love the banks of streams, and the timber furnishes tough, light wood adaptable to the manufacture of baseball bats and such robust instruments, while the soft and pliable osiers are twisted and woven into baskets, chairs and numerous other familiar articles of household use. The union of lightness and strength in the Willow, the close grain of the wood, and the uniformity of its fiber, make this tree very valuable in the commercial arts. In nature, it fortifies river banks against erosion, ties the soil, and gradually builds up embankments against floods. Tonics are distilled from the barks of some species, and others furnish a greater percentage of tannin — the vital principle of the tanner's curing acid — than the oaks.

The Willow always appeals to the sympathies of poets. In spring the catkins peep from the buds with the first warm breath. The trees seem to glow with a natural radiance. The tender little leaves clothe the slender branches, and even the long, sweeping twigs are gorgeously painted with new-born verdure.

The Weeping Willow — Salix Babylonica

Botanists deny that the American Weeping Willow is a descendant of the trees under which the Hebrews wept. They say "Fancy associating its pendulous branches with the hanging of harps!" The Hebrew, Psalm cxxxvii., says: "We hanged our harps upon the willows in the midst thereof." There is nothing absurd in this statement, and the beautiful history of the introduction of the Weeping

Willow into Europe and the United States goes far to support the biblical theory.

Alexander Pope, the poet, bought a country home on the bank of the Thames at Twickenham. A friend in far-off Smyrna sent him some dates. Within the drum-like bundle was an interesting twig. The poet planted it on the river's bank. It rooted and grew. It was the mother of all the Weeping Willows in Europe and America. The staminate, or male tree of this species, has never been imported. Hence this beautiful tree must always be propagated by slips deliberately cut and planted or detached during storms, and left to the chances of nature. Alexander Pope lived until 1744, long enough to admire the graceful tree whose ancestor swayed its long threads of branches beside the irrigating canal of a desert date grove. In 1775 a young British officer bound for America took with him, for the sake of "Auld Lang Syne," a twig of Pope's Willow. He presented the slip to Mr. Custis, the stepson of George Washington, who planted it near his home at Abingdon, Va., whence sprang the generations of American Weeping Willows. In 1790 General Gates, taking leave of his commander's family, procured a slip of this tree, and planted it at the entrance to his farm near the New York City of those days, on the spot which is now the intersection of Third Avenue and Twenty-second Street. For many years this tree was known as Gates's Willow. Thus the Weeping Willows of the United States link themselves with ancient Babylonian rivers and the pathetic story of the homesick Hebrew.

The Weeping Willow varies from thirty to sixty feet in height. The bark is gray and rough. The branches are greenish, very long, drooping and supple. The leaves are pointed at both ends and saw-toothed entirely around. The Hoop Willow (*Salix Babylonica annularis*) is a variety of the Weeping Willow, recognizable from its leaves, which curl and recurl into rings.

The Black Willow—Salix Nigra

The bark of the Black Willow affords an extract efficacious in allaying fevers. The tree attains a height of from fifteen to thirty-five feet. It ranges from New Brunswick to California and southward. The bark is blackish or light brown, rough and flaky. The branches are yellowish brown, slender, and so brittle at the bases, that they are easily detachable. This circumstance accounts for the fact that for a considerable distance from a Black Willow grove, a trail of detached trees is to be found. Storms carry away slips, which, falling upon springy or spongy ground, take root and thrive. The leaves of this tree are about two inches long, and the under side is paler than the light green upper surface.

The Western Black Willow — Salix Amygdaloides

The Western Black Willow is also known by the names Peach-leaved Willow and Almond Willow. Its habitat extends from New York to Ohio, and westward to Missouri and New Mexico. It is a small species, growing from fifteen to fifty feet high, and rarely attaining the latter altitude. The osiers of this tree are much used for basket-making. The catkins are very beautiful. They bloom in April and May, and throw out masses of little cottony bulbs or tufts. The leaves are smooth, and the under surface is slightly paler than the upper. This tree thrives in Canada, from Quebec to British Columbia, and is especially luxuriant along the shores of the Great Lakes. It takes its names of Almond and Peach Willow from the shape of its leaves. It is also called the French Willow in some localities. The trunk grows at an incline over the streams, and the pliable branches curve upward.

The Shining Willow — Salix Lucida

The Shining Willow is a native species of Willow shrub. It rarely exceeds twenty feet in height and is usually about twelve feet high. It is also known as the American Bay and the Glossy Broad-leaved Willow. The foliage seems almost to have a peculiar attraction for the sunshine. The light loves to shimmer through its quivering leaves. This plant is also recognized by its profuse bloom. Often more than one hundred pods have been counted on one catkin. Of the millions of seeds which are detached from the pods, very few germinate and become Willow shrubs.

The Brittle Willow — Salix Fragilis

The Brittle or Crack Willow is another valuable species used in basket-making. The withes of this plant are long and pliable. The tree grows to a height of sixty or eighty feet, and the head is bushy and irregular. The branches are easily detached from the main stem, a peculiarity of all basket willows. Its home is Europe and Asia, and in the United States it is a naturalized foreigner. It is grown principally in Massachusetts, New Jersey and Pennsylvania. A hybrid of this tree is said to contain more tannin than the best oak bark. The bark is gray and slightly rough; the branches greenish, tinged with red, and more brittle at the base than those of any other of the Willow species. The leaves taper at both ends, and the saw-like edges are uneven, but very well defined.

The White Willow — Salix Alba

The White and the Huntington Willow are the same. This is the giant of the Willow family, and the tree often towers one hundred feet. The trunk is thick set and the branches have a tendency to ascend. The twigs are olive green, not yellowish. The leaves retain, after maturity, the white, velvety hairs on the lower surface, thus giving the tree its name. This tree is also a naturalized citizen of the United States, and at present is to be found in New York, Pennsylvania and New Jersey. It is a good timber tree and its charcoal is very valuable, among other uses, as the best basis for gunpowder. This tree, although introduced into the country artificially, has escaped cultivation and is rapidly spreading through the country as a wild forest tree. It is very beautiful in appearance, especially when a light wind causes the silver sheen of the under surface of the leaves to flash through the greenery, with the radiance of light.

The Diamond Willow — Salix Cordata

The Diamond Willow grows along the banks of the Missouri and Yellowstone rivers. Remarkable diamond-shaped scars are found on the trunk and branches. These are due to the arrest of wood growth at the base of atrophied twigs or branches, which have decayed at the base and dropped. This species is worked into very beautiful canes.

Bebb's Willow — Salix Bebbiana

Bebb's Willow is also known as the Long-beaked Willow and the Ocher-flowered Willow. It is found from Hudson Bay to New Jersey and westward. It is a native American plant. It is named for the botanist who discovered and classified it. It is one of the earliest bloomers of the springtime. Scarcely has the sap begun to move under the bark, when the little flower buds make their appearance and glisten in contrast to the bare and bleak earth. This tree grows to a height of from four to twenty-five feet. It establishes itself along the borders of woods, and is frequently found growing in dry ground; although of course its best development is along the banks of streams. The bark is dark green or reddish, the branches yellowish and the twigs take on a reddish brown tinge in harmony with the trunk. The leaves taper to a point and are rounded or wedge-shaped at the base. They are smooth, and of a dull olive green above and beneath of a pale bluish green and covered with silky hairs.

THE BIRCH FAMILY

Betulaceæ

This family is somewhat numerous and widely spread. It is found in New England, the middle states, southward and westward among the mountains, especially in the Alleghanics, as far as Georgia. Michaux, one of the early observers of our forest trees, found Birches, and especially the Black or Sweet Birch, very abundant in Nova Scotia, as far as Newfoundland, throughout Maine, Vermont, the middle states and the Alleghany Mountains.

This Black or Sweet Birch, which is also often called Cherry, from the resemblance of its bark and leaves to those of a cherry tree, is esteemed the chief of the family, because of its beauty and value in manufacture. It is easily distinguished from the others by the dark color of its bark. In outline it is like an egg, with pointed apex and heart-shaped base. Its leaves are simple, sharply pointed and double toothed, from two to four inches long and about half as wide. When young, they are silky haired, but become smooth when grown, except on the ribs beneath. The tree rises from thirty to sixty feet in height, with many slender branches. The bark, at the trunk, is a dark chestnut brown and becomes rough in old age. The branches are smooth and dotted with white spots, and in color both leaves and twigs resemble the garden cherry-tree. Both foliage and bark are aromatic and sweet to the taste. The beauty and fragrance of this tree have been immortalized by the poet Bryant, in his lines on "The Murdered Traveler": —

> "The fragrant Birch above him hung her tassels in the sky,
> And many a vernal blossom sprung and nodded careless by."

Early in spring the Black Birch expands its long blossoms, which hang like tassels of purple and gold, filling the woods with fragrance, when most things in nature are still half sleeping. It is also among the first trees to put forth leaves. When growing in moist soil, on mountain sides and overhanging the banks of streams, where it thrives best, it sometimes reaches a height of seventy feet, and from the length and slenderness of its tortuous branches, it presents the form of a weeping tree, and one of the most graceful of this kind.

The wood of the Black Birch is hard, fine-grained and of a reddish tint. It is used in fine cabinet work, often in place of the more valuable black cherry. The ease with which it is wrought, added to its strength and durability, renders it a suitable wood for artistic work.

Its natural hue is a delicate rose which deepens with exposure but never turns black.

The age of the tree shows in circles in the grain of the wood, giving rich, clouded effects which have been called by the trade "landscape appearance." It is used in fine cabinet furniture, for chairs, polished head and footboards of bedsteads, for backboards in carriages, and because of its durability, for yokes. It is also highly esteemed for fuel; next, indeed, to the rock maple of the Green Mountains. The bark, when steeped and used with copperas, makes an excellent and durable dye for woolen cloth, the shade a deep brown, bordering on wine color. The special botanical name of the Sweet or Black Birch is *Betula Lenta*.

The Yellow Birch—Betula Luttea

This member of the Birch family grows most freely in New England and Canada, more rarely in the middle states and region of the Alleghanies. It is one of the most valuable of non-evergreen trees. Its outline, like that of the Black Birch, is egg shaped, the top is pointed, the base narrowing to a heart shape. Its leaves are simple, edged very sharply and coarsely toothed. They measure about four by two and one-fourth inches; thin, downy when young, growing smooth with maturity. The leaf stem is short and downy; the ribs straight. The outer bark of the trunk is thin and silvery yellow, and separating into narrow curling ribbons splitting outward at the ends. The twigs and bark are sweet and aromatic, but less so than those of the "Sweet Birch." In moist woods it reaches a height of from forty to eighty feet. Like the Black or Sweet Birch, it yields an enormous amount of sap—more, perhaps, than any other tree. While young it is apt to be slender and of a bottle-green shade, but when older its branches take on a copper or polished golden bronze tone. With this metallic luster, come horizontal dots on the outer epidermis, after which the bark begins to peel in frayed curling ends; growths intersperse themselves, making black and white cloud-like effects. In very old trees, the trunk becomes rough, with large dark scales, separated by furrows. In deep woods these furrows give lodgment to moss and liverwort growths. The Yellow Birch is often found seven or eight feet in circumference. The roots swell out above the ground in curiously fantastic shapes.

When the leaves first come out, they are covered with hair. They appear in twos, on short, curved, hairy footstalks. They are more or less egg shaped, tapering toward the point and contracted at the base, which is heart shaped, and are more coarsely serrated than

those of the "Sweet Birch." On the green, hairy, growing shoots the leaves are alternate, with short, taper, lance-like stipules, which soon fall off. In autumn the leaves become a soft, pale yellow.

The fact that Yellow Birch has not been much cultivated for ornament has occasioned comment. It has much beauty. In its natural state, its soft, drooping, abundant foliage, and its light bronze trunk, with mingled silver and pearl lusters, suggest how much more beautiful it might be made under cultivation.

Its wood is very useful. Bending more easily than that of the Sweet Birch, it is much used in the manufacture of many articles of furniture. It is also used for casks, staves and sometimes for floors. It is counted among the valuable fuel-woods.

Red or River Birch — Betula Rubra

Red Birch, which is also called River Birch, is somewhat different in aspect and character from the other Birches. It has, however, the egg-shaped outline, but this breaks sometimes into diamond form. Its base is often pointed, or blunt and wedge-shaped. The trunk's bark is reddish brown, bursting, as the tree grows, and hanging loosely in shreds of varying shades. The young twigs are downy. It is the only Birch that grows at its best in warm climates. It is found on low ground along river banks, from Massachusetts westward and southward, and becomes common in the lower part of New Jersey. It reaches a height of from thirty to fifty feet, with branches long, slender, arched and often drooping nearly to the ground.

The leaf stem is short and downy; the leaf is about three inches long by two inches wide; whitish, downy beneath, and in autumn turning yellow. The color of its loose bark is a light red, and the trunk, in old trees, a dark gray. The wood is close grained and very hard and durable. It has not been much used in the arts, but as fuel it has been rated next to hickory. The negroes of the South used to make bowls and trays of the wood, and from the young stocks of branches, hoops for rice casks. Of late it has been used somewhat in the manufacture of furniture, for which it has every quality needful. Birch brooms are made from it, especially the large ones used for streets and court yards.

Paper or Canoe Birch — Betula Papyrifera

Outline, egg shaped; apex pointed; base, rounded or slightly heart shaped. Leaf stem, downy. Leaf, two to three inches long, dark green, smooth above, dull beneath, with ribs hairy, especially in their

angles. It is native to New England, and to the mountains of Pennsylvania, and grows northward farther than any other non-evergreen tree, except the aspen. The bark is very tough, thick, and durable. It is snow white on the outside, easily removed from the wood, and can be peeled into many paper-like sheets, the inner part being of a reddish tinge. It grows from forty to seventy feet high. The wood is hard and very close grained, but decays more rapidly than that of any other of the Birches. Indeed, the wood has often been found rotted within, while the bark was perfect on the outside. This wood has been very largely used in the manufacture of spools, shoe lasts and in many kinds of turnery; for the making of wood pulp and above all for fuel.

But the most famous and interesting use to which this tree has been put is the manufacture of waterproof canoes, for which its bark is used. Every one will recall Hiawatha's incantation to the Birch-tree in Longfellow's famous poem: —

"Give me of your bark, O Birch tree!
Of your yellow bark, O Birch tree!
Growing by the rushing river,
Tall and stately in the valley!
I a light canoe will build me,
That shall float upon the river,
Like a yellow leaf in Autumn,
Like a yellow water Lily.
Lay aside your cloak, O Birch tree, . . ."

The Canoe Birch is one of the most picturesque of trees. It has certain differences of habit, but in general character is similar to the Birches already described.

White Birch — Betula Populi Folia

This has been known by various names, as Oldfield Birch, Gray Birch, Silver Birch, Cutleaf Birch, etc. It is a native of New England, and thence extends somewhat more northward, but rarely farther southward than Delaware and Pennsylvania. It is a graceful and beautiful tree, although it is short-lived and seems to seek, by choice, poor soil. It has the airy lightness of the Birch family in general, and spreads out its glistening leaves on the ends of very slender pensile sprays. It has a peculiar soft and tender grace; though not as beautiful as the European White Birch, which the poet Coleridge called "The Lady of the Wood."

It grows from twenty to thirty feet high, with more slenderness of spray and leaf, than has any other of the Birches. Its bark is chalky

white and thin, but, unlike that of the Paper Birch, does not separate easily. This bark is marked with blackish dots and lines. The branchlets and twigs are sometimes blackish and in young trees the bark is reddish brown. The tree is somewhat triangular in form, and the outline of its leaf is of similar shape. The whole foliage suggests feathery lightness.

The tree is valuable for the rapidity with which it grows on any kind of soil. As fuel, it does not rank as high as the other Birches, and is used mostly for the kitchen where a quick fire is needed, or for kindling wood. In former times it made a valuable charcoal for the forges.

The Dwarf Birch is a pretty little shrub about two feet high, which is found in New England and Canada, as far north as Hudson Bay, and in mountainous regions as far south as New Jersey and Pennsylvania. It grows best in wet meadows and on the slope of mountains.

THE HICKORY TREE

Carya Hicoria

THE Hickory family (*Carya hicoria*) includes some of the most shapely and useful forest beauties. Tall, standing from sixty to one hundred and twenty feet high, the strong branches of the Hickory swing gracefully, like a splendid, leafy tiara. It abounds from Maine westward and southward to Florida and Texas. The swampy lowlands, the mountain sides, and the level floor of the woods, all love to rear these handsome trees as pillars in the aisles of the forest cathedrals. The Hickory is hardy; the wood is tough and strong,—good for fuel and useful for timber. The fruit of some specimens is delicious, and the wood itself exhales a pleasant fragrance, whether in its native beauty or furnishing warmth for a winter's evening, while its nuts are being cracked and eaten with a sauce of reminiscence from the last vacation.

The principal kinds and names of the Hickory-tree — *Hicoria* or *Carya* — are the Mockernut (*Hicoria alba* or *Carya tomentosa*), the Pignut or Broom Hickory (*Hicoria glabra*), the Shellbark (*Hicoria laciniosa* or *Carya sulcata*), the Bitternut (*Hicoria minima* or *Carya amara*) and the Shellbark (*Hicoria ovata* or *Carya alba*). These will be discussed in groups.

The Bitternut (*Hicoria minima or Carya amara*), or Swamp Hickory, grows nobly upon swamp borders or in low, wet woods. Its range extends further northward than that of any other of the Hickories

and it is found abundantly in the forests of Canada. A height of fifty, seventy-five or a hundred and twenty-five feet is often reached by this tree. This species has a broad erown and upright branches. It blooms from May to June, according to latitude, holding back its tender greenery in the South, and being of more rapid growth in its northern wilds.

The beauty of its foliage, varying from a brilliant vermilion through the yellows to tender green, makes it as worthy, as it is susceptible, of cultivation. It owes its sunset tints to many small golden glands, which lie on the under surface of the leaflets. The bark of this tree is a light reddish brown, separated into thin, elose flakes, like scales. The leaves show a well-defined but sharp, saw-like edge, and are smooth on both surfaees, or very slightly hairy on the under side. Its fruit is large and rounded, soft and thin. The husk splits half way to the middle, but the kernel is extremely bitter. The wood is not of equal eommercial value with other Hickories, but is, however, very pliable and makes good hoops and ox yokes. On the hearth, it gives a bright snapping flame, and is a good fuel for eozy winter evenings.

The Mockernut, also known as the White Heart Hickory, the Shagbark, and the Small-fruited Hickory, flourish in the richer forest soils. The first two range throughout New England, southward to Florida and Texas, and westward in the same latitude. The Small Fruit variety is restricted to a territory from Massachusetts and Delaware, ranging westward.

The Mockernut or White Hickory — Hicoria Alba or Carya Tomentosa

This tree takes its common name from the deceptive character of its fruit. The hull is large and wholesome-looking, but the husk is thick and pulpy, and the shell hard, dense, and unusually heavy. The nut is from one and a half to two inches in length, and the husk splits nearly to the base, in four sections. The small kernel is indifferently flavored, although it is somewhat sweet. A characteristie of the tree is its large leaf buds. In the late autumn, the buds are covered with yellowish brown scales, which change to hard, slaty gray during the winter. This tree abounds in the forests of the southern states, and is also sparsely found along the Atlantic coast to the Canadian line. The bark is smooth and close and of a light gray color. It produces a tough, strong timber whieh is valuable in all manufactures where strength is a requisite.

The Shagbark or Shellbark — Hicoria Ovata or Carya Alba

This tree produces the Hickory nut of commerce, and is sometimes called the White Walnut. The nut is round, growing in a thick, green, smooth, lustrous husk, which opens to the base in four sections. The nut is flattened at the sides and contains a large, sweet kernel. The shell is soft and thin. This tree is a giant among its kind, often towering over one hundred feet into the air. The trunk is slender and column-like in its symmetry. The tree throws high its conical head, and the bursting of its beautiful, petal-like buds is one of the sights of the forest. Its strange, shaggy bark is loosely attached to the trunk, and breaks into long, loose strips, which curve away from the tree, at the bottom, but remain attached to the trunk toward the middle. This tree covers the usual area of the species throughout the country. The fruit ripens slowly and requires a hard frost to mature its full flavor and to open its husks. It bears a heavy crop every year.

The Big Shellbark — Hicoria Laciniosa or Carya Sulcata

This is a very similar tree to the Shagbark. It grows to the same height, and its light gray bark splits from the tree in thin, narrow plates. The name, however, is derived from the astonishing size of its nuts, which are sometimes known as king nuts. The tree is found in the richer soils of New York and Pennsylvania, and over a wide area westward and southward of these states. It is very slow of growth; its wood is dark in color, and very valuable for manufactures as well as for fuel.

Small-fruited Hickory — Hicoria Microcarpa or Carya Microcarpa

This tree loves rich soils, but it does not produce a large fruit nor grow to the average height of the Hickories. While the Shagbark and Shellbark rise to one hundred and twenty feet and over, the Small-fruited Hickory rarely exceeds ninety feet in altitude. Yet it is sometimes extremely difficult to tell it from the Pignut. The leaves of both are smooth on both sides and the fruit small. Many botanists regard the Small-fruited Hickory as a species of Pignut. The home of this tree is from Massachusetts to Delaware. The nut is small, smooth, not ridged, thin shelled, and sweet. The leaf buds are very beautiful, although the blossoms are so modest and delicately green that they are often mistaken for unfolding leaves. The wood is valuable; it is light brown and tough.

Pignut or Brown Hickory — Hicoria Glabra or Carya Porcina

This species of Hickory loves a light, dry soil. It is a lofty specimen and attains a height of one hundred and twenty-five feet. It is native over the widest areas where the Hickories grow, and, its high, narrow crown, and slightly drooping branches, are conspicuous features in forest scenery. It takes the botanical name from the fact that the upper side of the leaf is very smooth; its local name from the character of its nuts, which inexperienced persons sometimes eat under the idea that they are Shagbarks. The bitter, disappointing flavor, once tasted, explains the contemptuous name of "Pignuts." The husk splits only at the top or a little toward the middle. The tree is very common throughout the northern states. Commercially, its wood is valuable, and on account of its strength, toughness, and flexibility is largely used for the handles of tools and in the manufacture of agricultural implements.

THE CHESTNUT

Castanea

The American Chestnut (*Castanea dentata*) is one of the best-known and most popular of our trees. Although its original home was in Asia Minor, it now flourishes generally throughout the United States. It is an imposing and beautiful tree, of luxuriant foliage. As a shade tree, it surpasses nearly all others, owing to the density of its foliage and the large size of its leaves. It grows rapidly and attains maturity in about fifteen years. At five years of age, it has attained goodly proportions, and begins bearing fruit. When fully developed, it is from sixty to eighty-five feet high. It has a rough, grayish bark and the wood is coarsely but handsomely grained. When immersed in water, it remains sound for a considerable time and, consequently, is much used for piles and submerged work in rivers and lakes. Its wood is reddish brown, and when exposed to the weather, warps readily. It is, however, as an autumn tree that the Chestnut holds a dear place in our hearts. When the russet mantle of August falls on the woods, no tree wears its colors so prettily. The various tints of rich green, golden russet, and delicious brown, all harmoniously toned and touched by the setting sun, show the Chestnut at its rarest. The nut of the Chestnut is edible, and particularly so when roasted. It is said by many that as a fruit-bearing tree for commercial purposes, the Chestnut is as profitable as the apple-tree, and can be counted on to bring its owner larger money returns. There are many sub-varieties of the Chestnut. The nut of

the American Chestnut is smaller than that of the European kind, but it has a sweeter flavor and a finer grain; and perhaps it is because of the difficulty of preparing the smaller nuts that the Chestnut is not as largely used in the family kitchen in America as it is in some European countries. The gathering of the nuts in the autumn affords a popular diversion for old and young. Chestnuts are an article of commerce and when in season are sold not only by dealers, but raw, roasted or boiled, by vendors on the streets of all cities.

The Dwarf Chestnut or Chinkapin (*C. pumila*) is a small variety of the Chestnut. It grows from seven feet to about thirty feet high. The bur bears a single, small, rounded, sweet, chestnut-colored nut, very popular in the South and West. It is a handsome tree under cultivation. It abounds south of central New Jersey and southern Ohio. It is found cultivated farther north.

Æsculus

The Chestnut of the *Æsculus* family belongs to the natural order *Sapindaceæ*. It has broad, digitate leaves, and is of luxuriant foliage. The value of the *Æsculus* family lies more in its ornamental than in its useful qualities, as its timber is too soft for wide commercial uses. The genus is indigenous to North America, the mountainous regions of Mexico, New Granada, Persia, Northern India, and the Malay peninsula. Although the principal member of the family is called the Horse-chestnut, it has no botanical affinity with the Chestnut proper.

The Horse-chestnut (*Æsculus hippocastanum*) is a strikingly beautiful tree, especially in spring, when its leaves are full, and its conspicuous spikes of white flowers, dashed with pink and yellow, stud it thickly. Its outline is pyramidal and is perhaps too regular for picturesqueness, but despite the trimness of its form it is a handsome and impressive tree. Its height varies in different countries. In America it averages forty feet, while in St. Petersburg, Russia, it is kept as a hothouse tree. The boughs spread widest near the ground, converging gradually to the top. Its leaves have long stalks and seven (sometimes only five) obovate wedge-shaped leaflets. It flourishes best in moist, sandy loam, and flowers in May and June. Its fruit has a thickish husk, with strong prickles, inclosing within its valves one or two nuts of a mahogany color. This nut is not poisonous, although so regarded by some. Neither, on the other hand, is it very edible. It has a bitter and disagreeable taste. It is used in many European countries, particularly in France, as a fodder for horses, sheep, oxen and swine.

Authorities differ as to the origin of the name Horse-chestnut. Some say that it was so called because the nuts were used by the

inhabitants of Constantinople, for the relief of short-windedness and cough in horses. This is, however, a mere guess, and a more reasonable explanation is to be found in the comparatively large size of the nut,—horse signifying large. Curiously, the Horse-chestnut is not mentioned in any of the works of the ancient writers.

The commercial uses of the Horse-chestnut are small and few. As in all species of the genus *Æsculus*, the wood is soft, and ill adapted to the needs of the carpenter and turner. Its greatest employment, perhaps, is in the manufacture of artificial limbs and light utensils. The nut is rich in starch, but has not been much cultivated in that direction. The bark contains a bitter principle, useful in tanning and dyeing, and it is sometimes used as a cheap substitute for Peruvian bark. As a park or lawn tree, the Horse-chestnut fulfills its highest function.

The Ohio Buckeye (*Æsculus glabra*) is called Buckeye because of the shape and appearance of the seed, which looks not unlike an eye; it takes the name of the state from the large number of this variety found growing there. It is equally hardy in New England, and is to be found from Western Pennsylvania to Southern Iowa, Central Kansas and Indian Territory, and from Alabama to the lake region. It is found chiefly on the banks of rivers, and on low-lying ground. It is also called the Fetid Buckeye, because of its evil odor. The Ohio Buckeye is smaller than the Horse-chestnut, its average height being about twenty-eight feet. It has narrow, tapering leaflets, unlike the abruptly pointed leaflets of the Horse-chestnut. Its flowers are small and not showy, and of a light green color. Its nut is poisonous.

The Sweet Buckeye (*Æsculus octandra*) is so named because, unlike the other Buckeyes, it is not distinguished by a disagreeable odor. Its range is practically the same as that of the Ohio Buckeye. Each leaf has five to seven shapely, even-toothed leaflets, four to six inches long. The flowers are a dull yellow; the fruit is large, being two or more inches in diameter, uneven, but not of prickly surface. It is a comparatively large tree, frequently growing as high as ninety or one hundred feet. Its wood is stronger than that of any other variety of Buckeye.

The Red Horse-chestnut (*Æsculus rubicunda*) is the most beautiful of the *Æsculus* family. It has flowers of a warm pinkish red, which, against its foliage of rich green, give a delicious softness of color and tone. Other varieties of the *Æsculus* family are the *Æsculus Pavia*, or Red Buckeye, a tree little larger than a shrub, distinguished by its bright red flowers, and the *Æsculus octandra hybrida*, or Purple Buckeye.

Almond
Chestnut.
Brazil nut.

Life-size.
Filbert
Peanut.

Pecan.
Hickory nut.
English Walnut

232 Butter-nut.
Edible pine.
Cross section Black Walnut.

Cocoa-nut.

Butter-nut in husk.
Black Walnut.

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NOTICE.

HOW TO OPEN A BOOK.

From "Modern Bookbinding."

l the book with its back on a smooth or
ed table; let the front board down, then
her, holding the leaves in one hand while
)en a few leaves at the back, then a few at
ont, and so on, alternately opening back
'ont, gently pressing open the sections till
)ach the center of the volume. Do this two
ee times and you will obtain the best re-
Open the volume violently or carelessly
one place and you will likely break the
and cause a start in the leaves. Never
the back of the book.

:onnoisseur many years ago, an excellent
ıer of mine, who thought he knew per-
how to handle books, came into my office
[had an expensive binding just brought
:he bindery ready to be sent home; he,
my eyes, took hold of the volume and
holding the leaves in each hand, instead
wing them free play, violently opened it
center and exclaimed: 'How beautifully
bindings open!' I almost fainted. He
oken the back of the volume and it had to
ound."

THE WALNUT

Juglans

THE Walnut (*Juglans*) is an extensively cultivated tree, of the same family as the hickory. It is found in southeastern Europe, and in the north of India. Many varieties of the species are native to North America. It is a large, spreading tree, from forty to sixty feet in height, with a massive trunk. It is slow of growth and somber in appearance. Its great market value as a timber tree has been the cause of its destruction at the hands of the lumbermen, and many large tracts of land once covered with Black Walnut are now bare. As the trees take nearly a century to mature fully, there is every prospect of the demand exceeding the supply. Indeed, this handsome tree is now quite scarce. Its wood is highly prized, being heavy, hard, strong, easily worked and of a rich, brown color. It is a favorite wood of the cabinet-maker and the wood-carver.

The European Walnut (*J. regia*) is better known here as the English Walnut. It produces the sweet nut found so plentifully on the fruit-stands, and is also a highly esteemed timber tree. The shell of the nut is rough but thin, and incloses the kernel in a number of connecting compartments. The seed gives forth an oil called Walnut oil, which is used as a table oil and also by painters. After the oil is expressed from the nut, the seed is used as food for cattle. Prior to the introduction of mahogany, the Walnut was the favorite cabinet-maker's wood.

The Black Walnut (*J. nigra*) is a native of North America, and is found on rich bottomlands and hillsides in the eastern states. It is a taller tree than the *Juglans regia*, growing from ninety to a hundred and forty feet in height and frequently having a trunk five to seven feet in diameter. The nuts are not in as great favor as the nuts of the English variety, being closely confined to the husk and difficult of access.

The Butternut (*J. cinerea*) is an American tree, and derives its name from the nature of the oil contained in its seed. It is also called the White Walnut. It is an unkempt tree, with naked, sparsely-leaved branches, and resembles but is somewhat smaller than the Black Walnut. It possesses an agreeable fruit and a valuable wood. The latter, although soft, is close-grained, and for interior work is much used by cabinet-makers.

THE ALDER

Alnus

Let us not countenance those — and there are some — who speak slightingly of the Alders. Theirs is no small share in the beauty of those charming swamp thickets that we pass along the railroad, or on the banks of streams; nor do we agree that this little shrub merely sets off the brighter plants. The common Alder (*Almus glutinosa*), under favorable conditions, grows as high as forty or fifty feet; neverthcless it usually has a shrubby appearance in the spread of its branches. The bark is green and shiny, the leaves broad and irregularly toothed, dull green above, white and downy below, the pubescence, or growth of down, largely disappearing with age.

Winter is hardly gone before the reddish brown catkins, which have been all winter waiting impatiently to burst from their buds, are swaying in the breeze. They are so long and flexible that they respond to the least breath, and are very graceful. An interesting fact about these catkins is that they are formed one season, but do not develop until the next.

Alnus rugosa, the smooth Alder, is, like the preceding, either a shrub or a tree. It seldom grows singly, but forms little thickets along the banks of streams, its favorite home, although it is sometimes found on moist hillsides. There is a slight pubescence, or growth of down, on the young twigs.

Alnus incana, speckled or hoary Alder, is common in America. A beautiful species called *Alnus cordifolia*, or heart-leaved Alder, is native to Italy.

The wood of the Alder is prized for work which must be submerged, as it resists the action of water. Mill wheels, piles, and the like, are often made of it. The supports of the Rialto, at Venice, and many buildings on the canals in Holland, are of Alder. The charcoal produced from this wood is valuable in the manufacture of gunpowder. In the bark is an astringent juice used in making dyes. The bark is also used for tanning.

THE ELM

Ulmus

The Elm is a tree of the order *Ulmaceæ*, natives of temperate climes, deciduous, with an outline obovate or heart-shaped. It has straight-veined serrated leaves, unequal at the base, and small flowers in clusters which appear before the leaves. The fruit is a small compressed, one-seeded nut, winged all around.

The Elm has a wide geographical range, being natural to practically all of Europe, the west of Asia and North America, from Florida to the northern part of Canada. Chinese nurserymen use it largely for dwarf trees, as it can easily be dwarfed by certain methods of cultivation, while retaining all the other characteristics of a forest tree.

The Elm is esteemed as furnishing a good, cheap, and serviceable hard wood, and also for its beauty and dignity. Some of the Elms of finest appearance are to be found in America. Their lofty trunks reach three-fourths of their height; then start the diffused and pendulous branches, waving gracefully in the air. Where a line of forestry, at once stately and picturesque, is required, landscape gardeners choose the Elm. Hence it is that we see those magnificent, silent sentinels so often ranged along the broad sweep of an avenue, or giving shade to a quiet street.

The wood of the Elm, wherever found, is durable in water or when kept perfectly dry, but is liable to swift decay from exposure. It is subject to the ravages of a boring worm, a circumstance which limits its usefulness in certain directions; but it is valuable to wheelwrights, ship makers, and joiners, because of its fine grain and the rich mahogany color it can be made to assume. One of its most notable qualities is that it wears smooth. On this account it is useful for printers' and dyers' rollers, "dead-eyes," etc. In the United States, Elm of certain kinds is valued for its medicinal properties.

The American or White Elm (*Ulmus Americana*) has leaves from two to four inches long, of oval outline, with abrupt, sharp points. It is the most striking of all Elms, being taller than any of the other species. The fruit is about half an inch long, with sharp, uncurved points. It is called the White Elm, from the tender white of the bark. One hundred feet is not an unusual height for this tree; sometimes it towers as high as one hundred and fifty feet. It abounds in the basin of the Mississippi, but is not by any means confined to that region. It has a wide-spreading top, and its diffused branches and drooping branchlets give it a very ornamental appearance. The wood of the American Elm is not esteemed as highly as that of the English variety, as it is inferior in hardness and compactness, and by reason of its liability to split. It is largely used for piles, dock gates and engineering work generally, where its durability under water gives it value.

The English Elm (*U. campestris*) has leaves of a smaller size and darker color than the American Elm. It is a tall and graceful tree, but the branches grow out from the trunk more abruptly and the tree takes on a pyramidal appearance, not noticeable in the American

varieties. Although called the English Elm, it is not a native of Britain, but was introduced from the middle of south Europe and the Barbary States. It grows rapidly and attains a height of from sixty to ninety feet. It is a centenarian tree and in its old age has a diameter never more than five or six feet. There are several varieties of the English Elm, and many of them are in cultivation in the United States. It loses much in weight by drying, after being cut, and shrinks or warps readily, but, on the whole, its wood is highly regarded for its strength, toughness and closeness of texture. As it does not splinter, like oak or ash, when hit by shot, it is used extensively for gun-carriages.

The Wahoo or Winged Elm (*U. alata*) is a small tree, rarely exceeding forty-five feet in height. It is remarkable for wings of cork with which its branches are furnished on two opposite sides. It flourishes principally in the southern states. The wood is compact and heavy.

The Slippery or Red Elm (*U. fulva*) has large leaves and a tough and durable red wood, and grows from forty-five to sixty feet in height. It is found as far south as thirty-one degrees north latitude, and in the western parts of Canada. The leaves and bark yield an abundant juice, which is bland and demulcent, and is esteemed a valuable remedy in such affections as catarrh and dysentery.

The Scotch or Witch Elm (*U. Montana*) is the best timber tree of all the Elms. The wood, although more likely to split than that of the English Elm, has the peculiarity of growing straight and even, and possesses great longitudinal strength. There are a number of varieties of this Elm, many of them picturesque and graceful. The most remarkable of these sub-species is the Weeping Wych or Witch Elm (*U. pendula*), so called from its spreading, drooping branches.

The Cork Elm (*U. racemosa*) is a large tree with fine-grained, tough, heavy wood. Thick plates of cork cover the branches. It grows best on river banks in Vermont and southwestward to Missouri.

LIQUIDAMBAR

Styraciflua

THIS magnificent member of the Witch Hazel family is found in low woods in Connecticut and southern New York, and southward and westward to Florida, Illinois, Missouri and Mexico. In the middle states it is seldom found away from the coast.

As a forest tree, its maximum height is one hundred and fifty feet, with large, winged branches that have corky ridges. Its bark is very

rough and the tree is rich with resinous sap, which exudes a gum that is spicy and fragrant. The leaves are simple, alternate, with slender stems, and cut into five deep curves, giving the leaf a star-like appearance; they are finely serrated, brilliant, smooth and lustrous, with tufted ribs beneath.

As soon as the summer wanes, the leaves begin to turn a deep crimson. The flowers are of two kinds, sterile and fertile; the former are erect and spreading, in numerous small, greenish heads. The fertile heads are long and drooping, and borne at the base of the sterile ones. The fruit holds to the tree all winter.

The brilliant, shining, autumn leaves are the tree's greatest beauty; and when a spray is brought home from the woods, the closest inspection seldom reveals a worm-eaten spot on the foliage. Insects are shy of the tree and even refrain from marring the wood. The leaves contain tannin. Its fragrant amber fluid (which is the literal translation of the tree's generic name) is very valuable and is used as a substitute for storax. It is the only tree of its species in this country.

In the South it grows to an enormous height, and in beauty of outline is unrivaled. Every year it is being more extensively planted northward. The wood is brown, not very strong, and warps sometimes in drying; yet it has often been used as a substitute for black walnut.

WHITE CEDAR

Cupressus Thyoides

THE two species of Cedar, *Cupressus thyoides* and *Thuja occidentalis*, or Arbor Vitæ, have sometimes been confounded, each having been designated as White Cedar. They are similar in habit, both being evergreen, and the branchlets of both are formed in open, fan-shaped sprays. The leaves of both the Arbor Vitæ and the White Cedar are scale-like in formation, adhering closely to the twig, and so overlapping each other that they seem a part of the twig itself, but those of the White Cedar are finer, measuring only about one-half the width of those of the Arbor Vitæ. The cones are a distinguishing feature; those of the White Cedar are small, yellowish brown and round, opening toward the center when ripe, while those of the Arbor Vitæ are oblong and composed of six or eight loose scales.

The White Cedar is especially fond of swamps, crowding out as far into the water as possible, but it will also grow in dryer soil,

and there are said to be twelve varieties in cultivation; it is a good tree for ornamental use, growing symmetrically. The wood is very durable for purposes where it comes in contact with moisture, and has a pleasant aromatic fragrance.

THE LARCHES

Larix

An exception to a rule always interests, even if it does not actually please. A person or thing with an individuality stronger than the family or race characteristics that we expected to find, arrests our attention immediately. Among such evergreens as the pines, cedars, spruces and firs, to which it is allied, the dainty Larch challenges our notice by declining to wear her summer garment through the winter.

This beautiful tree, under favorable circumstances, sends its straight stem to a height of fifty or sixty feet. The lowest branches almost lie on the ground, from which the tree tapers gradually to a point. The bark is a bright reddish brown, rather scaly; the color of the young branches is first green, changing by degrees to a dark brown as they become older. The branches of the Larch are slender and pendulous, with whorls of light green leaves; they are pretty indeed. These leaves are linear, like those of the pine, but shorter, being never more than an inch and a half long The red blossoms come in May with the leaves. The cones are dainty little things, less than an inch in length, of a bright chestnut color. Unlike the pendent cones of the hemlock, hanging from the tips of the twigs, these grow along the branch, set close to it. There they remain until the second year.

The American Larch, Tamarack, or Hackmatack (*Larix Americana*), is found throughout British America, as far as the arctic circle, venturing into only the most northern states of the United States. Its chosen habitat is in cold, deep swamps, where it often forms thickets. It will also grow on dry land. The long, tough, flexible roots of this tree are mentioned by Longfellow; Hiawatha begs the Tamarack for some with which to bind his canoe. Another of the many names of this species is the "Black Larch."

The European Larch (*Larix Europæa*) is a native of the Alps. It is largely cultivated in England and in America. It differs little from the Tamarack of America, the leaves and cones being, perhaps, a trifle longer, the branches a little more drooping. The wood of the tree is very tough, elastic and durable. It is used largely in house-building,

for boats, and especially for things which must be under ground or under water. The bark is medicinal; it is also used for tanning and dyeing. Venetian turpentine, too, comes from this tree.

Other species of the Larch are the *Larix occidentalis*, of Pacific North America; *Larix griffithii*, the Himalayan Larch, which has a soft, yet durable wood; the *Pinus laricio*, or Corsican Larch, and the *Larix* (or *Pseudolarix*) *koempferi*, Chinese or Golden Larch.

THE OAK

Quercus

DR. EDWARD H. GREENE gives the following definition of an oak:—

"The Oaks, for which, as a genus of trees, botanists continue to use the name *Quercus*, are all easily recognized by the peculiar kind of nut-like fruit which they bear, and which is called in our language an Acorn. Every one knows that a kind of round or egg-shaped, cylindrical, elongated, thin-skulled nut, the base of which is set in a scaled or tubercled cup of circular outline, is an Acorn, and whatever tree or bush produces Acorns, is an Oak. Thus the Bearded Live Oak of the South, the gnarled giant of the northern woods and the Chinkapin bush, are brothers and sisters."

The Oak is also described as a slow-growing, dicotyledonous tree, of a peculiar spreading habit, and which loves a deep, tenacious loam with rocks in it. There are three hundred species of Oak in the world, of which fifty belong to North America.

The Oak is one of the most stately trees. Strong, sturdy and massive, the branches spread from the main stem with a peculiar jagged outline. The sudden shoots and angular twists of the branches resemble the zigzag path of a lightning bolt.

On this fantastic but majestic frame is spread a luxuriant foliage of glossy leaves. These are deeply cut and serrated so that the wind moving the tree brings out an added beauty. All the shimmering mass of green is finely edged in all its parts, and the huge bulk presents a filmy, lace-covered appearance. The great tree is rounded, and true in its exterior lines. The crown of green is usually flattened on the top, and the massive trunk, upbearing the wide-spreading branches, is true in its proportions.

The Oak attains its greatest beauty in the open. When growing in the unobstructed sunshine, its habit of spreading its great arms abroad, so that the birds of the air may rest in its branches, is unhampered. When situated at the edge of a forest, it irresistibly reminds the beholder of a noble and sturdy sentinel. Within the depths

of the woods it grows to greater height, and gradually shouldering aside less robust plants, it spreads out and covers a remarkable area. When shaded during its early growth, it shoots upward toward the light, and under these circumstances frequently attains a height of more than one hundred and fifty feet. When thus towering aloft with its extended crown, the glossy leaves changing color with every light and every breeze, there is no monarch of the vegetable world more worthy of homage.

The young Oak has one very interesting peculiarity. When the stem shoots up, the buds of leaf and branch arrange themselves in a very orderly manner. Each of the green leaves arises from a point on the young stem, which is a little higher and more to one side, than that from which the lower one springs. Hence a line joining the points of insertion of the successive leaves and future branches, describes an open spiral around the stem or young trunk. This is continued around the young tree, so that coming to the sixth leaf in the spiral, it is found in a line directly vertical to the first shoot or base leaf from which the count started; and the spiral has passed twice around the stem.

The Oak has another peculiarity. Some of the species mature the fruit or Acorn in a single year. Others require two years to complete this process of nature. All Oaks are very slow of growth, and live for hundreds of years.

The Oak is not the heaviest, the toughest, strongest, or the most pliable wood, but it combines all these qualities in such just proportions that its value as timber cannot be overestimated. At one time all war ships were built of heart of Oak. As early as the year 1799, the government of the United States spent two hundred thousand dollars to purchase tracts of live-oak land. It held these forests at the command of the Navy Department until the year 1895, when an act of Congress was passed throwing this valuable land open to the public. The demonstrated fact that all vessels in the future would be constructed of steel made these vast forests valueless to the government, but from the sturdy oaken timber of these lands such splendid ships as the victorious "Constitution," the "Hartford" and hundreds of others had been built.

A cubic foot of good oak timber weighs about sixty pounds. Mahogany, cypress and other woods are much heavier, but no timber has yet been discovered which combines such a general average of good qualities as the Oak. It is stiff and unbending under pressure, but, when properly steamed, will bend to any shape the shipwright or carpenter may require. It was this workable quality which gave Oaken timbers their immense value to shipwrights under the old methods.

It is still immensely valuable in building. Piers and under-water work constructed of Oak will last for years. In the British Museum is a section of one of the piles of London Bridge that was submerged for a period of six hundred and seventy years.

The principal varieties of American Oak include many species which scientific botanists have separated into distinct groups and named, but for all practical purposes the following matter describes the families of the Oak with sufficient accuracy to permit the amateur to recognize the various species.

The White Oak — Quercus Alba

The White Oak is so termed from the color of its wood. The bark is a light gray or nearly white, and smoother than that of most Oaks. It often breaks away from old trees in thin sheets. The leaves are large, wedge-shaped at the base, with from three to nine lobes in each leaf. These are very deeply incised, the cuts in the leaf following the main ribs of the leaf skeleton back almost to the main stem. They are bright green above and paler below. The Acorns grow in pairs on short stems.

The Acorn cup is saucer-shaped, shallow and rough. The nut is green, turning to a lustrous chestnut; it is oblong, from three-quarters of an inch to an inch in length, and the meat is sweet and edible. In the spring, the great gray mass puts forth leaves as tenderly pink as the shyest wood-flower; these, during the summer, are bright green; in the autumn they become bright red. The forms of the leaves vary greatly; often two or three distinct forms are found. The White Oak makes valuable timber. It is largely exported to Europe in the form of barrel and cask staves. It is also important in ship and carriage building.

The Red Oak — Quercus Rubra

The Red Oak differs broadly from the White, or the Scarlet Oak. Under favorable circumstances, it is a magnificent tree, often reaching a height of one hundred and fifty feet. The outline of the leaf is very variable, and the lobes or parts are small and unequal in size, and are bristol-pointed. This gives the tree a very light, airy appearance, although the foliage is dense. The Acorn is characteristic, and serves well as something by which the species may be identified. The nut is remarkably large in proportion to the cup. It is long, and is bitter.

The timber from the Western Red Oak is superior to that of the Eastern. It makes a fairly good barrel-stave or clap-board, but is not one of the more valuable Oaks. The bark is reddish brown,

rough, and broken into scales, but like that of the White Oak is smooth for an Oak. The leaves are dark green, smooth on the upper surface, and pale yellow-green beneath, with rust-colored leaves in the angles of the ribs. The wood is reddish brown. Both the White and the Red Oak grow throughout the United States.

The Scarlet Oak — Quercus Coccinea

The shortcomings of the Scarlet Oak are atoned for by the fact that in autumn the foliage blazes into a brilliancy of exquisite red, displaying the most delicately tinted garment of any of the Oak family. Its range is from New England southward and westward, and it is the glory of the autumn forests. The bark is grayish brown and rough, wth a reddish inner bark. This tree is highly prized for cultivation on account of its autumnal beauty. It thrives best in sandy, light, dry soil, and often grows beside the Black Oak.

The Black Oak — Quercus Velutina

The Black Oak differs from its companion, the Scarlet Oak, in a manner that may aid to distinguish them. The Black Oak assumes such various forms of foliage that frequently it resembles the Scarlet Oak; but the Acorns are smaller, and of a bright yellow, while the Scarlet Oak produces a white-meated nut. The bark of the Black Oak is dark brown, appearing black in the distance, while that of the Scarlet Oak has a grayish hue. The inner bark is deep orange, never reddish or gray. The budding leaves are red and turn to a silvery green in summer. In autumn they are red or russet, without a touch of the Red Oak's beautiful scarlet.

The Black Oak lifts a narrow head not more than a hundred feet high, and is not so stately as other varieties. The leaves frequently lose their bristles at maturity, giving the leaf a blunt appearance not consistent with its earlier forms. The Black Oak yields a well-known dark dye, Quercitron, and a large amount of tannin.

The Spanish Oak — Quercus Digitata

The Spanish Oak is found from New Jersey southward. It takes its Latin, or scientific, name from the appearance of the leaf, which is long and slender, breaking into pointed lobes resembling fingers. The leaves vary much in form, even on the same tree, but they are always downy underneath. The upper surface is smooth. The Acorn is small and the cup shallow. This tree loves the coast countries, and seems to prefer for its habitat low gravelly places, and barren land.

As far north as New Jersey it does not attain height or dignity equal to those of its southern representatives. It is frequently to be found side by side with the Swamp White Oak. It is one of those Oaks which require two years to ripen their Acorns. Its timber is not regarded as valuable except for fuel.

The Swamp White Oak — Quercus Platanoides

The Swamp White Oak is found from Maine to Iowa, and southward to Delaware and Georgia. Its greatest development is attained in the neighborhood of the Great Lakes. The brown bark separates into thin scales, and hangs down from the larger branches and sometimes from the trunk, giving the tree a remarkable appearance, which, once seen, can never be forgotten. The wood is light brown, strong, and closely grained; it has about equal commercial value with that of the White Oak. The Acorn is oval, chestnut color, and about an inch long. It is edible and sweet.

The Willow Oak — Quercus Phellos

This remarkable tree is found from Long Island, N. Y., southward and westward, and there is nothing, at first sight, in its appearance to denote that it is an Oak. The tree has leaves like a willow, and it is not until the Acorns appear that its family is distinctly shown. It retains its leaves green and fresh long after other trees have shed their foliage. For this reason it is much cultivated in the South. The Acorn is small, but perfect.

It is a very handsome tree. The bark is reddish brown and almost smooth, although it has very close scales. The foliage is a brilliant, light green. The tree grows in moist woods, or sandy uplands, and on the borders of swamps. It will be a pleasure for the amateur to identify this tree as an Oak. The Acorn will be about the only sure guide, but once seen, it will not be forgotten.

The Laurel Oak, Shingle Oak or Water Oak — Quercus Laurifolia

This Oak of many names is found from Pennsylvania to Iowa, and southward to Florida. The leaves are long oblongs, pointed at the base, and bristle-tipped. They are bright green, smooth and glossy above, and show a slight down on the under surface. This tree does not attain the usual height of the Oak, rarely growing more than eighty feet. Its trunk is tall and shapely, and the laurel-like foliage is very lustrous. The Acorns are small, the cup saucer-shaped, and the scales compressed. Its name of Shingle Oak connects it with the principal purpose for which its timber is used.

Post Oak — Quercus Minor

The Post Oak is another species known in different localities by various names, such as Iron Oak, Box White Oak, and Round-leaved White Oak. Its range is from Massachusetts southward, and westward to Indian Territory and Texas. The height of this tree varies from twenty to one hundred feet, and this peculiarity is one of its most remarkable traits. Indeed, in New England, this tree frequently becomes a mere shrub. The rough appearance of the plant indicates all the rugged strength of the Oak. Its dark foliage is disheveled and bristling.

The timber is very valuable, especially for railroad ties, cooperage and shipbuilding. It vies with the White Oak as a valuable commercial wood. It is frequently seen growing with the Black Jack. Its name of Post Oak indicates one of its most useful properties, as suitable for gate and fence posts.

Black Jack or Barren Oak — Quercus Marylandica

The Black Jack is a characteristic Oak, although it rarely reaches a greater height than fifty feet. In the spring the leaves open beautifully pink on the upper side. In the summer they are dark and lustrous, giving the plant its name of Black Jack. The wood shrinks badly in seasoning, and consequently is used principally for fuel, for which purpose it is commonly reduced to charcoal.

Chestnut Oak — Quercus Prinus

This tree is also known as the Rock Chestnut and Swamp Chestnut. It is distinctively an Oak, bearing a perfect Acorn, but the leaves resemble those of the chestnut rather than those of the Oak. The distribution of this tree is from Maine southward to Delaware and Kentucky, Tennessee and Alabama.

It lifts a broad, irregular head to a height of one hundred feet, and like the "spreading chestnut-tree," throws wide its arms. It is one of the handsomest and most noble of Oaks. The combination of the Chestnut leaf and the Acorn is sufficiently peculiar for identification.

Yellow Oak — Quercus Acuminata

This tree, also, is sometimes called the Chestnut Oak. It has, however, a tall, straight, narrow head and grows to a height of one hundred and sixty feet, which altitude is never attained by the true Chestnut Oak. The tree is very beautiful and imposing in appearance. The bark is light gray, rough, and broken into thin flakes. The trunk is graceful and lofty. The long leaves cling closely to the

limbs. In the Atlantic states the leaves resemble the true Chestnut. In the western limits of its range, the foliage is very variable in its form. The tree is found from northern Vermont to Alabama, and westward.

Burr Oak — Quercus Macrocarpa

The Burr Oak also goes by the names of Mossycup Oak, and of Overcup White Oak. These designations indicate a peculiarity of the Acorn, which is very large and handsome, inclosed in a deep cup, covered with rough-pointed scales, the lower row of which terminates in long, bristle points, and forms a soft, mossy fringe about the nut. The nut itself is from one to one and a half inches long. It is oval, and almost covered by the cup.

This noble tree is one of the largest of the Oak family. It grows to more than one hundred and sixty feet in height. Its range is from Maine to Pennsylvania, westward to Montana, and southward to Texas. It forms the famous "Oak Openings" of the western prairies.

The beauty of this tree cannot be praised too highly. The branches begin to spread afar at a small height from the ground, and cover a very wide area. The tree then towers aloft, well clothed in verdure, to the greatest altitude attained by the Oak. In appearance the outline is very graceful,—a wide-based cone of green, supported by a large, shapely trunk, not too high to lift the great mass of leaves and branches disproportionately above the ground. As a timber tree it is almost without a rival. Its dark brown wood is valuable for all the purposes for which the White Oak is sought.

Pin Oak — Quercus Palustris

The Pin Oak is another tree whose characteristics have impressed differently various communities. It is also called the Water Oak, and the Swamp Spanish Oak. The leaves strongly suggest the outline of the Scarlet Oak described above. They are, however, smaller. This tree is found from Massachusetts, southward and westward. It is not a giant, nor yet a dwarf of its kind. It attains, under favorable circumstances, a height of eighty feet or more.

The bark is dark gray, or greenish brown, rough, with furrows distributed very far apart. The outer skin often cracks, showing the reddish inner bark. The leaves are from three to five inches long, and have from five to nine lobes, each of which shows a tooth or bristle at the ends. The foliage is bright green above, and paler below.

Age seems to destroy the youthful symmetry and beauty of this tree. It is one of the few Oaks which droop the branches, although

the natural grandeur of the Oak clings to it until the last. Its coloring in spring, summer and autumn is good, and characteristic of the species. This tree warps badly in drying and is not useful for timber.

The Chinkiapin — Quercus Prineides

The Chinkiapin, or Dwarf Oak, is a remarkable specimen of the Oak family. It grows on a shrub, or small round-topped tree, from New Jersey southward and westward, and is generally found on rich hillsides. The leaves are oblong, and serrate, like a saw. The fruit is a little nut which grows singly within a bur which, when the nut is fully ripe, opens from the top to below the middle of the nut. It is very sweet and edible, and is gathered for sale. It is considered a dainty equal to the chestnut.

THE MAMMOTH TREE OF CALIFORNIA

The Mammoth tree of California (*Sequoia gigantea*) is the largest of known conifers. It is distinctively American, and is found flourishing only on the California coast. It is of the tribe of Abietineæ, and of the sub-tribe Taxodinæ. The Redwood is akin to it, both being of the same species. The name, Sequoia, comes from an Indian of the Cherokee nation, named Sequoiah, who lived in California, and invented an alphabet, which he taught to his tribe.

The Mammoth is found at its best at altitudes of from thirty-five hundred, to four thousand feet above the sea level. In appearance it is stately, tall, and columnar. The leaves are awl-shaped, short, rigid, with pointed apex, and of a light olive-green. This magnificent shaft of timber literally pierces the heavens. Many specimens over three hundred feet high have been measured. There are records of trees approaching to a height of four hundred feet, but the tallest now known, is one of the Calaveras grove, which is three hundred and twenty-five feet from tip to ground. Another, in the King's River forest, is nearly thirty-six feet in diameter inside the bark, and by its rings is calculated to be four thousand years old. The bark is from twelve to twenty inches thick near the ground. In color it has nearly the same tint as the Redwood, but the wood toward the center is of a deeper and duller red, approaching a brown.

The commercial uses of the *Sequoia gigantea* are not many. The heartwood, however, is dense, hard, and of a fine color; oiled and varnished, it has been used for cabinet work. The tree is not plentiful enough to be of great economic importance. As an example of massive and stately vegetation, the *Sequoia gigantea* is one of the most impressive natural features of the Pacific coast.

THE REDWOOD TREE OF CALIFORNIA

The Redwood tree of California (*Sequoia sempervirens*) is a variety of the "Mammoth" tree, and, of all American trees, is next to it in size. It is a coniferous tree, and grows plentifully on the coast ranges of California, but is found in its greatest abundance in the territory lying north of San Francisco.

Its proportions are noble and stately. It usually grows to a height of from two hundred to two hundred and fifty feet, but some have been known to tower higher than three hundred feet. The trunk is straight, cylindrical, and has an average mean circumference of from twenty-one to thirty-four feet. It is naked to a height of seventy to eighty feet, above which point it throws out symmetrical, spreading branches. The bark is from six to twelve inches in thickness, and is, when growing, of a bright cinnamon color.

The wood of the Redwood tree is, as its name implies, of a rich brownish red. After exposure, when cut, however, it gradually fades to a much duller shade. In quality it is light, straight-grained, easily worked, with the exception of a slight tendency to split, and takes a good finish. In contact with the soil, it is durable, and is a useful building timber. On the Pacific slope it is used for a variety of purposes, such as telegraph poles, railway ties, wine butts, fences, etc.

On good and favorable soil the Redwood tree grows with great rapidity, and though it flourishes when planted in the Eastern states, it is hardy only in its native California. The cones of the Redwood are small, roundish, and rarely more than an inch in diameter. The needles are from half an inch to a full inch long. The Redwood is much esteemed as an ornamental park tree.

THE BANYAN

Ficus Indica

The Banyan, a native of the East Indies and Ceylon, is one of the most remarkable trees in the world. It is, indeed, many trees in one, a grove springing from a single root. The woody trunk rises to a great height, and branches out extensively. Every branch from the main body throws out its own roots, at first in small tender fibers but, as they grow into the ground, they become stronger, and, when they have buried themselves, the stem becomes a fresh, stout trunk which carries further the spreading wood. The tree endures for many ages, for when the parent trunk, after centuries of upstanding,

has rotted, the offshoots of its branches have spread, multiplied, and grown strong.

The Ancients stood in awe of this remarkable tree, the Brahmins, especially, holding it in sacred reverence. One famous specimen of the tree, which is reported to stand on the banks of the Herbudda, has, although much reduced by age and floods, three hundred and fifty large trunks, about three thousand smaller stems, equal to large oaks, and covers an area of two thousand feet in circumference. One of the generals of the army of Alexander the Great described it as standing and flourishing in his day, and related that it gave shelter to an army of over seven thousand men.

Great swarms of monkeys, birds and fruit-bats inhabit the tree. The wood is of no commercial value, as it is soft and spongy, but the Hindoos claim many medicinal qualities for the bark; and milky juice. The tree furnishes lac and caoutchouc.

THE RED MULBERRY TREE

Morus Rubra

The Red Mulberry (*Morus rubra*) attains a height of sixty or seventy feet in its native forest, and its trunk is from two to three feet in diameter. This tree grows to a much larger size when planted in open ground, where it spreads its branches so as to make a finer display of foliage. The bark is heavy, and deeply furrowed, and, when the tree has begun to age, is of a grayish brown. In its wild state, the Mulberry has a ragged appearance. It blossoms in April and May, the flowers growing in catkins. The leaves are from three to seven inches long, and coarsely serrated; when young, they are rough on the upper side, and of a yellowish-green color. As they age they become smooth and are bluish green. The leaf ribs are a yellowish white, and very distinct. The fruit resembles the blackberry; it is red when in an unripe state, turning to a rich crimson purple when fully developed. The berries are very sweet; they have a peculiar, insipid, almost sickening flavor, greatly appreciated, however, by the birds, poultry and hogs which fatten upon them.

The wood is finely grained, of a yellow hue, and is said to possess strength and durability. It is used in some of the shipyards of southern ports, in building the upper parts of vessels. In its native regions it is largely used for building rural fences, especially for the posts, as it is said to withstand decay. There is a fiber taken from the inner bark of the Red Mulberry, which is woven into cloth by Indians in the southern states.

THE PLUM

Prunus

THE Plum (*Prunus*) is of the same Rosaceæ family to which belong the other cultivated stone-fruit — the Cherry, the Apricot, the Peach, and the Almond. The Plum, itself, is the most familiar of all fruit trees in the temperate countries. There are innumerable varieties of it, and the fruit varies considerably in size and appearance, but its value as a dessert is reckoned rather by its sweetness and flavor, than by its size. The Plum is a standard tree of the orchard. It is not over fastidious as to soil, but generally prefers a strong, but well-drained loam. The superior species of Plum are propagated chiefly by budding, and by grafting; the inferior, by layers, or by cuttings from the roots. The dried and preserved Plum is called the Prune, and its preparation in this form is an important industry of California, as well as of Germany, and of France. The Prune has many virtues possessed by few other dried fruits, and, as a consequence, its cheapness also being taken into the account, it is esteemed the world over.

The origin of the Plum is in dispute among botanists, though it is generally conceded that all the cultivated varieties are derived from the Sloe, Wild Plum, or Blackthorn, as it is variously called. Another theory is that all Plums are varieties of the common garden plum (*P. domestica*). The common Plum is believed to be indigenous to the south of Russia, the Caucasus, the Himalayas, and to many parts of Europe. In America, it is sometimes found in hedges, but never truly wild. Its introduction to America dates back to the earliest settlement, and since then the gardeners of the United States have originated several valuable varieties of the tree. What is supposed to have been the parent tree, was destroyed by lightning in New York, after many years of barrenness, at the close of the eighteenth century.

The wood of the Plum tree is much sought after by cabinet-makers, turners, and the manufacturers of musical instruments. It is hard, fine grained, and susceptible of a high and lasting polish.

The Wild or Canada Plum (*P. Americana*) is found from Canada to Texas, and it is, perhaps, the best known of the Plum trees of the United States. It is a handsome, showy tree, very thorny in many of its wild varieties, but thornless in some of its cultivated forms. It grows from ten to twenty-five feet high, and has a large, round head. It throws out white flowers in spring, just before, or at the same time with the appearance of its leaves. The fruit, which ripens

in August or September, according to the climate, is from one-half to one inch in diameter, globular, or somewhat oval, and is a charming transparent yellow, red or orange in color. The skin is tough and bitter. The fruit, itself, is pleasantly flavored. The wood is reddish.

The Chickasaw Plum (*P. Chicasa*) is indigenous only in the Southwestern states, but has spread by cultivation throughout the whole country. It is a small tree, or rather shrub, rarely exceeding fifteen feet in height, and is more often only eight or ten feet. It has long, narrow, fine-toothed leaves, and its fruit is from one-half to two-thirds of an inch in diameter. It is well flavored, and many excellent varieties of it are now cultivated. One of the best of these is called, by some nurserymen, the Wild Goose Chickasaw, the legend being that the tree sprang originally from a stone found in the crop of a wild goose.

THE WILD PLUM

The Wild Plum is found along the borders of streams, or at the edges of open woodlands. There are two closely allied species which are often confounded. One, the Canadian Wild Plum, is a Northern tree; the other, the American Wild Plum, is found throughout the United States as far west as the foothills of the Rockies. It is indigenous to America. The tree is small, with slender, spreading branches, furnished with thorns. The flowers are like those of the cultivated Plum, which are too well known to need describing. The fruit grows in cherry-like clusters. It is sometimes of an orange color, sometimes red, containing a single, flat stone-seed. The skin is tough and acrid, but the pulp within is edible, and pleasant to the taste. At one time the Wild Plum was much sought after by farmers' wives for preserving

THE CHERRY

Prunus Cerasus

The Cherry belongs to the same family as the Plum, the only distinction between them being in the varieties. In fact, the Plum and the Cherry merge readily into one another. They are subject to the same diseases, and present the same botanical features. The Cherry has even a greater number of varieties than the Plum, several

hundreds being recognized in the botanical catalogue. It had its origin in Asia, and it is recorded by Pliny that Lucullus introduced it from Cerasus, in Pontus, to Italy about B.C. 70, to celebrate his victory over Mithridates. One hundred and twenty years later it was introduced into Britain.

In the United States it flourishes greatly, and, every year, millions of trees are in cultivation. The fruit, which may be eaten fresh, dried, or cooked, is pleasant and wholesome, and, besides, is used extensively in the making of liquors, the best known of which are Kerschwasser and Maraschino. Cherry Brandy is made by steeping Morello Cherries in Brandy. Peasants and forest dwellers in some parts of France, use the Cherry as an ingredient in a favorite soup.

The wood of the Cherry almost rivals the mahogany. It is compact, fine grained, and of a dull red tint, which deepens with age. It takes on a brilliant polish, and is used in the manufacture of almost every kind of furniture. Not infrequently it is planted for ornament, as it gives forth a pretty and delicate flower. In China and Japan, it is esteemed exclusively for its flower, so much so that the fruit is entirely ignored.

The Black Cherry (*P. serotina*) is remarkable for its rapid growth and large size. It grows to a height of from twenty to sixty feet, and some trees have been known over eighty feet high. It is distributed all over the Eastern states, but is at its best in Pennsylvania, Ohio, and Virginia. The fruit is purplish black, about as large as a pea, and somewhat bitter to the taste. The flowers grow in clusters and appear in May or June, the fruit ripening in August, or September. The branches of the tree are scraggy and scattered, but in outline it is a picturesque and attractive tree.

The kernel of the Cherry contains a perceptible amount of Prussic acid which accounts for the bitter aromatic taste of the pulp. The wood of the Wild Black Cherry is the most valuable of all the Cherry woods, on account of the size to which the trees grow, and of the erectness of the trunks.

The Wild Red Cherry (*P. Pennsylvania*), sometimes called the Bird Cherry, is found principally in the northern United States, and is much used for culinary purposes. The fruit is borne in bunches, is translucent, red, and sour. It appears to be relished by birds, hence its secondary name. It is a small tree, rarely higher than twenty-five or thirty feet, and grows chiefly in rocky woodlands. The flowers appear in May, and are small, white, and long stemmed. The Red Cherry often grows in great quantities after forest fires, and covers the otherwise denuded land with a dense growth.

THE CHOKE-CHERRY

In April and May, the air in some parts of the country is fragrant for miles around with the odor of Wild-cherry blossoms. These appear on dainty sprays, very different from the ordinary Cherry blossoms. The fruit is, at best, not much larger than the largest cultivated currants. It is deep red, almost black when ripe, often acrid and unpalatable, but, a tree bearing such fruit, frequently stands beside one with cherries much larger, juicier and quite sweet. The flavor is entirely different from that of any cultivated cherry.

The tree itself is graceful and pretty. It grows by the roadside, in field corners, beside streams, and on the edges of woodlands. It springs quickly from the seed, and often a lane is fringed on both sides with Wild-cherry trees, self sown. The juice of the fruit is used for making summer drinks, and for cough syrups.

THE OSAGE ORANGE

This is a remarkably handsome, showy tree. It grows to a height of from forty to sixty feet, spreading out, and gracefully rounded at the top, with handsome foliage. It easily adapts itself to its surroundings, and flourishes throughout the North. Young shoots will grow from three to six feet in a single year; consequently, when planted for hedges, as they frequently are, the trees require constant pruning.

The fruit is a syncarp, that is, it has many fruits in one. In appearance, it is a pale green ball, composed of many small drupes grown together. These are filled with milky juice. The fruit is highly fragrant, but not edible. Cattle eat it, but it is injurious to them.

The name "Osage Orange" is from the Osage Indians, who greatly prized the wood for the making of bows and clubs, because of its elasticity, and remarkable resistance to decay. This wood, which is bright orange in color, is in favor for general use, in locations subject to alternations of dry and wet.

ORANGES

Citrus Aurantium

A rather low-branching, evergreen fruit tree is the *Citrus aurantium*, or Orange-tree. Its bark is generally greenish brown, and its leaves ovate. The flowers are white and fragrant. Oranges are large, globose fruit, of eight or ten membranous cells, each containing several seeds, which are packed in a pulp of tapering, bladder-like, cells, distended with an acidulate juice.

There are three principal varieties of the Orange: the sweet, or China Orange,—*Citrus aurantium* proper,—including the ordinary market sorts; the bitter, or Seville Orange,—or Bigarade, variety *Bigaradia*,—used much for making marmalade, its peel being especially valued; and the Bergamot Orange,—variety *Bergamia*,—classed by some, however, as a variety of *Citrus medica*.

The Orange is a native of India, whence it spread to western Asia, thence reaching Spain and Italy between the thirteenth and fourteenth centuries, through the agency of the Moors and the Crusaders. It is now cultivated in nearly all tropical and subtropical lands, including China and Japan, the whole of the Mediterranean basin, the West Indies, the southern borders of the United States, and California.

Of late years, the most noted feature in the Orange cultivation of this country has been the production of the famous Navel Orange in lower California. This variety is seedless, and of a slightly bitter, yet satisfying, taste. At the beginning of the twentieth century, the Washington Navel was the most popular of all foreign varieties growing in California. The fruit of this Orange is large, very juicy and highly flavored. The skin is smooth and of very fine texture, and the fruit is seedless. The tree is a prolific bearer, moderately thorny, and a rapid grower, although it does not attain a large size; it bears when very young, and the fruit ripens early. This variety of Orange was imported from Bahia, Brazil, in 1870, by Mr. W. Sanders, of the Department of Agriculture at Washington, and in 1874 two trees were received from Washington by Mrs. Tibbetts, of Riverside, California. They were soon in fruit, and the excellence of the variety being at once recognized, the tree was propagated rapidly, and the Orange received the name of Riverside Navel. Later, the name Riverside was exchanged for that of the national capital.

Throughout the world, the Orange is, as a rule, grown from cuttings and layers, but the favorite modern method of cultivation, in California and in Florida, is by seed. The seed chiefly used is obtained from cheap seedling fruit. When thoroughly decayed, the fruit is pulped by a mashing process. The mass is then rubbed through a coarse sieve, which catches and holds the seeds. Plump seeds will sink if thrown into the water, while the imperfect seeds rise to the top. The good seed is not allowed to dry, and is sown after the ground has become warm in the spring.

Orange seedlings are grown either in boxes or in the open ground. In either case, a rich, sandy loam, that will not harden, is made by mixing sand with rich garden loam. Boxes about two feet square are made, with holes in the bottom for drainage. The boxes are filled

to a depth of about four inches with the prepared soil, and the seeds are placed four inches apart, each way. They are then covered to a depth of one inch with a sprinkling of soil. The soil is kept moist, and in about six weeks the seedlings appear. During the first season they grow to about one foot in height. Planting in the nursery is usually done in the spring, after the ground is thoroughly warmed. The seedlings are then one year old. Orange seedlings are planted at a greater distance apart than is usual for deciduous trees, because the orange remains longer in the nursery, and because it is often desirable, when taking up the plants, to sack the ball of earth surrounding the roots. If the roots are not to be sacked, there is a space of nine inches between the plants; if they are to be sacked, the distance is made twice as great. In places where horses are employed in the work of cultivation, at least four feet of space between the rows is allowed.

Seedlings are usually budded after two years in the nursery, during which period they are sheltered in the winter, and well irrigated and weeded in the other seasons. The care of budded trees in the nursery is similar to that of the seedlings of the previous year. If too great a tendency to branch low is observed, the tips of the lower shoots are pinched off. About this period the intrusion of gophers and other vermin is carefully guarded against. Budded trees are given one or two years' growth in the nursery, and the same period of growth is allowed for the bud. In orchard planting, the trees are ranged from twenty to twenty-four feet apart. All the varieties now propagated are quick to bear fruit.

In the year ending November 1, 1898, over fourteen thousand carloads of oranges were shipped from California beyond the state line.

THE PAPAW

The fruit under consideration is not the real Papaw (spelled also Pawpaw) of the tropics, but a member of the Custard-apple family, named from its resemblance to the tropical Papaw. The plant is a tree or shrub found throughout the middle states, and as far west as Michigan and Kansas. Dense thickets of it are to be seen along the Mississippi. In rich soil it sometimes attains a height of thirty feet. The trunk is straight, its dark brown bark mottled with gray. The branches are slender and spreading, with leaves from ten to twelve inches long, and four or five inches broad. The blossom is interesting from the fact that it gradually changes color from a decided green, when it first appears in April, to a dark red-purple. The fruit, which ripens in September and October, is oblong,

and so curved as to resemble the banana. Inside, the pulp is yellow and soft, of a peculiar flavor not usually agreeable to the unaccustomed taste; nevertheless, it is often found in the markets of Western and Southern cities.

CUSTARD=APPLE FAMILY

Anonaceæ

The trees belonging to the genus *Anona* owe their popular name, "Custard-apple," to the custard-like pulp of the fruit. These are tropical, or subtropical trees, varying in height from two to thirty feet, and are indigenous to South America and the West Indies. One species is also found in the United States. This is the three-lobed *Anona* of the southern states, *Asimina triloba*.

The Custard-apple tree has a shining, silver-gray bark and dense foliage. The leaves are alternate, sharp pointed and of conspicuous size, being from ten to twelve inches long. On first leaving the bud they are hairy above, of a rusty color underneath; when full grown they are smooth, dark green above, and a little paler underneath.

The blossom has three sepals and six petals. Three of the latter are broadly ovate, spreading outward; the inner three are smaller and erect. An interesting peculiarity is that these blossoms change color, from green through a brownish hue to a rich purple. Stamens and pistils are many; nectar is secreted in abundance. The fruit is irregularly oblong, rounded, often curved, somewhat resembling a shortened banana. It is called Papaw, from its similarity to the real papaw of the tropics. This species loves a rich, moist soil, and shade rather than sunshine. Along the Mississippi it is found at its best, often forming thickets by itself, or sometimes a dense undergrowth among other trees. In the former case it acquires more tree-like proportions, sometimes reaching a height of thirty feet. It ranges from the shores of the Great Lakes southward to the Gulf, and from the Alleghanies westward as far as Michigan and Kansas

Two delicious fruits of the order, are the Sweet Sop (*Anona squamosa*) and the Sour Sop (*Anona muricata*) of the West Indies, both juicy and pleasant, the latter possessing a strong acidity. This is cultivated in the East Indies, also. It is a large, greenish, pear-shaped fruit. *Anona reticulata* is the common Custard-apple, good, but not quite so luscious as the two preceding. From its shape it is sometimes called "Bullock's-heart." *Anona cherimolia*, the Cherimoyer of Peru, far excels any other species in flavor.

THE JUNIPERS

Juniperus

THE Junipers, of which there are about thirty species, are scattered throughout the north temperate zone, and in mountain regions farther south. The common Juniper of Europe and North America, *Juniperus communis*, is either a low shrub or a small tree, usually the former. Often it is quite prostrate, the branches spreading along the ground, rooting here and there. It has a soft, reddish bark, smooth in the younger branches, scaly in the older ones. The linear leaves are arranged in whorls of three. They are short, rigid and slightly curved at the base; bright green on the under side; on the upper, glaucous along the center. Like others of the evergreens, the blossoms are composed of whorls of little scales protecting, in the fertile flowers, the ovules; in the sterile flowers, the anthers. They grow in aments, or catkins, from the axils of the leaves. The flattened berry that follows is formed from the three fleshy scales of the flower, enlarged. This is shown by three slight projections, and three lines marking the points and edges of the previously separate scales. The berries are highly aromatic. The volatile oil obtained from them is used in the making of gin, which owes its flavor to them. A variety of Juniper, found in Europe, is valued for its handsome yellowish brown wood, pleasantly aromatic, and capable of taking a high polish. It is used principally by turners for small articles. As a tree, the Juniper sometimes reaches a height of twenty-five feet.

The Red Cedar (*Juniperus Virginiana*) is one of the most picturesque of trees. Its usual height is about thirty-five or forty feet, but it is known to attain to one hundred feet, while, on the other hand, it is sometimes but a mere shrub. It is always scraggy, often twisting itself into fantastic shapes, but its rugged appearance is very attractive. The bark is a reddish brown, scaly, and often falling off in long shreds, leaving the trunk bare and smooth. The wood, from which the tree takes its name, is red, except for a few layers of white sap-wood. It has a most delightful fragrance; is very fine and straight-grained, and takes a high polish. Such a favorite for many purposes has it been, that it is now rather scarce, and correspondingly expensive. It is used for interior finishings of houses, and in general cabinet work; for railroad ties and posts, because it resists decay in contact with the soil; for certain parts of ships, and very extensively for lead pencils.

A distinguishing peculiarity of this tree is that it has two kinds of leaves, the awl-shaped, and the scale-like. Only the former occur in

the young shoots, but on the older branches the two occur side by side. The awl-shaped are furrowed and glaucous above, convex beneath. The scale-shaped are very small and crowded, each bearing a little gland on the outer side. The flowers are similar to those of the common Juniper, previously described. In the fruit, there are no traces of the scales, as in that tree. The cones are about the size of an ordinary pea and purple when full grown. Earlier they are green, covered with a white bloom. They mature, sometimes in the first, usually in the second, season.

The Red Cedar will grow in almost any soil. It is at its best in Virginia. At present the principal commercial supply is from Florida. The tree is frequently attacked by certain fungi. These are often seen in bright-yellow or orange masses, resembling gelatin, with a long, thread-like growth springing from depressions. Savin, a name commonly applied to the Red Cedar, belongs properly to *Juniperus Sabina*, of southern Europe. *Juniperus Bermudiana* is similar to the Red Cedar and is used for the same purposes.

GINSENG FAMILY

Araliaceæ

The Aralia, the root of which is so prized by the Chinese as a stimulant, is the *Aralia panax*, Ginseng or Shinseng, a native of northern China. *Aralia quinquefolia*, of North America, is almost identical, but the root is less valued, although it is imported into China from this country as a substitute for the Chinese Ginseng. The commercial product is chiefly from the states of Ohio, Minnesota and West Virginia.

The Angelica Tree (*Aralia spinosa*) is perhaps the best-known American species. As the Latin name indicates, it is a spiny tree. Occasionally it grows from twenty to thirty feet high, with spreading branches, but oftener it is found growing in clusters, not more than ten or fifteen feet high, and almost without branches. These young stems are stout and club-like, hence the common name given to this tree, "Hercules's Club." It has a light brown bark, ridged and broken. The branchlets are prominently marked with leaf scars and furnished with prickles. The leaves are pinnate, *i. e.*, feather-shaped, thus differing from the species mentioned above. These leaves are said to be the longest found on any tree or shrub in this country, frequently measuring three feet.

The Angelica Tree does not put forth its flowers amid the general display, but saves them as a pleasant surprise after other trees have

lost their showy bloom. They appear in July, August, or even September, in large, loose compound panicles borne at the very end of the stem; often rising several feet above the leaves, that the plant may show her belated treasures to the world. The fruit is a little black drupe, which hangs in clusters throughout the winter, unmolested by the birds, which do not find them edible. The fleshy roots of the various *Araliaceæ* are medicinal, but really of little value.

The real rice paper of the Chinese, which comes only from the island of Formosa, is made from the pith of *Fatsia papyrifera*, a member of the order *Araliaceæ*. There is one species of this genus found on the Pacific coast of North America. In addition to this, eight varieties of the Aralia are found in our country. The common ivy (*Hedera helix*, or *Hedera nigra*), is also a member of this same family.

COMMON PERSIMMON

Diospyros Virginiana

This is a tree common from southern New England to Illinois, and through the South and Southwest. The roots run to a great distance and produce numerous shoots. The tree frequently grows to a height of sixty feet, and some have been found of one hundred feet, the fruit being high in the branches. The bark is dark colored, deeply furrowed, the ridges crossing like the meshes of a net.

The foliage is bright, the leaves four to six inches long, oblong, somewhat thick, smooth, dark and shining above. The flowers are small and yellowish, and urn-shaped, the staminate ones with mouth nearly closed. The leaves decay quickly after falling and furnish nourishment for the soil, so that the grass near the trees is very luxuriant. The fruit is about the size of a small apple, the flesh soft and pulpy, of a dull yellowish color, very acrid and disagreeable to the taste until mellowed by the frost, when it has a sweet and pleasant flavor.

The wood of the Persimmon is very hard and close-grained, the name *Diospyros* being from a Greek word signifying "grain of Jove." The heartwood does not fully develop until the tree is nearly one hundred years old; it is very dark, almost black, really an ebony, to which general order it belongs. Almost all parts of the tree are useful. The Indians had a way of drying the fruit and making from it a sort of beer, and it is still used in making a spirituous wine. The bark of the root contains a tonic medicinal property, and the wood is used for articles requiring hardness and toughness, such as mallets, shoe lasts and shuttles.

JAPANESE PERSIMMON

Diospyros Kaki

THE Japanese Persimmon is successfully cultivated from Washington, D. C. southward, but in Japan and China many varieties have been produced. In Japan it is found in almost every garden, and horticulturists cultivate it almost as universally as we do the apple, with the result of producing nearly as many varieties. Some of these have been introduced into California and are cultivated; the fruit sent to our Eastern markets comes under the name of California Persimmon. This variety has large, leathery, shiny leaves, and the fruit is somewhat larger than the native American variety. Although semi-tropical, traces of the various species of *Diospyros* have been fossilized in the rocks of Greenland and Alaska.

THE BANANA

Musa Sapientum

IT MAY be a surprise to those not especially interested in botany, to know that the plant bearing this common fruit belongs to the lily family, being quite closely allied to the common iris. The blossom, small, but pretty, is distinctly the six-parted flower of the liliaceæ, and the fruit corresponds to the three-celled pod of the iris, with the seeds in three rows, along the central placenta. But unlike the iris, the Banana has its seeds imbedded in a sweet pulp, which forms the edible part. The plant is usually from ten to twenty feet high, with long, upward-pointing leaves. The true stem is underground, the apparent stem being merely the overlapping lower part of the leaves. Naturally, therefore, it is weak and easily broken down by the violent winds of the tropics, a whole season's crop being sometimes destroyed in this manner. The fruit forms in hanging spikes, with from fifty to one hundred Bananas in a cluster. After it has ripened, the plant dies to the ground, new shoots from the rhizome taking its place. Of these, two or three are allowed to remain, the rest being destroyed or transplanted. It is thought that the undisturbed shoots produce better fruit. Propagation is almost entirely from these suckers, the cultivated fruit being seedless. In a year or two after establishing themselves they begin to flower, the fruit maturing from ninety to one hundred days later.

There are countless varieties of this plant; the two best known being the Banana proper, and the Plantain. The fruit of the latter is larger and coarser, with little flavor; yet it is a favorite food of the natives. In fact, this plant supplies the staple food of a larger percentage of the human race than does wheat bread, our "staff of life." What the potato is to the Irish, what oats are to the Scotch, what rice is to the Chinese, the Plantain is to the natives of the tropics. It is picked green and prepared by baking, boiling, or frying in slices, just as we cook potatoes. The Banana is usually eaten fresh when ripe. Strangers seldom find the Plantain palatable at first, but learn to like it. It is said that the same area of ground that will produce thirty-three pounds of wheat, or ninety-nine pounds of potatoes, will bear four thousand four hundred pounds of Bananas (or Plantains). Humboldt has estimated that an acre of land planted with Bananas will supply a greater quantity of solid food than the same area will yield of any other product.

The Banana is one of the oldest of cultivated plants. Legend says that Adam and Eve reclined beneath it in the Garden of Eden, whence the name that Linnæus bestowed upon the Plantain — *Musa paradisiaca.* Whether or not the Banana was actually the forbidden fruit, as some say, it is certain that the plant was cultivated many centuries ago in the Malay Archipelago, in China and in India. Linnæus called the Banana proper *Musa sapientum*, because of the story that the Greeks of Alexander's expedition saw native "sages resting beneath its shade, and eating of its fruit" in India. The plant grows wild in Cochin China, in the Philippines, in Ceylon and in Khasia. In the wild state it produces seed, and the tough skin, that we know as perfectly smooth, is covered with little sharp or knobby protuberances, or with stinging hairs, a provision of nature to keep off small molesters, which could not help in the dispersion of seeds, as the larger birds and the monkeys do.

There is evidence that the Banana had found its way to America before the time of Columbus. The fruit was offered to Pizarro by the Peruvians; and Banana leaves have been found in the tombs of the Incas. In its wild state, the plant is unknown on the Western Continent. The fruit was brought to the mainland of America from Cuba as late as 1804. The first full cargo, fifteen hundred bunches, was imported in 1830. The annual importation is now more than ten million bunches. Banana-growing is successfully followed in Florida and Louisiana. Those grown in the latter state are especially fine. They are large, red skinned and of a delicious flavor.

The Plantain is useful not only as food, but the stem supplies a fiber which is woven into textile fabrics, and is used in paper-making.

BANANA.
⅔ Natural-size.

PINE-APPLE.
½ Life-size.

PRESENTED BY LOUIS G. KUNZE.

Several varieties are cultivated exclusively for this valuable fiber, of which the best known is the "manilla hemp," grown in the Philippine Islands. Manilla rope is well known, but it is a curious fact that some of the finest Indian shawls are woven from the fiber of the Banana stem.

THE PINEAPPLE

The Pineapple is the only important fruit that cannot be traced to Asia as its home. It appears to be of purely American origin. Its cultivation was at one time confined to certain islands of the Bahama group, but it has now spread to every tropical region where civilized man has made his abode. Dutch traders took it to Holland in the seventeenth century, and it was afterward carried to the southern shores of Asia, the fields of Eastern Africa and the isles of the Pacific. In India, it has escaped from cultivation, and is found in the jungles, where it propagates itself. When not under cultivation, the plant ripens seed from which new varieties may be produced when brought under different conditions. There are several common varieties, which differ in size and in the quality of the fruit, but all have the same distinctive flavor. The common name, Pineapple, comes from the resemblance of the fruit to a pine-cone.

It is related that the Spaniards found the Pineapple in Peru and took it to the West Indies. The Portuguese are said to have been the first to carry it to the East Indies. The Dutch attempted to cultivate it under glass in their cold climate, and succeeded to a marked degree. The same device was adopted in England at one time, but commerce has brought this fruit readily within reach of the civilized nations, and artificial cultivation is not now so extensively practiced.

The Pineapple cannot be called a tree, for the stalk springs from the midst of a tuft of great leaves. A small and curious flower forms on this stalk, from which comes the fruit which is conical in shape, varying from six to twelve inches in length and from three to six inches in diameter. It is always crowned with a tuft of thick, strong leaves. The fruit is really a densely packed collection of berries and fleshy bracts.

The plant can be readily propagated from suckers, or from the tuft on the top of the fruit. Placed either in earth or in water, this tuft will grow and make a good window-plant. Great care must be taken in cultivating the plant, or the fruit will be fibrous, with little sweetness or flavor. By careful cultivation the delicacy and richness of flavor can be greatly increased.

New York is the great mart for this fruit, but it is carried to Europe in an unripe condition by fast steamers and is there matured under glass. It is thought that its quality is much improved by this process. In cold and temperate climates it is generally cultivated in hot houses, in which tropical heat is maintained. The best soil is a rich, sandy loam. When ripened under glass, it is essential to keep the air moist as well as hot, and also to allow ventilation from time to time. The canning of Pincapple is one of the largest industries in some of the West Indian Islands.

THE GRAPE

The Grape was known to man at a very early period in his existence, for mention of it comes down to us from the first records of history. Pictures left by the ancient Egyptians, and relics of the Lake Dwellers of Italy and Switzerland, show that the Grape was well known to these primitive peoples. It was certainly cultivated in Egypt as early as 4000 B.C., and the ancient Scriptures frequently speak of the Fruit of the Vine. It seems to have been native to Europe as well as to Asia. It was not known in the British Islands, when they were visited by the Romans, but the vine was soon introduced, and vineyards became valuable portions of Saxon estates. In the twelfth century, a vineyard was attached to every monastery in the south of England.

The Grape is indigenous to America, and much attention has been given to its cultivation. For many years after the settlement of the new country, the only grapes cultivated were of European origin, but slow progress was made in securing good results until the native varieties were taken up. The first of these to attain prominence was the now famous Catawba, which was found wild in North Carolina in 1802. The greatest advance was marked by the appearance of the famous Concord variety, which was produced about the year 1840, by Ephraim Bull, of Concord, Massachusetts. The Delaware Grape is a natural hybrid containing some blood of the European Grape. It was found in a garden of foreign Grapes in 1850, but received its name from Delaware, the Ohio town in which it was first brought to general notice.

The fruit grows upon a woody vine which climbs by tendrils. The leaves have five lobes, and are downy underneath, while the edges are serrated. The flower is of a greenish yellow. The grape vine flourishes all over the world through a wide belt of the temperate zone, and in this country the centers of growth are the middle Atlantic

ENGLISH GRAPES.
⅔ Life-size.

PEACH
½ Life-size.

states and California. A high temperature, lasting for a long period is necessary to ripen the fruit.

The grape is among the most delicious and highly prized fruits of the temperate zone. It is extensively preserved, and is a favorite material for jelly. The Raisin, or Grape in the dried state, is an article of great importance in the household. In central and southern France and in Italy, the chief use made of the Grape is for the manufacture of wine. Southern Germany, Spain and Portugal, are also wine-making countries, but in this industry, no country surpasses France, which produces more than five hundred millions of gallons a year. In Spain and Portugal more attention is paid to making Raisins. The manufacture of wine has become an extensive industry in California also, where several varieties of the Grape grow in great profusion. In all vineyards the vines are carefully trained so as to turn the available space to the greatest account. Superfluous shoots are removed by pruning, that the strength of the vine may be directed into the fruit-growing branches. The bunches of Grapes are generally thinned out, also, in order that finer fruit may be produced.

WILD FLOWERS

TRAILING ARBUTUS

Heath Family.

One of the earliest flowers you will see in the spring, if you live in New England, or in any other northern part of America, is the Trailing Arbutus, or, as it is more commonly called, the Mayflower. The poet Whittier has written a lovely poem about this flower, in which he connects it with the Puritan ship "Mayflower," from which the pilgrims landed at Plymouth, in 1620. We all ought to read that poem, and if we know the Mayflower, and have gone into the woods and gathered it, we will read with much keener pleasure what the poet has so beautifully said.

Every wild flower, no matter how small or unimportant looking it may be, has been given a Latin name. These names are sometimes very long — in fact, almost as large as the flowers themselves, — and you may wonder, for instance, why this plant cannot be called the Mayflower, which is a much prettier name than the one the botanists use — *Epigæa repens.* The reason is that by the use of Latin words men and women of all nations have one name by which the flower is known the world over, so that a botanist has only one name to learn, instead of learning one in each language. The name *Epigæa repens* means "creeping on the ground," which is a very good name for the plant, for that is just what it does.

You will find this flower in April and May, just after the snow has melted. Its leaves are rounded, and the base is indented so that it is heart-shaped. If you feel them you will find that they are quite thick and hard. The stem is covered with rusty, brown hairs. You will be surprised to see the plant have so many leaves so early in the spring, but you must remember that it is evergreen.

The blossoms are generally pink, some being a much deeper shade than others, and a few are white. They grow in clusters, and are very fragrant, which helps to make the Mayflower a welcome visitor. The blossoms look quite waxy, and if you examine them closely you will see that the colored portion, which is called the *corolla*, is made up of five parts. When you look into the tube you will see a number of hairs, and you can count ten match-like bodies that are called

stamens, while in the center is a single upright part called the *pistil*. This is different from the stamens, and is a very important portion of the flower, since it and the stamens are chiefly concerned in producing the seeds.

Around the outside of the corolla is a greenish portion, called the *calyx*, which is composed of five leaf-like little parts, each of which is called a *sepal*. Now every single part of a plant or flower has its uses, and one of the most interesting things about the study of plants is to find out what each part is for, and to see how wonderfully each organ is fitted for the work it has to do.

The chief use of the *calyx*, and the *corolla*, is in the protection of the bud, for you will notice that when the flower is in the bud it is all rolled up so as to protect the delicate parts within from injury. The *stamens* and the *pistil* reproduce the plant by forming the seed, and they do this in a very interesting way. If you look closely at one of the *stamens*, you will see that it consists of two parts: one of them, called the *filament*, is long and thread-like, and supports the other, which is a larger body, called the *anther*. If you open this *anther* you will see a yellowish dust fall out. This dust is called the *pollen*, and it, too, plays a very important part in the formation of the seed.

The central organ of the flower is the *pistil*, which is made up of three parts; the lowest of these, called the *ovary*, is the part in which the little seeds form; the second is the *style*, and its use is simply to support the third, called the *stigma*. This *stigma* is covered by a sticky juice, which holds the pollen grains when they fall from the *anther* upon the *stigma*.

Dalmatian powder, which is sold for sprinkling about the house to kill flies, is the pollen of a plant that is grown in Dalmatia, on the shores of the Adriatic Sea. When you think of the immense quantities that are used, and then of the small size of the *anthers* in which it is formed, you can form some idea of the number of plants that must be grown for its production.

You may have noticed in early spring a quantity of yellow dust sprinkled over the surface of a brook or pond, where there is an overhanging tree. This is pollen that the wind has carried there. If you can see the grains of this powder under a magnifying glass, you will notice that each is a little ball. It is more like a football than any other kind, for each grain has two coats, an outer one that has a few weak spots in it, and an inner one that is quite elastic. Inside of all is a peculiar matter that is almost liquid.

When the pollen falls on the sticky juice of the *stigma*, the grains absorb enough of this liquid to make them swell, and the inner coat

bursts out through one of the weak spots in the outer one and forms a tube. This tube finds its way down through the cells in the *stigma* and *style*, and the liquid contents of the pollen grain passes down into the *ovary*, and changes the little bodies it holds into seeds.

Does it not seem wonderful indeed that the tube of the pollen grain should be able to find its way, sometimes as far as one or two inches, down through the other parts to the *ovary?* This is only one of the many really wonderful things that are hourly going on in Nature, of which we take little notice; but the study of Nature brings them to light, and well repays us for our interest. So try to find the parts named, in the first flower you see, and next spring, after the snow has gone away, go out into the woods, especially among the pines and push aside the dead brown leaves of last year, and you will see what the poet meant when he said: —

> "But warmer suns ere long shall bring
> To life the frozen sod,
> And through dead leaves of hope shall spring
> Afresh the flowers of God."

SHEEP-LAUREL — LAMBKILL

Heath Family

THIS plant is not so large as the Mountain Laurel, attaining a height of only three feet. Its flowers, too, are smaller; but they are exceedingly pretty, with their delicate crimson-pink color. As in the Mountain Laurel, the stamens are bent over and caught in depressions of the five-lobed corolla; the calyx is five-parted. There are ten stamens and one pistil. This flower is the most poisonous of the genus. It is fatal to sheep, but deer are said to feed on it without danger.

MOUNTAIN-LAUREL — SPOON-WOOD — CALICO-BUSH

Heath Family

THIS plant is one of the glories of nature, and is found not only in the mountains, but in the lowlands as well. It probably assumes its greatest height in the mountains of Pennsylvania. To see it growing there in its wild luxuriance, is a sight never to be forgotten. Sometimes a whole mountain side is flushed with it; one might imagine that the roseate clouds of the summer skies had become entangled among the trees.

It is an evergreen shrub, with glossy, oblong, pointed leaves of a leathery texture. The buds are pink, and the full flowers are pure white, or pink-white. They have a five-pointed calyx, and a peculiar wheel-shaped corolla, with five lobes and ten depressions. There are ten stamens and one pistil. It is the stamens that produce the wheel effect; each is bent over and fastened in a depression of the corolla. Nature did this for a good reason; whenever a bee touches one of the stamens, the slender filament springs back, throwing pollen dust over the bee. The dusty insect then carries the pollen to another flower. This is not the kind of Laurel with which the Ancients crowned their brows, although it is similar.

A sticky substance exudes upon the blossoms and flower stalk. This is to hold fast the smaller insects that might loosen the stamens and scatter the pollen, without being able to carry it to another flower. It is one of the wonderful ways in which plants protect themselves.

The Laurel leaves are said to be poisonous, and there is a tradition that the Indians used them for committing suicide. The scientific name of the plant is Kalmia, and was given to it by the great botanist, Linnæus, because a man by the name of Peter Kalm first told him about the American Laurel. It is called Spoon-wood, because the Indians made eating utensils from its wood. It is sometimes called Calico-bush, because it bears a certain resemblance to that cheap, printed material.

AMERICAN RHODODENDRON, OR GREAT LAUREL

Heath Family

The luxuriant beauty of this shrub rivals the Mountain Laurel. It grows in the eastern states, and is found more abundantly in the Alleghany Mountains than elsewhere. It is from six to thirty-five feet high, has thick, leathery, oblong leaves, and the clustered flowers are white or pale rose, about one inch broad; they have a very small, five-clefted calyx, ten stamens, and one pistil. The five-parted corolla is somewhat bell-shaped, with a greenish throat, and the upper part is marked with yellow or reddish spots.

As in the Laurel, a sticky fluid exudes from the flower stalk, in order to protect the blossoms from the assaults of the little, useless insects. One of the greatest rewards of a mountain climb in June is to find the Rhododendron; it springs like a glory from the most inaccessible spots of the twilight woods. Sometimes we find it hanging over the edge of a great cliff, like a flurry of sun-flushed snow.

Indeed, some districts of the mountains are so overgrown with its interlacing branches as to make the woods well-nigh impassable. These jungles are called "Hells," by the mountaineers.

The nectar of the flower is said to be poisonous. Xenophon, the renowned Greek historian, relates that, during the return of his ten thousand troops, they found and ate some honey that the bees made from this nectar, and became very ill in consequence. The leaves retain their green color all winter. In some of our public gardens the plant is cultivated, and under these conditions the flower attains a width of one and a half inches.

SQUAW HUCKLEBERRY

Heath Family

THIS plant grows to a height of two or three feet, its stems are profusely branched and the flowers are greenish white or purplish, reminding one of the Blueberry or the Huckleberry. The pear-shaped berry is hardly good to eat, but the fragrant flowers are very pretty and the leaves have a dainty effect, being pale green above, with a whitish under surface.

LABRADOR TEA

Heath Family

THIS shrub grows from two to three feet high. It is found throughout Pennsylvania, but flourishes most freely in the mountains and swamps in the southern and eastern portions of that state. It is easily recognized by the woolly under surface of its leaf.

The small, white flowers cluster at the end of the stem; they have a five-petaled corolla, and a small, five-toothed calyx. There are from five to ten stamens and one pistil.

PIPSISSEWA OR PRINCE'S PINE

Heath Family

THIS fragrant flower ornaments the woods during the latter part of June and in July. It grows in sandy soil, amid decaying leaves, and is one of the last blooming of those dainty flowers which make the springtime woods so beautiful, and which are crowded out, as the season advances, by hardier flowers; consequently, as we observe the frosty pink flower and inhale its delicious fragrance, our pleasure is mingled with regret.

The stem is from four to ten inches high, the glossy leaves are olive green, and somewhat lance shaped, with sharply-toothed edges; they retain their color all winter. The flowers grow in a loose cluster at the end of the stem; they have a corolla of five, rounded spreading petals, and a five-lobed calyx. There are ten stamens, and one pistil. In the White Mountains there is a variety of this plant with white-spotted leaves.

THE SHIN=LEAF

Heath Family

This is a beautiful plant with an ugly name. It is so called because our forefathers used its leaves for healing bruises and cuts, and a leaf, or plaster, for healing bruises, no matter on what part of the body, was called a Shinplaster. Its Latin name is *Pyrola elliptica*. Salmon, the herbist, says the Romans called it *Pyrola*, because they thought the flowers and leaves resembled those of the pear tree.

The Shin-leaf grows in damp, shadowy, woodland dells, and is a fragrant companion of the *Pipsissewa*. It has a scaly, upright stem, and the thin, dull green, somewhat ovate, leaves are clustered around the root. At first sight the nodding white flowers remind us of the Lily of the Valley. The corolla is divided into five, rounded, concave petals; the calyx is five-cleft, there are ten stamens, and one pistil.

WINTERGREEN — CHECKERBERRY — MOUNTAIN=TEA

Heath Family

It is a great pleasure in the hot month of July to penetrate a shady dell, and find the Wintergreen blossoms. They look like flakes of snow, but lately fallen upon the glossy green leaves. The slender stem is from three to six inches high. The flowers grow from the axils of the leaves, and have a five-lobed calyx, and a corolla of five small teeth. There are ten stamens and one pistil.

The young leaves, having a pleasant aromatic flavor, are often used for making tea. Later in the season, the flowers give place to savory, bright red berries, that are eaten by the birds and deer. These berries hang upon the stem all winter, and the plant, with its evergreen leaves and ruddy fruit, is one of the welcome sights of an early spring ramble.

JACK=IN=THE=PULPIT—INDIAN TURNIP

THIS picturesque flower makes its appearance in May. The spathe, or "pulpit," in which Jack stands, is sometimes pale green, with whitish stripes; sometimes stained with purple. These purple stains give the plant its scientific name, *Arisæma*, which means *Bloody Arum*. There is a legend that says this flower was present at the Crucifixion:—

> "Beneath the cross it grew;
> And in the vase-like hollow of the leaf,
> Catching from that dread shower of agony
> A few mysterious drops, transmitted thus
> Unto the groves and hills their healing stains,
> A heritage, for storm or vernal shower
> Never to blow away."

It is called Indian Turnip, because its bulb-like base was used as food by the Indians. They first cooked it, thus destroying its sharp, stinging taste. The plant is a great favorite with children, who are delighted to find its striped pulpit, hidden by the shelter of six bright green leaves. Later in the season, a cluster of brilliant, scarlet berries appears. Jack is also a cousin of the Calla Lily, but a more acceptable one than the Skunk Cabbage.

SKUNK CABBAGE

Arum Family

THIS plant occupies a distinguished position, being the first to flower of the year. This fact will surprise those who have given that honor to the Trailing Arbutus, the Anemone, or the Violet. The Skunk Cabbage begins to push up from the swamps in February, and one would never imagine that it contained a flower, for it looks like a snail rising above the mud. Besides, it gives forth a disagreeable odor, that is very well in keeping with its name.

These peculiar plants are composed of a purple, mottled spathe. Within this spathe, the little flowers nestle as within a hood, and are thus protected from the cold, biting winds. Later in the season, these spathes are a favorite resort for bugs, spiders, beetles, flies and honey bees, and one can hear them buzzing, and having a merry time within. Just why they are attracted to such a malodorous place, it is hard to tell. It is especially surprising, that the honey bees can leave the beautiful scented flowers, and enter the Skunk Cabbage House.

About June, when the pistils have been dusted with pollen, the spathes wither away, and the plant puts forth clusters of bright, green leaves. It is amazing to learn that the Skunk Cabbage is a near relative of the Calla Lily. The spathe of the former corresponds with the snowy petal-like leaf of the latter. Fine plants, like fine people, sometimes have very disagreeable relations.

COMMON ST. JOHN'S-WORT

St. John's-wort Family

THIS plant is greatly disliked by farmers, because its rank, rapid growth impoverishes the soil. Once it gains a foothold, it is hard to extirpate. It is a much-branched plant, and reaches a height of two feet. The small, oblong leaves are opposite, and are marked with pellucid spots. The numerous yellow flowers grow in clusters, and have a calyx of five sepals, and a corolla of five bright, yellow petals, that are dotted with black. There is one pistil, and numerous stamens. Many are the superstitions that have gathered around this plant.

It is called St. John's-wort, because it was thought that the dew which formed on the flower the evening before St. John's day, would cure sore eyes. In the course of time it was accepted as a remedy for many afflictions. In early times, an ointment was made from the flowers. One of its names was "Balm of the Warrior's Wound."

COMMON MULLEIN

Figwort Family

THIS plant, which makes the pasture lands so picturesque, is not a native of this country, although in England it is called "American Velvet Plant." It is a native of the Isle of Thapsus. The Mullein, so familiar and common to us, played a prominent part in classical times. It was called "Candelaria" by the Romans, who dipped the long dried stems in fat, and used them for funeral torches. The Greeks utilized the dried leaves for lamp wicks. In recent times, Mullein tea is often used for pulmonary diseases. From its efficacy in curing cattle, it is often called "Bullock's Lungwort."

The Mullein is a rugged plant, growing to a height of three or five feet. The leaves are oblong and woolly, and the flowers are clustered in a long, dense spike; they have a five-parted calyx and a yellow corolla, divided into five rounded lobes. There is one pistil

and ten stamens. During the first year, the Mullein bears only its woolly rosette of leaves; not until the middle of the second summer does it bring forth its yellow flowers; but the leaves are very dainty when they first appear, being pale green, and soft as velvet.

JEWEL=WEED—TOUCH=ME=NOT

Geranium Family

THIS beautiful plant, of which there are two varieties, is found fringing the woodland rills, and making glad the damp, shady spots. The Pale Jewel-weed abounds in the North, and has pale yellow flowers, spotted with reddish brown. The Spotted Jewel-weed is common in the South, and has orange-yellow flowers, likewise spotted with reddish brown.

The plants grow from two to six feet high, and have alternate, coarsely-toothed, oval leaves, from the axils of which grow the nodding, loosely-clustered flowers. The calyx and corolla, being of the same color, are hard to distinguish; they are divided into six parts. Five short stamens are united over one pistil. The plant is called "Touch-me-not" because, when the seed pods are touched, they spring open with such force as to violently scatter the seeds. This is one of nature's tricks of dispersing seed. The flower is closely related to the Garden Balsam, and, although so gaudy, is scentless.

HERB ROBERT

Geranium Family

THE small, purple-pink flower of the Herb Robert is found, from June till October, in woods and shaded ravines. It has a forked, hairy stem, and three divided leaves, that are again dissected. It has a five-sepaled calyx, and a five-petaled corolla, ten stamens, and one pistil. The ripened seed-pods split open, sometimes projecting the seed a distance of twenty-five feet.

The stem being ruddy, the plant, on that account, is called "Redshanks" in the Scotch highlands. A resinous secretion, such as is common with several varieties of geranium, gives it a strong odor. This secretion is sometimes so abundant that the stalks can be burned like torches.

The name Herb Robert is derived from the fact that the plant was used as a cure for "Robert's Plague," during the time of Robert, Duke of Normandy.

EVENING PRIMROSE

Evening Primrose Family

PERHAPS you have noticed during the heated summer days, a rank-growing flower by the roadside; you pass it by with a glance, for its flowers are pale and withered. If, however, you were to see it after sundown, you would give it more attention, for then the pale yellow flowers are fresh and beautiful, and give forth a delicious perfume. This is the Evening Primrose (*Onagra biennis*), which blooms at night because its flowers cannot endure the heat of the day. But notice how well it is fitted to thrive in the darkness: the flowers are fragrant and yellow, so that they can easily be detected by the pink night-moth, that carries away the pollen. On cloudy days, its blossoms are fresher looking, and, at the end of the summer, it blooms during the day, because the sun rays are not so hot.

Its stout stem averages about three feet in height, and the lance-shaped leaves are alternate. The flowers grow in a leafy spike. The calyx is a long, four-lobed tube, and the corolla is composed of four, somewhat heart-shaped petals. There are eight stamens, and one pistil.

FIREWEED—GREAT WILLOW HERB

Evening Primrose Family

THE chief peculiarity of this plant is that it grows to best advantage on burnt-over ground. Where fire has devastated the woods, the Fireweed springs up, in great abundance, as if anxious to hide the black waste with color.

Its lance-shaped leaves are scattered, and willow-like. The large purple-pink flowers grow in a long raceme at the upper part of the stem. The calyx is four-cleft, and the corolla four-parted. There are eight stamens, and one pistil. The flower gives place to a seed vessel that contains silky-tufted seeds. There is a great similarity between the blossoms of this plant and those of the Evening Primrose.

YELLOW LOOSESTRIFE

Primrose Family

DURING the summer, the golden stars of the Loosestrife shine in the marshes and damp woodlands. They have a dainty appearance, and are related to the little frosty star flowers that delighted us in the early spring days.

The plant ranges from one to two feet in height, and has opposite, lance-shaped leaves. The small, yellow flowers grow in a long cluster at the termination of the stem; they have a five or six-parted corolla, a five or six-cleft calyx, four or five stamens, and one pistil. There is another variety of Loosestrife, in which the leaves are whorled in groups of four, at intervals along the stem, and the flowers, instead of growing in a loose cluster at the end of the stem are scattered along its full length.

STAR-FLOWER

Primrose Family

HERE is another flower, which gives us pleasure. It is somewhat similar to the Anemone, with a smooth stem and pointed leaves, whorled at the end of the stem. The flowers have a calyx of seven sepals, and a corolla of seven petals. They are star shaped, white and delicate, with one pistil, and four or five stamens. As the shafts of sunlight fall upon these starry flowers, they gleam like bits of frost against their dark green leaves.

PITCHER-PLANT — SIDE-SADDLE FLOWER — HUNTSMAN'S CUP

Pitcher-plant Family

THIS is one of the most remarkable of plants. Its leaves are pitcher shaped, and hold water; they are lined, near the mouth, with a sweet substance; below this there are hairs, pointing downward. Insects lured by the sweet are trapped by these hairs, and, not being able to return, are drowned. Their bodies dissolve in the water, and make a nutritious juice on which the leaves feed.

The plant is very beautiful; its broadly-hooded, winged leaves are of a rich, striped yellow, or deep-red color. The flowers are also very striking, being red, pink, or green; they have the scent of

sandal-wood. The calyx has five colored sepals, and the corolla has five petals which arch over the greenish yellow style. There are numerous stamens, and one pistil. The Pitcher Plant blooms in June, and inhabits shadowy bogs.

DOG VIOLET

Violet Family

FROM May until July this dainty little flower is found in the low, damp grounds. Its leafy stem is from three to eight inches high. The leaves are heart shaped.

TWIN-FLOWER

Honeysuckle Family

THIS is one of the most exquisite of the wild flowers. Its nodding pink petals give a flush to the cool, mossy woods of June, and its delicate fragrance is quite in harmony with its color. The stem is slender and trailing, with rounded, evergreen leaves, and the dainty flowers grow in pairs, on thread-like, flower stalks. The calyx is five-toothed, and the bell-shaped corolla is five-lobed. There are four stamens, and one pistil.

No flower has ever received a greater compliment: it was the favorite flower of Linnæus, the great botanist. There is a portrait of him that shows him wearing one of the blossoms as a *boutonnière*.

WOOD ANEMONE OR WINDFLOWER

Crowfoot Family

THIS is another exquisite flower of early spring. It has a slender stem with delicate leaflets. Its solitary flower, purple, pink or white, has a calyx of four, or seven, sepals, and has numerous stamens and pistils. One of the joys of the springtime is to walk through a wood where the Anemone grows. The flower quivers with delight beneath the breath of the gentle winds. Bryant, speaking of these flowers, said: —

> « . . . within the woods,
> Whose young and half-transparent leaves scarce cast
> A shade, gay circles of Anemones
> Dance on their stalks. »

The word Anemone means wind-flower. Pliny tells us the ancients called it by that name, because it opened at the touch of the wind. A Greek legend says that the Anemone sprang from the tears that Venus shed over the body of her beloved Adonis. Surely this flower is beautiful enough to justify such legends.

WHITE BANEBERRY

Crowfoot Family

This plant grows in the damp, shady spots of the woods, and, in May, is noticeable, on account of its feathery, white flowers. It is about two feet high, with leaves that are divided into two or three sharp-toothed leaflets. The small, white flowers are gathered in a thick bunch at the end of the stem, and have a calyx of five small sepals, that fall off when the flower opens. The corolla is composed of from four to ten flat petals. There are numerous stamens, and one pistil.

The White Baneberry becomes more attractive in the late summer; then the flowers disappear, and are replaced by a bunch of waxy, white berries. These berries are marked with purple-black spots, and are supported by a thick stem, that turns red as the berries ripen.

In penetrating the dark woods, it gives one a pleasant sensation to find this glow of color. The White Baneberry is common in the White Mountains. The Red Baneberry grows farther north, and blossoms somewhat earlier; its berries are red and grow upon a slender stalk.

MARSH MARIGOLD

Crowfoot Family

This is one of the early spring flowers, and a sight of the golden petals is like a thrill of sweet song, for we know that the ice-winds have gone, and the happy spring days have come, with their rainbow hues, and subtle fragrance. The Marsh Marigold has a hollow, furrowed stem, with rounded, somewhat kidney-shaped leaves. The golden blossoms have a calyx of from four to nine petal-like sepals, five to ten pistils and numerous stamens

It is thought that Shakespeare referred to this flower in "Cymbeline" where he says: —

"Hark, hark! the lark at heaven's gate sings,
And Phœbus 'gins arise,
His steeds to water at those springs,
On chaliced flowers that lies;
And winking Mary-buds begin
To ope their golden eyes;
With everything that pretty is—
My lady sweet arise!
Arise, arise!"

It is very probable that the "Mary-buds" are the same as the Marsh Marigolds, because, along certain English rivers, the latter are abundant. Indeed, one observer says that when the rivers overflow their banks, the ground is so covered with these flowers, that it seems to be paved with gold.

COMMON MEADOW=SWEET

Rose Family

The Meadow-sweet is not so common as its name might imply; in some regions it is plentiful, in others it is rather scarce. Neither is it fragrant, and this is a great disappointment, because the feathery, plume-like flowers are very pretty, with their flash of pinkish white.

We find it growing in the low meadow-lands, or fringing the river banks. It attains a height of two or three feet. The stem is nearly smooth, and the broad-toothed leaves are lance-shaped and alternate. The small flowers grow in pyramidal clusters. The corolla is composed of five rounded petals, and the calyx is five-cleft. The stamens are numerous, and there are five to eight pistils.

The name Meadow-sweet is said to be a corruption of Meadow-wort, which means "Honey-wine Herb." Hill, in his "Herbal," says that "the flower mixed with mead gives it the flavor of Greek wine."

". . . near the unfrequented wood,
By waysides searched with barren heat,
In clouded pink or softer white,
She holds the summer's generous light—
Our native meadow-sweet!"

COMMON CINQUEFOIL—FIVE-FINGER

Rose Family

DURING the summer, the yellow flowers of this plant enliven the woods and meadows, and fringe with brightness the country highways. The slender stem is sometimes erect, sometimes prostrate. Its leaf is divided into five leaflets, hence the name *Cinquefoil*, which is the French for "five leaves."

The flowers grow from the axils of the leaves. They have a five-cleft calyx, but between each two teeth of the calyx, there is a bract, making it appear ten-cleft. The corolla has five rounded petals; there are many stamens and pistils.

Many people mistake the Cinquefoil for a yellow-flowering strawberry; but there is much difference between the two. The leaf of the strawberry is divided into three leaflets, while that of the Cinquefoil is divided into five. Again, the stem of the former is hairy, while that of the latter is smooth. Besides, the yellow flowering strawberry is very rare.

YELLOW AVENS

Rose Family

THIS is another flower that adds golden light to the damp meadow lands. Later in the season, it also adds prickly burs, that cling to our clothes as we pass. The hairy stem grows from three to five feet high, and the leaves are divided into three or five leaflets. The golden yellow flower has a five-cleft calyx, and a corolla of five broad petals. There are numerous stamens and pistils.

BLUETS—QUAKER LADIES

Madder Family

THIS exquisite little flower is common both North and South, but it grows in greater profusion, and reaches the climax of its beauty in the New England states. There, in the month of May, the woods are full of the dainty, modest flowers.

It has an erect stem, three to five inches high, with small, opposite leaves. The flowers are a pale, purplish blue, though they are

sometimes white, with a golden yellow eye. They have a four-lobed calyx, and corolla. The tube of the latter is long and slender. There are four stamens, and one pistil.

Some of the flowers have long stamens and a short pistil, others have a long pistil and short stamens. Because of these two forms, they are called "Dimorphous." As a rule, in order to fertilize, the long pistils must receive pollen from the long stamens, and the short pistils must receive it from the short stamens. This flower has been successfully cultivated in gardens.

PARTRIDGE=VINE

Madder Family

THIS is another plant whose evergreen leaves and brilliant berries give us a thrill of pleasure, when the snow disappears. As we come upon it in some sheltered, hillside nook, we cannot help wondering how the mass of dainty leaves could withstand the cold winter.

It does not bloom until June; then the little twin, funnel-shaped flowers intoxicate the senses with their exquisite perfume. They are pink-tipped. The corolla is divided into four spreading lobes, and the calyx is four-toothed. There are four stamens and one pistil, and the ovary of each flower is united to that of its sister flower.

The stem is smooth and trailing, and the rounded leaves are veined with white. The bright scarlet berries, like the flowers, are double. The Partridge-vine is found in Mexico and Japan, as well as in America.

SKULL=CAP

Mint Family

DURING July and August, the Skull-cap is found lifting its blue plumes in the tall grass of the meadows and waysides. There are three varieties, of which the *Scutellaria integrifolia* is the most attractive. Its flowers are about one inch long, and grow in terminal racemes. They have a two-lipped calyx, the upper lip having a helmet-like appearance, from which the plant derives its name. The corolla is also two-lipped, the upper lip being arched, and connected with the side lobes; the lower lip is spreading, and notched at the point. There is one pistil, and four stamens in pairs.

The best-known variety is the "Mad-dog Skull-cap," (*S. lateriflora*). It was once thought to be a sure cure for hydrophobia. It abounds

in wet places, and its flowers grow in one-sided racemes. The *S. galericulata* is found in the North. Its flowers which grow from the axils of the upper leaves, are smaller than the *S. integrifolia* and larger than the *S. lateriflora.*

SELF=HEAL—HEAL=ALL

Mint Family

FROM June to October, all over the land, this little blue-purple flower decks the roadsides and the pastures. It has a low stem, with opposite oblong leaves, and the flowers grow in a spike. The calyx is two-lipped, the upper lip having three teeth, while the lower one has two clefts. The corolla is also two-lipped, the upper one arched, the lower one with three clefts. There are four stamens, and one pistil.

This plant is not only common, but it is also valuable as a medicine. The Germans thought it a sure cure for quinsy. Indeed, the scientific name of the plant, Brunella, is a corruption of the German word Prunella, which means quinsy. In England, it was often applied to the wounds of laborers. The French also knew the virtue of the flower, and this is one of their proverbs, "No one wants a surgeon, who keeps Prunella." Its honey is a great favorite with the bees, and so long as the Prunella blooms, a bee is almost always to be found with his head buried in the succulent corolla.

PURPLE FRINGED ORCHIS

Orchis Family

NATURE sometimes adorns the hidden swamp with her rarest gems. We have seen that she places the gorgeous Pitcher Plant there, and here is another beautiful flower that blooms unseen, save by a few eyes. In July we find the Purple Fringed Orchis making glad the wet places.

There are two varieties, the *Habenaria fimbriata*, and the *Habenaria psycodes.* The former has oblong or oval leaves, the upper ones are few, and pass into lance-shaped tracts. The large flowers grow in a spike and have a long, curving, fan-shaped, three-parted lip; the divisions are fringed.

The latter variety has lance-shaped leaves, the upper ones passing into a linear bract. The fragrant, purple flowers resemble the *H. fimbriata*, but are much smaller, and have a less fringed lip. They also grow in a spike. The Purple Fringed Orchis attracted the admiration of Thoreau, the eccentric New England nature lover.

THE LADY'S=SLIPPER

Orchis Family

You will find the beautiful wild Lady's-slipper blooming in the latter part of May, and you cannot mistake it, for its peculiarly shaped blossom is sure evidence. The Indians called it the "Moccasin Flower," and in the French it is "The Virgin's Sabot," or slipper. Our English forefathers called it "Our Lady's Slipper," which came to be the common name for the flower. One sort is yellow, and another is rosy purple, mingled with white. Both are so showy and lovely that the lucky finder can hardly resist the temptation to pluck them, and thus they grow rarer every year.

The Lady's-slipper belongs to the Orchids, that royal family which the botanists tell us is the most highly organized of all plants. It is a large family and widely distributed in both hemispheres. The Lady's slipper is generally a single flower, which hangs from a long, leafy stem. It has three sepals, of which the upper is the largest. The formation and arrangement of these with the petals, the stamens and stigma, give it the resemblance to a slipper.

Its method of securing fertilization is different from that of other Orchids. There are two stamens, and the pollen is powdery, and not very different from that of ordinary flowers. The stigma is large, flat, and shaped something like a trowel, with the face turned downward. It is supported on a stout style, to which the anthers have grown fast, one on each side. This apparatus grows just within the upper part of the Slipper. You will notice three openings into the Slipper. The one in front is large and round, and the edges are turned in, after the fashion of some kinds of mouse-trap. The other two openings are small and far back, and directly under each other. Flies and like insects enter by the large opening in front, and find a little nectar bedewing the long hairs that grow from the bottom of the Slipper. The mouse-trap arrangement makes it difficult for the fly to get out by the way it came in, and as it pushes on under the stigma, it sees light beyond on either side. Thus, in escaping by either one or the other of these small openings, it is sure to get some of the pollen on its head.

Flying to the next blossom and entering as before, the fly cannot fail to rub the pollen-covered top of his head against the large stigma which forms the roof of the passage. When he passes out, he takes on his head a fresh load of pollen with which he may fertilize another flower.

The early flowering and purple stemless Lady's-slipper differs from the others in that its larger slipper has a long, narrow opening in front, instead of a round one. Although the two lips of the slit almost meet, the fly readily pushes his way in. The way of exit, however, is more open than in the other species.

LADIES' TRESSES

Orchis Family

This plant, with its slender spike of fragrant white flowers, decks the damp lowlands toward the end of summer; it is, however, sometimes found on higher ground. The lance-shaped leaves are long at the lower part of the stem, but above they are shorter and cling close to the flower-cluster, as in all orchids. The lips of the flower are wavy and crisped.

This plant is closely related to the pink and the yellow moccasin flowers. It gains its name from the peculiar way in which the flowers twine about the stem. In New England it is sometimes called "White Hyacinth."

HAREBELL

Campanula Family

Among the wild flowers, the Harebell is second to none in delicate charm. Its dainty bright blue or purple bells, nodding on their hair-like stems, are a sight to make the heart leap with joy. The plant is exceeding fragile and ethereal looking; yet it is one of the hardiest flowers, for it survives the strongest mountain winds. It blooms from early June till late in September, and is found in the meadows as well as on the mountain cliffs.

It is identical with the rugged Bluebell of Scotland. It has a slender, branching stem, five to twelve inches high, with ovate root leaves. These, however, are not so hardy as the flowers and die early. Its numerous stem leaves are long and narrow. It has a five-cleft calyx and a bell-shaped, five-lobed corolla, five stamens, and one pistil.

FRINGED GENTIAN

Gentian Family

In late September and October, the Fringed Gentian makes its appearance. One feels as though Nature had reserved her most joyous surprise for the end of the season. It was a favorite flower of Bryant, who says: —

"Thou blossom, bright with autumn dew,
And colored with the heaven's own blue,
That openest when the quiet light
Succeeds the keen and frosty night;

"Thou waitest late, and com'st alone,
When woods are bare and birds are flown,
And frosts and shortening days portend
The aged Year is near his end.

"Then doth thy sweet and quiet eye
Look through its fringes to the sky,
Blue — blue — as if that sky let fall
A flower from its cerulean wall."

One is not likely to find this flower in the same spot two successive seasons; it dies after blooming and the seeds are washed away and fall in other places.

Its stem is one to two feet high, with opposite, lance-shaped leaves. It has large, blue flowers, with a four-cleft calyx of unequal lobes, and a funnel-shaped corolla, with four fringed, spreading lobes. There are four stamens and one pistil.

The flower bells are about two inches long; they close at night and on cloudy days, but when the sun shines, they quickly open. Surely their color rivals the blue of the sky.

THE IRIS

Iris Family

Midsummer in New England finds the Blue Flag, or Wild Iris, revealing its splendors on the edge of sunny waters or in low, moist fields. This is the famed lily of France, the *Fleur-de-Lis*, *Lis* being a corruption of Louis, the king who first adopted it as his badge. Its favorite haunts are concisely pictured in the first verse of a beautiful poem by Longfellow: —

"Beautiful lily, dwelling by still rivers,
Or solitary mere,
Or where the sluggish meadow brook delivers
Its waters to the weir."

The family name, Iris, is the Greek word for rainbow. It belongs to the same family as the Crocus and the Gladiolus, whose sword-shaped leaves are so placed that one seems to ride on the back of another. The species of Iris are numerous and are chiefly natives of the temperate zone. The flower of the common variety, in the British Islands, is yellow and we have some yellow varieties in this country, but our common sorts are in various shades of purple and lilac. There are three erect petals and three backward-curving sepals. The latter are adorned with a delicate tracery in dark purple and gold, the real beauties of which cannot be seen with the naked eye. The bees and marsh flies are attracted by it and carry the pollen from flower to flower. A most complex and wonderful structure enables the Iris to attract bees and larger insects, and to repel crawlers. The three spreading stigmas resemble corolla leaves, and are slightly bent backward. Under each is an anther, which is protected beneath the concave surface from the entrance of a crawler or a drop of rain.

The Iris is one of those thrifty plants which owe their splendors to the industry and economy of last year's roots. In the spring, when they begin to prepare their pretty new dresses, they are already in possession of material ready for use. Thus, they can make their appearance in dainty costumes very early, in some localities as early as March.

After the Iris has shown its rich colors for a time, it withdraws into its green sheathing again, and looks like a bud. The seeds are carried far and wide, but they perish unless they fall near the water. If you notice when a pond is made near the meadow, or the surface of the land is changed, so that there is a wet spot somewhere, it will not be many seasons before the new body of water is surrounded by the Iris and other plants that delight to keep their feet wet. The seeds of these plants were doubtless dropped into the meadow just the same when the ground was dry and unfit to nourish them. But they must have perished, as countless thousands of wandering seeds do every year.

Some varieties have been improved by the florists and are very beautiful. The Persian Iris is delightfully fragrant. Much attention is given to the production of new species in Holland, in which country much business is done in growing and exporting roots of various kinds.

BLOODROOT

Poppy Family

THIS is one of the most beautiful wild flowers of the year. It grows in early April, among the hillside rocks and along the borders of the woods. Its leaves are round and deeply lobed, and the flower has eight or twelve snow-white petals about a center of gold. It has one pistil and about twenty-four stamens, and the calyx is divided into two sepals.

This early visitor is apt to come and go without being seen, unless closely watched. One or two warm, sunny days bring the stem from its hiding-place, and open the exquisite flower; in a short time the strong, spring winds blow over it, scattering its petals like snow-flakes. It derives its name from the blood-red juice in the stem. This red fluid was used by the Indians to paint their faces and color their weapons.

THE POPPY

Poppy Family

THE brilliant Poppy of our gardens belongs to the same family as the Poppy which yields opium. This family of plants is distinguished by a single blossom growing on a long stalk, a large pod containing numerous seeds and a milky juice. There are several well-marked species in each branch of the family. The most common species in this country are the Corn Poppy and the Long-leaved Poppy. In both of these, the stems are long and slender and reach upward about two feet. The tints of the flowers are usually shades of red, though they are sometimes variegated. Under cultivation, beautiful double blossoms may be produced. White and purple are also seen, and the wild California Poppy is yellow or orange color.

The word Poppy is a corruption of the word "papa," which, though the same in form, is not the same in meaning as the word which the child applies to his father, and which is derived from a Greek word. The "papa" from which the word Poppy sprang is a Celtic term, applied to a soft food, which the Celts fed to their infants. The seeds of the Poppy were boiled into a pap, to induce sleep in the child, and so the plant came to be called the "papa" and then the Poppy. This is a good illustration of the odd way in which some of our words have come down to us. While the seeds of this European Poppy are slightly narcotic, they do not contain the active qualities peculiar to opium.

Opium is the juice of a species of Poppy which especially flourishes in Asia, where it is very extensively cultivated. The plants are sown so as to stand about a foot apart. When the capsules or pods which contain the seeds, are nearly full grown, men pass through the fields in the evening, and cut little gashes in every pod. This is done with great care, and with knives so made that the cut does not sink below the skin of the pod. The milky liquid oozes out the following morning, and is removed by long spoons and collected in earthen dishes. From these it is poured into shallow platters or trays, which are tilted, so as to allow the water to drain off. The remainder is then evaporated, and continually turned until hard enough to be kneaded into balls, which are placed upon slates in large rooms to dry. Here they are tended and turned by boys, till they are dry enough to pack.

As a medicine, opium is very useful in relieving pain, but when it is indulged in to excess, it enfeebles the mind and weakens the body, and ultimately makes a miserable wreck of the user.

In cultivating the Poppy, the seeds are often sown during autumn in places where severe frosts are not to be feared; but in our Northern climate it must be sown in the spring. Poppies have an interesting way of sowing their own seed. On the under side of the pods are small holes and when the wind blows, seeds are shaken out of these little holes, just as you would shake pepper out of a pepper-box.

PHILADELPHIA FLEABANE

Composite Family

DURING July and August, this plant, with its yellow and pink, gives a dash of color to the moist lands. The highest leaves are smooth, oblong and heart-shaped at the base; the lowest ones are wedge and tooth-shaped. The flower heads have numerous pink ray flowers and a center of yellow disk flowers.

THE CINERARIA

Composite Family

CINERARIA is the name given to a genus of plants belonging to the natural order *Compositæ*. Under it is included a variety of herbs or small shrubs, having minute flower heads, usually of a bright yellow. But there are numerous variations, and in different climates one may find species having white, flame-colored, purple or

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CINERARIA.
Life-size.

HYACINTH.
Life-size.

red flowers. While it flourishes in many countries, it is most abundant in South Africa and along the shores of the Mediterranean. The class common in southern Europe is especially delicate and pretty, having silvery, finely-cut, downy tomentose foliage, and small, yellow flowers.

The name Cineraria is derived from the Latin word *cineres* (ashes, allied to the word cinder) and refers to the gray, ash-like down that covers the surface of the plant's leaves. The blossoms are formed of minute florets, congregated upon a single receptacle and surrounded by a leafy or scaly wrapper, called an involucre.

In our own country, the name Cineraria is applied to an early spring flower that is grown in most greenhouses. This came originally from Teneriffe, in the Canary Islands, but the flower, as we know it to-day, is the product of cultivation. It is popular as a decorative plant, its delicate form and color combining admirably with flowers of larger growth and more brilliant hues. It may be reproduced either by the propagation of offsets or by sowing its seeds. The former method is preferred.

When the Cineraria has finished blooming, the old flower stems should be cut down and placed in pots out of doors. As soon as the offsets are an inch or two above the earth they should — without injury to the roots — be cut off with a sharp knife, planted in small pots and placed in a cold frame. Here they must remain for a fortnight, well shaded from light, and, at the end of that time, be changed to larger pots. This must be done very gently, for the young leaves are brittle and tender.

The great difficulty in the cultivation of the Cineraria comes from the pests that so frequently attack it. The commonest of these are the green fly and the red spider, and they must be dealt with as soon as they appear. The former may be killed with tobacco smoke, and the latter is best destroyed by dusting the hairs of the plant with powdered sulphur. The plant is so very sensitive, that it is necessary to use extreme care in the treatment of it.

THE ASTER

Composite Family

THE Aster well illustrates some of the peculiar characteristics of the Composite family. The center is an assemblage of hundreds of little trumpet-shaped flowers, set as closely together as possible. In the ring around the outside are the ray flowers, but, while they each have a pistil, they have no stamens. If you look into one

of the little central flowers, you will see something like a bud, but it is really a ring of stamens with their heads together. Under these is the pollen. After a time the pistil, which likes sunshine and air, breaks through the stamens and drives the pollen with it. Then if a fly chance to alight close by, he receives a sprinkling of the pollen which he may carry to some other plant of the species.

This colony of two different kinds of flowers, which really make one, puts into practice the principles of a division of labor without which no society can thrive. The outer flowers attract attention, or do the advertising for the colony, by their conspicuous corollas. Their more quietly dressed sisters in the center furnish the pollen, without which no Asters would be produced.

But the Aster, because of its natural beauties and variations in color, has been extensively cultivated and it is possible by cultivation to develop the inconspicuous little flowers in the center into strap-shaped ray flowers like those which form the border. In this way double Asters are produced. This cannot be done all at once, and in our double Asters there still remain at the center some few disk flowers. By the pollen from these some seeds can be secured, but when the flowers shall have been so developed that none of the disk flowers remain, the plant will have to be propagated by cuttings.

There is a large number of species, but one of the most common native ones in cultivation is the New England Aster. The best known and the most valued of all is the China Aster, a summer species of which many varieties are grown, and others are being constantly introduced. This was brought from China in the early part of the eighteenth century. The plant delights in a rich, free soil. The seeds are generally sown in April in a hotbed, and the young plants transplanted in May. They flower from July till frost, and contribute much to the beauties of the flower garden. The native wild varieties have various colors and are in their full beauty in September.

"Bold are its footsteps in loneliest places,
Scaling the steep crag and climbing the height;
Blossoming over with fairest young faces,
Up to the woodlands and far out of sight.

"Light is its tread on the broad gracious meadow,
Fringing the hedge-rows with purple and gold;
Clustering softly in stillness and shadow,
Freely and freshly its fringes unfold."

THE DANDELION

Composite Family

Go out beneath the twinkling stars, on a clear night in early May, when the frogs are piping their sleepy yet hopeful song from the swampy pastures; then look forth upon the broad green fields at morn, when the sky bends over a verdant earth, dotted with the simplest and most cheerful of flowers. Then you can understand the full meaning of the poet Longfellow, when he said: —

"Wondrous truths, and manifold as wondrous
God has written in those stars above,
But not less in the bright flowers under us
Stands the revelation of his love.

"Bright and glorious is that revelation
Written all over this great world of ours,
Making evident our own creation
In the stars of earth, these golden flowers."

And surely he meant the Dandelion, for what flower is more brightly, purely "golden"? Lowell calls it,—

"Dear common flower that grow'st beside the way,
Fringing the dusty road with harmless gold,—"

and we are convinced that if the Dandelion were rare, it would be one of the most sought after and treasured of blossoms, for its intrinsic brightness and beauty. How delightful, however, that it is free to all, and, like the grass, "goes creeping, creeping everywhere," at home, in Asia, Europe and America,—indeed in all the temperate climes!

Though it seems a simple flower, on account of its humble, hardy ways, it is not simple to the amateur botanist, for the ordinary parts of a flower, such as petals and stamens, are hard to discover. We must first of all conclude it is a composite flower, for, looking closely, we see multitudes of fine, irregular florets. A magnifying glass will show them to be peculiar strap-shaped cups, with long curling anthers. These florets are planted in a round, light green knob, or receptacle, similar to that of the Daisy or Sunflower. The green involucre consists of long spikes reflexed, until the florets turn to arrows of down and fly away. The fruit is a little brown seed at the base of the downy particles.

It is properly a stemless plant, since the leaves grow directly from the ground, though the flower has a long, hollow stalk which affords

great amusement to the little ones, who are always delighted with the playthings furnished by Mother Nature. How they puff out their round cheeks to blow these stout little trumpets; how they enjoy turning back the ends of the tube, in segments which curl tightly, until a whole bunch of curls hangs from the pretty pale green stems! How they make rings by inserting the smaller end of the long, hollow stem in the larger end, slipping the next stem through the first ring, before bending it, thus forming links to a chain of any desired length, or, by fastening the last ring through the first one, forming a large ring made of smaller rings!

The reason for the name Dandelion (from *dent de lion*) lies in the odd notches in the leaves, which were compared to lions' teeth. The plant is valued for greens in this country, and in France it is raised and cultivated by the acre for that purpose, being harvested like spinach. The roots are said to be good for medicine, called as a drug, Taraxacum, having bitter, tonic properties. The flower has been found to be a natural barometer, as it closes at the approach of stormy weather. It has also been called the Shepherd's Clock, since it opens and closes at fixed hours. There is more of romance attaching to the rose, and the lily is more exquisite in its beauty, but for a hardy, cheerful bloom, typical of life in the temperate climes, we turn to the bright-faced, cosmopolitan Dandelion.

BONESET—THOROUGHWORT

Composite Family

THIS plant probably needs no introduction, especially to those who live in the country, or in small cities or towns. It is one of those plants whose medicinal properties compensate for its lack of beauty. Many children shake at the very name of it, because when they catch cold, they are compelled to drink copious draughts of the bitter Boneset tea; they consider it an added penalty of sickness.

It is usually a good medicine for malaria, and the "Break-bone" fever of the South. From the latter disease it undoubtedly acquired its name. The virtues of this plant were discovered by the Indians, who had a great knowledge of the medicinal properties of plants. It grows in the low meadow-lands, and reaches a height of four feet. It is easily recognized by its wide, lance-shaped leaves, that grow opposite, and unite at the base around the stem.

The small clustered flowers are dull white and composed of tubular blossoms. In the autumn one often sees the Boneset being gathered by boys, who carry great arm-loads home, where it is stored in the garret for the winter's use.

THE GOLDEN ROD

Composite Family

GO WHERE you will, from Maine to California, in August or September, and you will see the Golden Rod waving its plumes from the roadside, banks, and field borders. It blooms later in the season than most other flowers, and thus it is of great advantage to the bees, which, as one writer has said, "have their calendar." Their calendar, in truth, begins in the spring with the Pussy Willows and Crocuses, goes on with the Hyacinths, Columbine, Apple blossoms, Clover, and Thistles, and ends in the splendors of the Golden Rod and Aster.

The bees must have a succession of flowers all the year round, except in midwinter, or they never could get on at all. On the other hand, the flowers themselves each need a time when they can depend upon receiving their full share of attention from insects, or they might never set their seed at all. Thus are all the objects of nature adapted to the needs of one another.

The Golden Rod reaches its glory with the Asters and the Chrysanthemums, and all three belong to the remarkable Composite family. But while the Aster and Chrysanthemum are more pleasing in their cultivated forms, the Golden Rod revels in its natural, wild beauty. It lingers even into the golden days of October, and maintains its splendors till Jack Frost touches it with his icy fingers. Though closely allied to the Aster, the Golden Rod is distinguished by the single-rowed pappus and a tapering, rather than a compressed, fruit.

The species, while native in all temperate climes, are most numerous in North America. At least seventy-five different species are found in the United States, and because of the abundance, wide distribution, and showy qualities of the plant, many botanists and lovers of flowers have claimed for the Golden Rod the right to be called our national flower.

The plant thrives best in a rich soil, but like others in this vigorous Composite family, it makes the most of whatever opportunity it has and refuses to die, even when the soil is poor and dry. Its appearance, however, greatly varies with the soils in which it grows. On the dry hills, the plants are dwarfed and scattered, and the blossoms small, but when they line the outside of a garden wall they wave their heads gayly over the barrier, and their hungry roots reach underneath for the fertilizers on the other side. They delight to grow in clumps by the roadside, and they also thrive near rotting logs or rails.

There are fewer varieties of this interesting plant in Europe than in this country, and none of them claim so prominent a place in the autumn fields. One peculiar variety has cream-colored or nearly white flowers. The leaves of another kind when crushed have an odor something like anise and have been used as a substitute for tea.

THE HYACINTH

Lily Family

Among the earliest flowers to bloom in the spring are the Hyacinths. They belong to the Lily family and in their native soil are found, in the month of May, along the river banks and on the moist meadow land, where clusters of fragrant, bell-shaped flowers fill the air with rich perfume. The Hyacinth is a bulbous plant, and grows in water as well as in the moist soil, if properly cared for. It is not a constant flowerer, but continues to add to its bulbs, after the blossoms have fallen off, so that each season one plant produces several more. These bulbs, if kept in a dry place, retain their life, and when planted in pots or boxes, where they can be kept from the light until the delicate roots have had a chance to become strong, the tender leaves, which form a protection for the blossom, are full grown before the flower appears.

The Hyacinth has a six-parted perianth, of which three must be calyx and three corolla. It has six stamens and a single pistil. In the Wild Hyacinth, the six parts of the flower draw closely together and form a deep cup, which is partly filled with a nectar much appreciated by bees and other insects that live on the sweets produced in flowers. The Wild Hyacinth is generally blue or purple in color. Those which are cultivated are in delicate shades of pink, blue and white. Cultivation has resulted in an enlargement of the blossoms, the leaves of which have become double and curl gracefully like the petals of a rose.

In Haarlem, Holland, the cultivation of the Hyacinth is carried on extensively, and very beautiful, rare plants have been developed. There is found in them a great diversity of color, and the flowers are almost overpowering in the sweetness of their fragrance.

The Oriental Hyacinth, which is much prized by florists, is a native of Syria and Persia, but it has been naturalized in some of the countries of Southern Europe. It has broad leaves, inclosing a large cluster of flowers which point in all directions, and present a striking appearance.

GOLDEN ROD.
4/5 Life-size.

LILY OF THE VALLEY
Life-size.

LARGE WHITE TRILLIUM

Lily Family

THE remarkably beautiful flowers of this plant are set above a whorl of rich green leaves. They are large and white, with sometimes a tinge of green, sometimes a flush of pink, and are composed of three long, pointed petals, and a calyx of three spreading sepals. They have six stamens and one pistil. They also bear fruit,—a large, dark, purple berry. One finds these gleaming white flowers nestling in the edges of the woods, or hanging like stars above the banks of the rushing streams.

There are two other varieties—the Painted and the Nodding Trillium. The former is found in the Catskill and the Adirondack Mountains. The flower is smaller than the Great White Trillium, but it is none the less beautiful, for it is marked with fiery stripes.

The Nodding Trillium has small pink or white flowers that are sometimes entirely concealed beneath the leaves. Its delicate fragrance is one of the delights of the budding woods.

THE LILY OF THE VALLEY

Lily Family

THE Lily Family is not so much noted for its size as for the wide differences between many of its members. It includes about sixteen hundred species, which inhabit chiefly the temperate and warmer regions of the globe. Among them you find not simply such pleasing and widely cultivated plants as the Tulip, the Hyacinth, and the Lily of the Valley, but such medicinal plants as the Aloe and the Sarsaparilla, and such vegetables as the Onion and the Asparagus. You might think these differed enough to make them distinct families, but in all of them the regularity and fixed plan of the flower is constant, and it is so characteristic that we have no doubt that the Onion and the Tuberose are relatives, despite their difference of odor.

The perfect flower has six petals, and the stamens are always six, opposite the clefts of the perianth. Whether they grow singly or in spikes, these features are the same. The roots are either bulbs or tubers, the fruit capsular in shape, and the leaves simple and entire.

The Lily of the Valley belongs to a branch of the family which puts out its bell-shaped flowers in clusters. The flowers are white and have the six clefts characteristic of the family. The common species grow in bushy places and in woods throughout Europe and North America. It prefers a damp soil but does not thrive in water.

You will notice one peculiarity in the flowers, and that is their drooping attitude. This is a device which some flowers of this family have to shelter their honey from the wet, and especially to protect it from certain insects, like ants. Many plants protect their honey from ants by a little bunch of hairs. The pansy and the violet, for instance, while they have smooth stalks that are easily climbed, place a tuft of silky hairs just in the throat of the flower and directly on the road to the honey, which is thus saved for the bee. This useful insect can run his long proboscis through the hairs, and reach the honey intended for him.

But instead of using hairs, the Lily of the Valley protects its honey by the droop of the blossoms. In vain do ants try to get into such flowers, for when they come to the downward slope, which leads to the blossom, they invariably tumble off to the ground. This device of hanging flowers for protecting their honey from ants, is similar to the swinging nests of the Oriole, which protects the eggs from snakes and other enemies.

Ants are not welcome visitors to these flowers, because they rarely carry the pollen to another blossom of the same species. After taking the honey from one plant, they crawl down and clamber up the one that happens to be nearest, no matter what kind it is. This plant can make no use of the pollen sticking to the ants, unless it be of the same species as the one last visited.

THE WATER=LILY

Water-lily Family

THE Water-lily, to which the pretty name "water nymph" also has been given, is well known as an inhabitant of ponds, lakes, and slow-moving rivers. It is securely anchored in the mud at the bottom by a root-stock, that is, a stem like a root, which sends the leaves and blossoms up to the surface, where they float, swaying back and forth on their long stems with the motion of the water. The leaves are large, flat, and nearly round. The blossoms are very showy, measuring, in our common American species, nearly six inches across. The many petals curve upward, forming a bowl-like flower, until almost ready to wither, when they spread out more flatly. In color they are white, blue, pink, or yellow.

Both the leaves and the blossoms have a shining appearance, due to an oil which prevents water from remaining on them and clogging the little mouths, or *stomata*, through which the plant breathes.

For the same reason these *stomata*, which are usually thickest on the under side of a leaf, that they may not be closed by the gum in the Water-lily, are on the upper side. Enough moisture is absorbed from below to prevent their drying up in the sun, and yet they can get air.

In fine weather, the Water-lily opens its flowers in the morning and closes them at night; on dull and chilly days, it does not open them at all. This is to protect the pollen from dampness, as the Water-lily does not hide its pollen away as some plants do. When open, it emits a delightful fragrance, which, together with its bright, shining color, attracts the water beetle, which is to aquatic flowers what the bee and other insects are to land blossoms, carrying the pollen from flower to flower. The bloom is short-lived. After a day or two, the stem contracts in length, as with most water plants, and the seeds are drawn down, to ripen under the water.

One member of this family is worthy of especial mention, namely, the *Victoria regia*, so called after Queen Victoria. It grows in South America, especially in the smaller tributaries of the Amazon. The leaf is often six, sometimes even twelve, feet broad, with a curious rim, giving it a tray-like appearance. These leaves are deep green above and pink below. They are so strong that two men have been supported by a single leaf. The blossom is usually about twelve inches in diameter, sometimes attaining twice that size. Reversing the habit of the ordinary Water-lily, it opens at night and remains closed during the day.

There are several varieties, differing somewhat in color. This plant was discovered in Bolivia, in 1801, by Haenke. The first cultivated blossom, which opened in 1849, in England, was presented to the Queen.

The far-famed Egyptian Lotus is also a Water-lily. One often sees the common Lotuses in fountains and artificial ponds, along with the other Water-lilies, among which they form a pleasing variety.

SOLOMON'S SEAL

Lily Family

As we walk along the roads of the springtime woods, this plant appeals to us by the graceful beauty of its bending stem. It is from one to three feet high, the alternate leaves are light green and set close to the stem. The tiny bell-like flowers grow in pairs and are not very beautiful; they are creamy white or greenish, giving

a faint suggestion of the wintergreen blossoms. However, they are suspended in an artistic way beneath the stem, to which they are joined at the axil of the leaf. The flowers hanging below and the leaf bending above make a delightful curve.

At each touch of the wind, the little bells swing to and fro, as if ringing out the glad tidings of spring. In the fall they give place to violet-blue berries. If you were to dig beneath the ground, you would find peculiar marks upon the root of this plant; they are caused by the broken-off stalks of former years, and seem like strange letters or signs, as on a seal,— hence the name.

FALSE SOLOMON'S SEAL

Lily Family

It is puzzling to know why this plant should be called False Solomon's Seal. It has some points of similarity with its cousin, but it is so very different that it deserves an individual name. The stem, as a rule, is curving, and from one to three feet high. Its dark green leaves are wavy and marked with parallel veins.

The small, white flowers are gathered in a leafy cluster, at the end of the stem, and are often very fragrant. They have six stamens and one pistil, and are divided into six petal-like parts. In the autumn they are replaced by pale-red berries. This plant is so beautiful that it would be an ornament to a cultivated garden. One striking peculiarity of the True and False Solomon's Seal is the fact that they always grow close together.

YELLOW ADDER'S TONGUE — DOG'S TOOTH VIOLET

Lily Family

This is another of the early spring flowers, and not the least beautiful of them. Indeed, nature is so profuse in the variety of her exquisite flowers, that we wonder how she can produce them all. Those who keep their eyes open while walking through the woods have a constant pleasure; it seems strange that so many people should be blind to the manifold beauties of nature.

Boys and girls should cultivate the art of seeing, for it will bring them rich rewards. What greater pleasure can there be than to follow the voice of a gurgling brook, and find unexpected myriads

of the Yellow Adder's Tongue growing on a sheltered bank! It seems as though the leaf-filtered sunbeams, that fall like golden lances, had taken root and blossomed into tangible petals. The Yellow Adder's Tongue grows from six to nine inches high. On each side of the large, russet-yellow, purple-marked flowers grow two long, lance-shaped leaves; they are pale, and mottled with purple and white.

The flower has a perianth of six spreading sepals, one pistil and six stamens. Its names are not very appropriate. It is called a violet, but it belongs to the Lily family. It is called "Yellow Adder's Tongue," but its speckled leaves are not like an adder's tongue.

John Burroughs has suggested that it be called either *Trout Lily*, because it is speckled like a trout; or *Fawn Lily*, because the leaves are not only marked like a fawn, but they stand up like the ears of a fawn when it is startled. It is to be hoped that one of these more suitable names will be adopted.

BELLWORT

Lily Family

THE flowers of this plant are small and insignificant, and one would hardly notice them unless the plant were plucked, for the little bell-shaped, cream-colored blossoms are suspended beneath the curving stems They are divided into six distinct sepals, and have six stamens and one pistil. The leaves are set close to the stem, sometimes clasping it; their upper surface is pale green and the under one is bluish green. The plant grows to a height of about eight inches.

POISON IVY

Cashew Family

THIS plant is dreaded because of its poisonous properties. Some people are so constituted that they become poisoned by merely passing close to it, for the surrounding air is laden with its noxious breath. Other people can touch it without any bad results, but it is best to avoid the plant, as all will agree who have seen a sufferer from its poison. The face and other parts of the body swell and become scarlet, all the while itching and burning like fire.

The Poison Ivy is often confounded with the Virginia Creeper, but the difference between them is distinct. The leaves of the latter are divided into five leaflets, while those of the former have but three. Boys and girls should bear in mind this fact.

This poisonous vine, by means of its little rootlets, climbs over rocks and walls. It blooms in June, and the greenish or yellowish white flowers grow in loose clusters at the axils of the leaves. Its fruit is a small dun-colored berry.

The Witch Hazel plant is sometimes found growing close to the Poison Ivy. This is a curious fact, because the Witch Hazel extract is one of the best remedies in a case of Ivy poisoning. Nature holds disease in one hand, and a remedy in the other.

SPRING BEAUTY

Pulsane Family

EARLY in April, you should look in moist ground, along the edges of woods, for the exquisitely delicate Spring Beauty, and when you know the plant you will say that it is indeed well named. Its flowers are sometimes white, with pink veins, while others are pink, with deep-colored veins; they grow in loose clusters. Each plant has only two leaves, and these grow opposite each other. By "opposite" is meant that they spring from the same point on the stem, but are on opposite sides of it. There are five petals in the corolla of the Spring Beauty, but only two sepals in its calyx. There are five stamens, but only one pistil.

You will notice, too, that the style of the pistil is divided into three parts. The stem above ground is quite pink, and sometimes even red, but when you pluck the flower you will see that there is a very long, white part of the stem under ground, and you may think this is the root. If you dig down six or eight inches, however,—and a good stout knife or a trowel is useful for this purpose,—you will come upon a small tuber or bulb of very peculiar shape, with the small, fibrous roots growing from it. So the long, white part was not a root at all, but an underground stem.

If the day is cloudy, you will notice that this flower closes, and one of the most disappointing things about the plant is that it wilts so soon after you gather it. But do not throw it aside too quickly, —put it where good, strong sunshine will reach it, and you will be surprised to see it unfold again.

The botanical name of the Spring Beauty is *Claytonia Virginica*. Sometimes, by means of the scientific names, botanists keep alive the memory of men who have spent a great deal of time in studying plants. They often give to a plant the name of some eminent man, and for a second name, join with it an adjective that tells something about the plant. In the case of the *Claytonia Virginica* the second

word is the Latin name of the place where it was first found. The first name is like your surname, or family name; the second is like your Christian, or given name. But you see the two parts are differently arranged, as that which comes first in your case is last in the flower's.

After you have admired the flower, which is worthy of your praise, you may be struck with the appearance of the root. The bulb, so large and irregular in shape, between the small roots and the long, slender stem, is really a sort of storehouse or pantry, in which food is stored up for the plant's use. If you were to transplant one of these plants into a pot of sand, which contains no food for plants, you would find that it would live for some time. Then if you should examine the bulb, you would see that it had shriveled up, and was small and empty.

Our garden vegetables, such as the carrot, beet, and turnip, are good examples of the same thing. They have large, fleshy roots, and you know that if they are left in the ground all winter they will grow the next year, but will go to seed. After they have done this, you will find that the root has shriveled up, and that the plant has been living the second year on the food it stored up during the first.

So you see it is not alone the squirrels and the bees that work to lay up a supply of food when it is plentiful, so as to be prepared for a time of scarcity, but plants and vegetables, too, have work to do for the future as well as for the present. When more plant food comes near to their roots than the plants need, many of them store it up for future use, and so are able to live over a dry season. But there are some plants, just as there are some people, which, during times of plenty, live the more luxuriantly, and make a great display of showy blossoms, only to suffer and fail in times of adversity. Many of us would laugh if we were told that among the many interesting things that plants can teach us we might learn a lesson of thrift and economy from a carrot.

RED=OSIER DOGWOOD

Dogwood Family

THIS is a gaudy shrub, from three to six feet high; it grows in wet places, and is more usually found in the North. One's attention is quickly caught by its bright purple branches that shoot like slender flames amid the foliage.

The rough ovate leaves are rounded at the base and short pointed, with whitish underparts. The small white flowers have four spreading petals, and a calyx of four sepals; they are arranged in flat

clusters and have four stamens and one pistil. Later in the season, the flowers give place to lead-colored berrics.

There are three or four varieties of the Dogwood family, all of which add greatly to the color scheme of the woods. One genus that is worth mentioning is the Round-leafed Dogwood. Its bark is used as a tonic, and also yields an extract that is similar in its effects to quinine, although not so strong. The Chinese and the Creoles are said to use the peeled twigs to whiten their teeth.

BUNCH=BERRY OR DWARF CORNELL

Dogwood Family

IN OUR woodland journeys, one of the pleasant surprises in store for us is the Bunch-berry. In June, it bears, at the tip of each stem, what at first sight appears to be a large white blossom; when, however, we examine it closely, we find that what seems to be the white petals, are only involucre leaves that surround the little green flowers in the center.

The stem of the Bunch-berry is five to seven inches high, and has ovate, pointed leaves, the upper ones being gathered in a whorl. The calyx of the tiny flowers has four small teeth. There are four stamens and one pistil. But the attractive flower is not the only interesting thing about this plant; later in the summer bunches of bright scarlet berries appear.

One who has toiled hour after hour up a fragrant mountain side cannot forget the thrill of pleasure that the sight of these brilliant berries produces. They seem like torches held by fairies. Sometimes, even in the late summer, a few white flowers nestle among the berries, making a striking contrast of color. In the Scottish Highlands this plant is called "The Plant of Gluttony," because it is said to produce a keen appetite. It is also related that the Eskimos use it as a food during the winter months.

EARLY SAXIFRAGE

Saxifrage Family

AT THE beginning of April we find this flower growing in the crevices of rocky cliffs. At first sight it reminds us of drifted snow, loath to leave its shelter. The stem is from four to seven inches high, with wedged-shaped leaves clustered around the root. The flowers are white, clustered, and small, with a five-cleft calyx, five petals, one pistil, and ten stamens.

MITRE=WORT, OR BISHOP'S CAP

Saxifrage Family

In April and May we find this flower growing upon the hills and in the woods. Its crystal-like flowers are fragile looking and exquisite, having five slender petals with one pistil and ten stamens, and a short, five-cleft calyx.

Its hairy stem is ten inches high, and the lobed, heart-shaped leaves grow opposite one another. The name Mitre, means "turban," or the high, two-leaved head-dress of the medieval bishop, and is derived from the shape of the pistil.

THE CULTURE OF THE ROSE

The "little cottage in a bower of roses" has been the dream of many a romantic young person, but such sweet surroundings are not attained without labor. Suppose the little cottage to be standing bold and bare in a monotonous little yard,— let us help you to plan to make it the ideal one mentioned.

Take cuttings of choice young Rose bushes — not in the soft state, but when the woody part has attained some hardness, and when the young shoot (of which the cutting is made) has developed a flower bud about the size of a large pea. There is no need of cutting at a joint, though European gardeners invariably do so.

Put a number of the cuttings into a plate or large saucer of sand, about an inch deep, then water with a very fine sprinkler until it is like mud. Put the vessel on a shelf in a sunny window, and keep the sand constantly saturated. The average temperature of the room should be from seventy to eighty degrees,— never below sixty-five.

In about three weeks the Roses will be rooted and ready for potting. The pots should be from two to three inches in diameter, and the plants should be treated with especial care as to shading and watering for several days. When the spring is well advanced, they may be set out in the ground, and soon in your case, even though on a small scale, "the desert shall blossom as the rose."

Now take another case, — suppose you have just taken up your abode in an old mansion, whose garden runs wild with neglected Rose bushes, whose flowers are of inferior size, and have no variety in coloring. You may take a leaf bud from a choice variety of Rose, insert it in the stem of any new shoot of the old Rose bush, and the branches afterward proceeding from it will bear the new and

more choice species of flower. Indeed, on every separate shoot of a Rose bush, you may bud a distinct variety if you wish, and each will retain its own characteristics of color, form, and fragrance. But this is a very delicate operation.

The stock to be budded upon should be in a thrifty condition, so that the bark can be raised easily from the wood. Rub off all leaves and shoots below the spot chosen, and make a lengthwise incision through the bark to the wood, then one crosswise near the upper end of the first.

Take a shoot of the chosen variety, cut from it a healthy bud, with as little wood as possible. Lift the edges of the bark, insert the bud and press the bark of the stock into place. If any part of the bark attached to the bud extends above the cross incision in the stock, it should be cut off. The tying material is cotton wick, but Raffia bark is preferable, as it entirely covers the wound, and excludes the air and water. In two or three weeks the wrapping may be removed, and if the budding has been done in June, the plant will make some growth the same season; if in late summer or early fall, not before the following spring. When growth begins, the stem should be cut back just above the new bud, that the latter may receive the full benefit of the food supply from the root.

The selection of varieties is, of course, very important. In the northern states, the Hybrid Perpetual Rose is "a thing of beauty and a joy forever," but in a southern climate it becomes enervated and feeble. Evergreen and ever-blooming Roses, like the Tea, Bourbon, and Bengal, are beautiful in the far South, where frosts are slight.

The best kind for all sections is a new class of Roses known as the Hybrid Tea, of which the American Beauty, a bright crimson, has the most delightful odor, and La France is the most attractive in color. Roses need particularly rich, well-drained land. The soil should be dug up to the depth of one foot, at least, and well mixed with cow manure or bone dust, the former being preferable.

The Hybrid Perpetual or Hybrid Tea Rose needs frequent pruning, while the Monthly or Tea Rose only calls for the thinning out of old stocks in the spring, or the occasional pinching off of an overabundant shoot, whose presence would destroy the symmetry of the bush.

The Rose bug is the terror of those who love the "queen of the garden," and is the Rose's most insidious enemy, though the aphis, or green fly, and a certain little red spider, are also troublesome. The fly is a small, grayish-brown insect about half an inch long, resembling a cockroach. It seldom shows its colors openly, but makes hiding burrows at the roots, and these burrows soon destroy the life of the bush. It would be a paying investment to employ some bright-eyed

boy, at a salary of one cent each, to kill the little pests, for by this method you may soon get rid of them.

To remove the aphis, or better, to prevent it, tobacco in some form should be applied. The fumes may be used, or the leaves may have tobacco dust sprinkled on them, though probably the most effectual way, for a small number of plants, is to wash them in water in which tobacco leaves have been steeped. A little flower of sulphur scattered over the leaves will insure against mildew. The red spider's presence shows the atmosphere has been too dry, and the leaves should be sponged and the air kept more moist.

Suppose you wish to adorn the interior of the first "little cottage," during the winter, with some of the brightness and fragrance of June. Rose plants, in five-inch pots, may be obtained from the florist, at from four to six dollars per dozen. The pots must be well perforated, as, in order for Roses to flourish in winter, the soil should be well drained.

The earth used in the pots should be good, loamy soil, well mixed with cow manure. Syringing, which is the best method of watering, should only be done once a day, the forenoon being the prefcrable time. A top dressing, applied every three or four weeks, is very helpful. This should consist of half an inch of compost, made up of cow dung, fresh soil and a small amount of pure bone dust. The soil should be stirred occasionally to give the roots air. About February, liquid manure should be used in watering, and, soon afterward, light pruning should begin.

Some of the finest winter Tea Roses are the Marshal Robert (pale yellow), the Bon Silene (carmine) and the Bride (white). The Hybrid Perpetual is harder to raise in winter, and had bctter be left for outdoor purposes, at least by amateur gardeners.

Beautiful Climbing Roses are the Marèchal Neil (yellow), and the Gloire de Dijon (salmon pink). They all need frequent fertilizing, and will amply repay onc's most tender care, with their beauty and grateful fragrance.

FERNS

The Fern is a plant whose leaf consists of delicate, lace-like radiations which, in the species called Tree Fern, often reach from twenty-five to thirty feet in length. In some varicties, the plants are less than one inch in height.

If one search for Ferns early in March, a small evergreen variety may be discovered. In April, the woolly croziers, or fiddleheads, appear, and quickly develop into the luxuriant plant found on low,

wet ground and along roadsides. Early in May, the Osmundas reach a goodly state of development, and the Royal Fern is to be found, delicate and fleshy, in wet meadows. The Interrupted, or Cinnamon Fern, grows in the open wood or along roadsides. These three plants soon reach maturity, and correspond to one another in size and in the appearance of their flower-like fruit clusters.

The fragile Bladder Fern is to be searched for on rocky banks, and among the spreading roots of forest trees. It unrolls its little fronds, on which the fruit dots appear, early in the spring. Several of the Rock Spleenworts are evergreen. They are sensitive to cold weather, however, and the plant is seldom encountered in winter walks in the woodland. A number of the Shield Ferns endure until spring. Even in the middle of January, the keen-eyed Fern hunter may hope to make some discoveries as to the haunts and habits of his favorites.

In the cultivation of Ferns, a compost of peat, or bog earth, with decayed leaf-mold, yellow loam and silver sand, in equal proportions, should be used when the Ferns are potted. All must be well underdrained. Fragments of mortar and limestone in the pot will prove dangerous to growth.

Collections of the various species of Ferns were practically commenced in 1628, when Mr. John Tradescent returned to England from a trip to Virginia, taking with him many new kinds of Ferns. Rear-Admiral Bligh carried home from the West Indies, where he had sailed in the interest of bread-fruit culture, thirty-seven species of the Fern. In 1813 one half of the known Ferns were growing in the West Indies and in North America.

Some of the most magnificent Ferns of the world grow in the numerous isles of the Pacific Ocean. The island of Mauritius has produced two hundred and thirty-five native species; Java claims four hundred and sixty; Brazil, three hundred and eighty-seven; and the Isthmus of Panama, one hundred and seventeen. Compared with these results in warm climates, there appear annually within the borders of the arctic zone twenty-six species of Ferns.

The general character of the Fern is much the same all over the world. Members of the species, distinct from the Tree Fern, grow to a height of from one inch to six or seven feet. Some of these varieties are stout and fleshy, others are delicate and filmy, but nearly all are herbaceous, resembling in the nature of their foliage the ordinary flowering plants.

In structure, the plants vary greatly. Some have fronds rising from different points on the root stalk; others are tufted — as, for instance, the Ostrich Fern — while some grow in crowns, with fronds

continually rising from the older ones. One of the most interesting species of Fern is the Aquatic, the sterile fronds of which float about in the shallow waters of southern Florida; and there are a few species that are epiphytic. In tropical countries Ferns have been found growing on trees at a height of two hundred feet.

Still another species of the Fern family varies as to the size of its fronds, according to the character of climate and soil. The Lady Fern, which in ordinary localities grows from two to four feet high, has, in mountainous regions, only reached a height of a few inches. In the northern states of this country, some specimens are produced in May, others as late as September.

In flowering Ferns, the Osmunda includes some of the largest and coarsest specimens. In rich woods, somewhat moist, may be found a few Spleenworts, most of the Shield Ferns, the Beech, Grape, Maidenhair and others. In such situations are found the finest development of Fern foliage. On dry cliffs, the Woodsia species may be looked for, also the Cloak Ferns, Lip Ferns, and Cliff Brakes. Many of these are leathery in texture, while others are thickly covered with tangled hair or scales.

It would be somewhat in the nature of a surprise for a resident of the continental portion of the United States to receive an invitation, when on a visit to a fellow-citizen in the newly-acquired Hawaiian territory, to a feast of roasted Ferns. It is a fact, however, that the Ferns of those islands are cooked, and found palatable, if rather leathery; without salt, they are tasteless.

In past times, the stems of the Fern Tree were sometimes cooked in the steaming cracks of volcanoes. The bases of the petioles of another species have been cooked and eaten in times when there was a scarcity of other food. When raw, these have an odor like that of raw potatoes.

MOSSES

If you wish to find plant-life delighting in the cold, damp days of winter, fearing neither frost nor snow and welcoming mist and rain, you must go into the woods and study the Mosses. As autumn passes away, they begin to cover the woodpaths and to creep over the roots of trees. They suck up the water in the bogs and clothe the damp walls and stones with their soft, green carpet. Doubtless you have often gathered patches of this thick-felted carpet and, when you have pulled it apart, have seen that each leafy stem is separate and can be taken away from the others without breaking. In some dense Mosses, each stem is single and clothed with leaves

wrapped closely around it. In others, the stem is branched, and in others still, the leaves grow on side stalks and give them a feathery appearance.

But in every case each stem is like a separate plant and has its own tuft of tender roots. The reason why these independent stems grow in such a dense mass is, partly, because Moss multiplies so rapidly, that new stems are always thrusting themselves up to the light and, partly, because the stems were not always separate, but in very early life sprang from a common source.

If you go where Moss is growing and look very carefully on the surface of the ground, you will discover a spongy, green mass, below the growing Moss, very much like the green scum on a pond. This tangled mass of green threads is the first growth from which the Moss stem springs. As soon as it has started, it grows and spreads very rapidly. It drinks in water and air through all its tiny cells, and sends up the Moss buds, which swell and grow and give out roots below and fine stems above. The latter become crowded with leaves and form the velvety Moss.

Although each stem has a few hairy roots, they are very feeble and not at all like the roots of other plants. They are not sufficient to gather nourishment. The fact is that the Moss is built up entirely of separate cells, like the green film on the ponds. These cells are not shut in, but each has the power to take in water and gases through its tender skin. Each acts as a separate plant and grows quite independently of the roots below, whose chief use seems to be to hold the plant in position.

This explains why the Mosses grow so fast and so thick, for new growths can start from any part of the plant. They practically make their own soil, since the matted threads decay and form a rich loam. Thus the Mosses, providing their own food, can spread over the poorest soil and clothe walls and roofs with their rich green.

After the Moss has gone on, through the damp winter, spreading and growing, there appear something like tiny flowers at the tops of some of the stems. These flowers are really formed of a few green leaves, shorter and stouter than the rest, and they inclose little sacs of two kinds. The two together form the plant eggs or spores, which answer to the germs in the seeds of higher plants, and from each a new plant may grow.

There are a great many varieties of Moss which differ in the shape and arrangement of their stems and leaves. In the arctic regions, the Mosses live on vast, marshy plains called Tundras, where they flourish during the coldest winter seasons, and appear fresh and green when the snow melts away from above them. The flowers on some of these

From col. Chi. Acad. Sciences.

CACTI.

¼ Life-size.

APPLE BLOSSOMS.

arctic mosses, instead of being green, are of the most beautiful colors. What a wise provision of nature that in these cold regions, where few plants can grow, the hardy Mosses supply the need that all people must feel for some of the pleasure that only flowers can give!

The beautiful gray Moss, known as the Spanish Moss or Long Moss, drapes the trees of the southern part of the United States and Central America. Feathery tufts of this Moss, several feet in length and perhaps eighteen inches through, are attached to the branch of a tree by a single thread-like root. It differs from most of our other Mosses in being of a silvery-gray color. This is the Moss so much used, when dried, for stuffing mattresses and cushions.

In many localities, the nature-lover can more easily make an interesting collection of Mosses than of other plants. He may live many hundred miles from the seashore and have difficulty in obtaining desirable specimens of seaweed, yet few localities are far removed from some beautiful species of Moss.

When gathered, Mosses should be washed clean and laid out on paper to dry. In this dry state, they may be put away in envelopes of cartridge paper, until the collector is ready to identify and arrange his specimens. A portion of the plant to be identified should be placed in water, until it is restored to its natural state. It is easier for the young student of Mosses to identify the species that bear fruit, and later he will learn to know other kinds, by their leaves.

THE CACTI

This curious and always interesting order of plants is distinctly American. Widespread throughout North and South America, and the West Indies, there are in the world but two varieties, of a single species, the origin of which has not been traced to the Western Hemisphere. The Cacti in general are known for their succulent, curiously-jointed, often leaf-like stems and almost entire absence of true foliage. A striking characteristic is that they flourish under apparently the most adverse circumstances.

A favorite habitat, in fact, appears to be a hot, arid desert, where the soil would seem to be anything but nourishing; where the air cools suddenly with the going down of the sun; and where the occasional rainfalls are followed by long periods of drought. But the Cactus is possessed of that great virtue, adaptability, for, while even a crevice in the rock will satisfy it, it does not utterly scorn the luxury of a rich soil. There are more than seven hundred well-established species of Cactus, and several of these deserve special mention.

The red or creamy-white flowered plants, with flat leaf-like stems distinctly jointed, belong to the genus *Epiphyllum*. The genus *Cereus* is well known, chiefly on account of the much-prized night-blooming variety. This plant has showy, white flowers, exceedingly fragrant, which open in the evening and close early in the morning. Some of these open but once a year; and it is quite common in small towns and villages for the owner of such a plant to invite his neighbors in to see the blossom. It is a slender, trailing or creeping plant, native to the West Indies. Much handsomer, however, is the Macdonald Cereus, a gigantic species, the flowers of which measure more than a foot in diameter when fully expanded. These flowers also are white, but last only a few hours. When eight or ten open in one night, as sometimes happens, the plant presents a magnificent spectacle. The original home of this rival of the Victoria Lily is Honduras.

The Torch-thistle, belonging to the same genus as the two preceding species, grows to a height of twenty or thirty feet, having a straight, fluted, cylindrical stem, or, sometimes, polygonal, flattened into four, five, or six sides. In time the stem becomes woody, and is used for house-building and other purposes. It bears a delicious fruit, sweet and juicy, resembling the Indian fig. This and similar varieties are found in abundance from Mexico to Chili.

The Giant Cactus thrives in the hot, arid regions of New Mexico, attaining a height of sixty feet, and a maximum thickness of about two feet. The stems are cylindrical, usually simple, but sometimes branching upward in a manner to give them the appearance of gigantic candelabra. It bears an edible fruit relished by the Indians, who call it "Saguara." This is about three inches long, oblong in form, green on the outside, with a crimson pulp and many black seeds.

The Old Man Cactus is a native of the district of Real-del-Monte, in Mexico, where the climate is hot. It also has a cylindrical stem, reaching to a height of twenty or thirty feet. Both this and the preceding species find a foothold in the crevices of bare rocks. The entire plant is gray, with curious long, white hairs at the top, whence its name.

The juicy Hedgehog Thistle of Mexico furnishes drink to cattle and mules in the high plains of that country, where water is not always to be had. The animals, especially the mules, break the stems very cleverly with their hoofs, that they may get the juice within. This is used by the Indians, also, who find it cooling, though slimy.

The Barbadoes Gooseberry, of the West Indies, bears an edible fruit used for preserving. An interesting member of this large family is the Mistletoe Cactus, so called because, like that parasite, it prefers to make its home on a tree. The Prickly Pear, or Indian Fig, is another edible fruit of a species of Cactus. It is native to the United States.

LICHENS

When you find the mosses growing in the woods, you will also see the Lichens hanging from the branches of many of the trees, like gray beards. The leafy Lichens encircle the branches and their pale and yellow patches look as if they were made of crumpled paper, cut into wavy plates. The crusty Lichens are scarcely distinguishable from the bark of the trees, and they usually cover every available space which the mosses have left free. They are such strange-looking plants that it is difficult to imagine that they are alive at all. They resemble fungi, in the fact that they prey upon all kinds of living matter, but they are different in one very important respect.

Botanists have discovered that the Lichens are really the result of a partnership between single-celled fungi and single-celled green plants. The gray part is from the fungi, but when we examine it under a microscope we find that it is not at all of fungus growth. A number of green cells can be seen scattered through it. Through the fibers of the hairy Lichen, which you so often see upon trees, are the circular rows of these green cells. In the leafy Lichen, which presents only one surface to the sun, while the other is against the tree, there is a single layer of green cells near the surface.

The way the Lichen grows, then, is this. First, a green cell falls on some damp spot and begins to grow. Then comes the spore of a fungus, which first thrusts its tubes into the bark of the tree and then spreads around the green cell. Then the green and the gray go on living together. The fungus uses a part of the food made by the green cell and, in return, gives the latter the advantage of being spread out to the sunlight and of protection from the rough weather. On the whole, the fungus gets the better of the bargain, for while the green cells may live without the fungus, the latter dies without the green cells.

There is hardly any part of the world, except the tropics, where Lichens do not abound. They grow close to the limits of perpetual snow, in the high mountains, and they flourish in the sandy wastes and over the tundras of the Arctic regions. A species, known as Reindeer Moss, sometimes reaches a foot in height under the snow. The Reindeer brushes the snow away with his nose to reach this food. In time of scarcity the moss serves as food for the people.

Iceland Moss is another variety of Lichen that forms an article of diet. It flourishes where nothing else can live. Like the mosses, Lichens can be dried up, so that you might suppose them dead, and

yet, because they can absorb nutriment at all points of their surface, when the heat and moisture reach them, each cell drinks in food again and the plant revives. So, when a scorching sun or biting cold kills other plants, the Lichens bide their time, till moisture comes again.

They are great soil makers, everywhere. They break up the tissues of other plants and change their substance into forms fitted for food for higher vegetation. They have, then, their important place in nature, and if they have not the beauties of some plants, they help to make others beautiful.

The little green cells multiply by dividing, as they do in the pond scum, but the fungus forms little pockets, out of which, when they burst, is thrown a very fine powder, whose particles go to form other Lichens. These seeds can only grow, however, where there is considerable moisture. Those which fall in dry places must remain only seeds.

FUNGI

THERE are many dark and damp places in the world where most plants cannot get enough sunlight or air to make green coloring-matter and manufacture their own food. But there is another class of plants which has found a way of taking in its food ready-made, from other decaying plants and from animals. These plants can live hidden away in dark cellars and damp cupboards, in drains and pipes where no light ever enters, under the thick covering of dead leaves in the woods, and wherever there are decaying substances on which they may feed. Such plants are the molds on cellar walls, the mildew in bread, the smut filling the grains of wheat or ears of corn, the rank toadstools and puffballs you often see in the woods, and the mushrooms, some of which are eaten. All these are called Fungi.

They are so widely spread over all things living and dead that there is scarcely anything free from them in one shape or another. Their minute spores float in the air and settle down wherever they find suitable food. Then they feed, fatten, and increase with wonderful rapidity.

Suppose you take, for example, the thin mold you have doubtless seen forming over a cup of delicious jam that had been uncovered for a time. This mold begins with a minute spore or cell from the air. Settling on the surface of the jam, it begins to feed and at the same time to send out very many tubes. Some of these, instead of working down into the jam, reach upward and form at the top tiny balls, in which are many minute, seed-like bodies or spores. The ball bursts, the spores fall out and are sprinkled over the jam. So

little by little, but quite rapidly, the whole surface is covered with a mold which grows thicker and thicker. These molds appear anything but beautiful to the naked eye, but if you have the opportunity to look at them through a microscope, you will be surprised at the delicacy and beauty of their structure.

While these minute Fungi are found everywhere, the larger varieties are confined to the fields and forests, or wherever rotting leaves or wood provide them with nourishment. Few people have any clear idea of the growth of a Mushroom, except that the part we pick springs up in a single night. The real fact is that a whole Mushroom plant is nothing more than a gigantic mold, spreading its tubes underground or through the trunks of decaying trees. The part which we gather and call a Mushroom, a toadstool, or a puffball, is only the part which answers to the little round ball of spores in the mold or mildew. These spring from the underground tubes, from time to time, and at first are egg-shaped, the top half being the larger. Inside this ball are formed a series of folds made of long cells, some of which are to bear spores. As the Mushroom grows, the skin of the ball is stretched more and more till it can stand the strain no longer. Then it breaks away from the stalk, and the ball expands into the shape of an umbrella. All this happens in a single night, and this much you can see for yourself, if you will find a place where it grows and watch its progress. It is in the autumn that you will find these molds most abundant in the woods, and if you study them you will see that they are breaking up, the dead remains of all kinds forming a soft, spongy soil. It is in such rich places that the tender plants of spring will flourish. Thus the Fungi, though they feed upon other life, really help to prepare the soil for the beautiful blossoms of spring and summer.

LIVERWORTS

The Liverworts, as a class, are closely allied to the mosses and, indeed, were once classed with them. Their processes of growth are quite similar. But while Liverworts have a leafy stem, they seldom expand into a leaf-like form. They are generally found in such situations as the mosses delight in, and are widely distributed over the globe. The greater number, however, belong to the warmer climates, in which the mosses are less abundant. In such places they grow on the bark, and even on the leaves, of trees.

Our most common species is a small, green, creeping plant, which has a flattened appearance. It consists of a leaf-like stem, about half an inch wide and from two to four inches long. Instead of putting

forth little urns, containing spores, it runs up a branch which is the shape of an umbrella, for the slender stalk supports a flat disk. The plant attaches itself firmly to the soil by silk-like roots.

It grows most readily in a moist soil and is common to almost every part of the United States. It is often seen on shaded rocks, walks, or fences. You can readily gather it, with the soil attached to it, and you may carry it home and keep it for any length of time, in a moist chamber, protected from the direct rays of the sun.

There is another species which can always be had at the greenhouses, and can be distinguished from the more common species by the form of its little cups, the rims of which are broken and shaped something like a crescent. In many of the varieties the spore sacs contain, besides the spore, small green filaments called "elaters." Each consists of two spiral fibers, which remain coiled up together so long as the case is unbroken. But when the case breaks and the pressure is removed, the elaters fly apart and aid in the dispersion of the spores.

ALGÆ

IF, WHEN you go to the seashore, you seek a place where the tide runs in and out among the rocks, you will notice clinging to them and to everything that touches the water, masses of green, feathery weeds. They do not appear very inviting, and they are so common and so plentiful along the shore, that you might suppose them unworthy of much attention. But if you will examine them closely, you will be rewarded by finding in these, the very lowest forms of vegetable life, structures of such delicate beauty as you can find nowhere else.

In collecting specimens of seaweed, care should be taken to keep the brown, green, and red species separate. Some species must be carried home in sea water, as their color is changed by contact with the air. As some species change color in fresh water, it is well to wash them in a clean pool before leaving the shore. On reaching home, the specimens should be placed in vessels of clean sea water. In mounting them, place one on a white dish, and if any of the branches stand up so as to be in the way of pressing smoothly, or overlie others too thickly, they should be pruned off with a penknife or with the edge of a porcupine quill.

The specimen should then be placed in a flat dish of very clean sea water, and a piece of strong drawing paper slipped under it. Hold the specimen in place on the paper and with a porcupine quill carefully spread the branches, while they are still under the water,

and brush out the feathery tips with a camel's-hair pencil. The paper should be removed from the water gradually, as the sprays are placed in position. If the delicate tips run together, they may be dipped in the water again just deep enough to float them. The work of spreading should always be done from the center outward. When the seaweed is in the desired position on the paper, the sheet should be laid on a stout, blotting paper and covered with a piece of old muslin. New or starched muslin would stick to the wet seaweed.

In a short time the water will have been sufficiently absorbed, and the sheets may be laid one over another, with blotting paper between. The pile of sheets should rest on a smooth board and an even weight should be placed over the top. A board, with bricks or irons upon it, will serve this purpose nicely. Within two or three hours, and again in twelve hours, the blotting paper should be changed.

You will not need to search the ocean itself to find the really wonderful things which lurk among the green and slimy weeds. It will be better to pick out one little pool lying just above the limits of the low tide, so that it is uncovered only for a very short period each day. It will be convenient to choose a pool not more than two feet across, so that you may step over it, if you take care not to slip on the masses of green and brown seaweed. Lie flat down on the rocks, so that your eyes are free to observe and your hands free to handle.

This little pool is as full of living things as the heavens are full of stars. The tide, as it comes in, brings many a mother cell to find a safe home for her little ones, and many a waif spore, to seek shelter from the troublous life of the open ocean. The fine, feathery weeds are the haunts of millions of beings, just as the giant trees of the forest are the haunts of millions of birds and animals.

There are many hundreds of varieties of these seaweeds, and there is a great difference in their size, and forms, but science classifies them all as Algæ. Such plants are not confined to the salt water, but are found in rivers, lakes, marshes and moist places all over the world. Some of them have what you might call roots, but they do not act like the nourishing roots of flowering plants. They simply fix the weeds to the rocks or decaying stumps. The leafy appendages are called fronds, which vary greatly in size, color and firmness. The three leading colors which you will find in the little pool are green, red, and olive or brownish. These tints mark roughly three kinds of weeds, which, however, occur in an endless variety of shape.

You will doubtless find in the pool a pale green seaweed called the Sea Lettuce. It grows in long ribbons in shady nooks in the

water. If you should examine it under a microscope, you would see very small cells, with lashes breaking away and swimming off, to start other plants. This plant is merely a collection of cells, and each can work as a separate plant, feeding, growing, and sending out its own young spores.

Another deep olive-green and feathery weed which has a very long, scientific name is of a somewhat higher order of life, and its cells divide their work. Those of the feathery threads make the food, while others, growing on the shafts of the feather, make and send out the young spores.

More lovely still to look upon, are the red, thread-like weeds. One variety carries urns on its stems much like those which may be seen on mosses. The stony corallines are near relatives of the seaweeds, and you will find plenty of them in the little pool. Some of them, of a deep purple color, grow upright in stiff groups about four or five inches high, and others, which form crusts over the stones, are of a pale rose color. Both kinds, when they die, leave pure white skeletons which used to be mistaken for corals.

You will find the little pool full of different forms of these four weeds. The green ribbons float on the surface rooted to the sides of the pool, and the glittering bubbles rising from them show that they are working up food out of the water. The brown weeds lie chiefly under the shelves of the rocks, for they can manage with less sunlight and use the darker rays which pass by the green weeds. The red weeds and corallines, small and delicate in form, line the bottom of the pool in its darkest nooks.

To see the wonderful beauties of their forms, you must try to get one upon a piece of white paper. You cannot do this by dipping your hand in the pool and bringing up the delicate weed between your thumb and finger. If you do this, you will have nothing but a mangled mass of dark stuff. You may place such a shapeless mass on the paper and endeavor to straighten out its many branches, but you will find that you cannot do this. You must catch it as it floats naturally in the water.

Take a small pane of glass and, dipping it in the pool, work it under one of the delicate red weeds. Have your eyes very close to the water, so that you may see as well as possible. When you have a weed over your glass, slowly raise it and, as you bring it near the top, see that the tiny branches of the weed are well spread out, like the branches of a tree. If, when you have it near the top, the weed is tangled, lower the glass and try again, till you bring the weed up in good form. As you cannot see it clearly on the glass, now place a paper over it and turn the glass, so that the weed will leave the

glass and adhere to the paper. Then you will behold the wonderful texture of this plant, which is one of the lowest forms of vegetable life.

In mounting seaweeds, they need to be dried, but some must first be carefully washed in fresh water to remove the salty matter. With the delicate forms, this can hardly be done. They must be dried first in the air, and afterward pressed between sheets of drying paper. You will be surprised to find how many varied kinds of beautiful forms you can bring out of that little pool between the rocks.

There are many other wonderful forms of life in it, which you cannot see with the naked eye, some of the creatures being classed as animals, and some as plants. One of the most wonderful of the latter is called a Diatom. Diatoms are so small, that many of them must be magnified to fifty times their real size, before you can even see them distinctly. Yet the skeletons of these almost invisible plants are wrought in patterns of the most delicate designs. Some of them look, when magnified, like a number of rods clinging to one another in a string, but each of them is a single-celled plant. Other forms look more like plants, but all have flinty skeletons running through their jelly-like forms. Each plant leaves its skeleton, and these forms accumulate in the waters of ponds, lakes, rivers, and seas all over the world. Thus, in millions of years, these innumerable microscopic skeletons have formed layers of earth.

It is said that the cities of Richmond, in Virginia, and Berlin, in Germany, are built upon earth composed almost entirely of these minute diatoms, which have accumulated to a depth of even eighty feet. Those under Berlin are fresh-water forms, while those under Richmond belong to the salt water. Every inch of ground under these cities represents millions of living plants, which flourished in ages past, and were all so small that they could not be seen except under a strong magnifying glass.

But there are other Algæ which grow to an enormous size. One long, cord-like seaweed runs out to great length, and masses of it form, in the North Sea and in the British Channel, in beds of twenty miles in length and six hundred feet in width. The Gulf weed can be seen by any one who crosses the Atlantic. It is never attached to anything but is always floating. In one section, between the West Indies and the Azores, it covers many miles and is called the Saragossa Sea. Other similar varieties form patches on the sea which look like enormous green meadows, and yet ships can readily sail through them. Many specimens of this class have been found to be over seven hundred feet in length. Thus, you will see that the Algæ range from great monsters to such minute plants that you cannot hope to see them without the strongest magnifying glasses.

While many of the seaweeds constitute the food of higher forms of life in the ocean, some forms are also valuable as food for men. None of the seaweeds are known to be poisonous. You may have heard that a dish much relished in China consists of a soup made of birds' nests. You will be right in thinking that none of our ordinary birds' nests would make an agreeable soup, but the nests which the Chinese use are largely made of seaweeds of a certain species, which the swallow known as collocolia, or glue-house swift, collects and fastens together with a glue-like secretion from his own mouth.

One variety growing on the rocks is much used for food in Scotland and Ireland, and is called Dulse. It has an odor something like that of violets and is eaten raw or roasted. It is an important plant to the Icelanders and, after being washed and dried, is stored in casks to be eaten with fish. Another delicious variety grows on the rocky seacoasts on most parts of Europe, and on the eastern shores of North America. The Irish call it Carrageen, but here it is commonly spoken of as Irish Moss. When properly prepared it makes a delicious dish.

The fresh-water varieties of the Algæ form that soft, green material which is called "pond scum." The color varies according to conditions. When taken in the hand it has a delicate and slippery feeling. There are varieties of these fresh-water Algæ not very unlike seaweeds, though they do not present so many beautiful forms, and are always green. None of the lovely red varieties exist in fresh water.

PHYSICS, CHEMISTRY AND ASTRONOMY

INTRODUCTION

SOME COMMON METALS AND THEIR ORES

By BAXTER MORTON, M. D.

THE term *Metal* is a very familiar one, but if we try to define it exactly, we find it quite difficult to do so. The various substances that we call metals differ considerably in their properties, and it is almost impossible to select any property which is possessed by all the metals and not possessed by any other substances. For this reason we shall not attempt to lay down any rule by means of which we may always distinguish metals from other substances.

But, before beginning our discussion of the various metals that we use most frequently in our every-day lives, we will consider the properties that we are accustomed to find in metals, and which are possessed by all metals in varying degrees. These properties are luster, sonority, hardness, density, tenacity, malleability, ductility, conductivity and fusibility. With some of these terms you are no doubt familiar, but some of them are probably new to you, and it may be well to explain them all.

By the luster of metals is meant the bright and glistening appearance that they possess, through their power to reflect the light that falls upon them. In some metals, this property is much more noticeable than in others. Iron, in the form of steel, is capable of exhibiting a very high luster, because its hardness makes it possible to give it a high polish, by rubbing it with fine particles of such substances as emery and diamond dust. Tin and silver also possess a marked metallic luster, but they do not take so high a polish as steel. Lead and zinc, on the other hand, are rather dull metals, whose luster is never great.

All the metals that have been mentioned are white or grayish in color, and most of the metals resemble them in that respect; but a few, such as gold and copper, have very different colors. Both the color and the luster of most metals are shown much more perfectly upon surfaces that have not been long exposed to the air. The reason for this is that some of the substances present in the air combine chemically with the particles of metal, on the exposed surface, and form films that cover the surfaces of the metals, so that their real color and luster are hidden. In most cases, these films are formed by the action of the oxygen of the air and are, therefore, called oxides; but some metals, silver for example, are not tarnished rapidly by oxygen, while they are quickly affected by other substances that are occasionally found in the air.

The sonority of metals is that property which, in common language, we call *metallic ring*. The degree in which we find this property present in different metals varies greatly. Lead, zinc and tin are almost without it,

and, when struck, give off a sound that is dull and flat; but most metals have the property in more marked degree and yield a clear, ringing sound when struck.

The common metals, with the exception of mercury, which is liquid at ordinary temperatures, are quite hard,— that is, they resist cutting or scratching. Even lead, which is one of the softest of the common metals, is tolerably hard, while steel is one of the hardest substances known.

The great density of metals, by which is meant their great weight in comparison with the weight of equal volumes of water, is one of their most striking properties. Density is sometimes called *specific gravity*, and is expressed by a number that shows how many times as heavy as an equal volume of water a quantity of the metal is. Thus, the specific gravity of gold is said to be 19.34, which means that a cubic inch of gold weighs 19.34 times as much as a cubic inch of water.

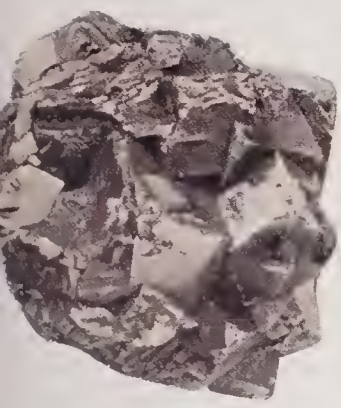
That property of metals which makes some of them useful in the form of chains or wire ropes, namely, the strength with which they resist attempts to pull their particles apart, is known as tenacity. Iron, in the form of steel, has more tenacity than any other common metal and is, consequently, used more than any other metal for purposes in which that property is of importance.

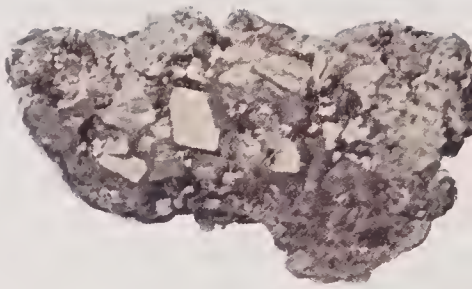
Malleability and ductility are two properties of the metals that are closely related, and a metal possessed of a high degree of malleability, usually has a similar degree of ductility. By the malleability of a metal, is meant its capacity of being hammered out into thin sheets, and to say that a metal is ductile, is to say that it can be drawn out into wire. Gold, silver and platinum are the most malleable and ductile of the common metals, gold being possessed of both properties in the greatest degree. Gold can be beaten into sheets thinner than the thinnest tissue paper, and drawn into wire so fine that it can scarcely be seen.

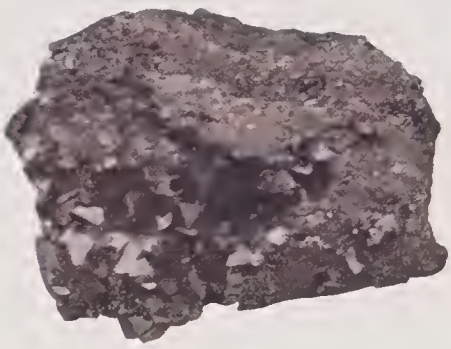
From the fact that metals, as a class, allow heat and electricity to pass through them, they are called good conductors, or, in other words, they have "a high degree of conductivity." Silver is the best conductor of heat, and gold, copper and aluminum follow, in the order in which they are named. As a conductor of electricity, copper is best, and next in rank come gold and zinc.

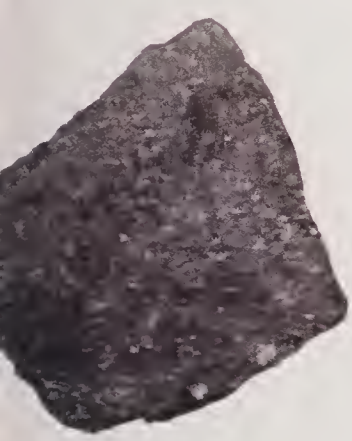
No doubt you have observed that when some metals, such as lead, tin and zinc, are heated to a high temperature, they are converted into liquids. The property of changing into a liquid, as the result of heating, is known as *fusibility*, and it is possessed by all metals; but the temperature required to melt some metals is so high, that it can be produced only with great difficulty. The temperature at which each metal melts is always the same, and is known as its *melting* or *fusing point.*

The fusing points of metals that melt easily, such as tin, lead and zinc, may be determined quite accurately, but we have no way of measuring the temperature at which platinum melts, as well as other metals of difficult fusibility. Mercury is, of course, the most readily fusible of the common metals, for it is liquid at ordinary temperatures. In fact, it was not









IRON ORES

Pyrites
Limonite
Hematite

Magnetite.

Pyrites
Limonite
Specular

FROM COL. CHI. ACAD. SCIENCES.

QUARTZ AND SILICATES.

1—Asbestus. 2—Feldspar. 3—Quartz Crystal. 4—Small Garnets in rock. 5—Garnet. 6—Opal. 7 Smoky Quartz

known, until long after mercury had been discovered, that it could be converted into a solid by cold. For this reason, it was not at first considered a metal, but when it was found that it could be solidified by cold, and that it thus possessed the other properties usually found in metals, it was so classed.

Tin is the most readily fusible of the metals that are solid at ordinary temperatures. Its melting point is 442° F., a temperature that is more than twice as high as the boiling point of water. Lead melts at 617° F., zinc at 773° F., silver at 1800° F. and gold at 2000° F. Steel is said to melt at 4000° F., but this is only a guess at its melting point, for it has never been measured accurately.

When most metals are heated to the melting point, they pass suddenly from the solid to the liquid state, but iron changes very slowly. First, it softens into a pasty condition, and this paste gradually becomes softer and softer, until it reaches the liquid state. While in the pasty condition, two pieces of iron may be made to unite into one piece, if they are laid one on the other and hammered briskly. Uniting pieces of metal in this way is called *welding*.

In some instances, metals can be made to mix by melting them together, and the mixtures of metals produced in this way are known as *alloys*. The properties of alloys are sometimes different from those of the metals that compose them, and consequently alloys are often better suited for certain purposes, than any pure metals. Brass is an alloy of zinc and copper; type metal is composed of lead and antimony; and bronze consists of 95 parts of copper, 4 of tin and 1 of zinc.

Gold is always used in the form of an alloy with copper or silver, and the proportion of gold in the alloy is expressed by saying it is a certain number of carats fine. Pure gold is 24 carats fine, and in an alloy of gold, each carat represents 1-24 part; thus, 10 carat gold is an alloy containing 10-24 gold and 14-24 silver or copper, usually the latter.

You probably know that all metals are obtained from deposits in the earth, by mining. You may not know, however, in what form they are found in the earth. Very few are found in large lumps of pure metal. Some are occasionally found in small particles, mixed with large quantities of other material, usnally rock; but most metals are found chemically combined with other substances, and these compounds, containing the metals, are usually mixed with rock. All of the natural substances that contain metals in sufficient quantity and in such form that they can be profitably extracted, are known as *ores*. These ores vary greatly in color, hardness, density and other properties. The ores of the same metal are frequently so unlike, that only those who have studied them, recognize them.

Let us now turn our attention to some of the most useful metals and consider them separately, beginning with iron, because it is by far the most useful of all.

Iron is the strongest, and at the same time one of the lightest, of metals. It is capable of assuming the forms of cast iron, wrought iron and

steel, each of which has properties that make it useful for a number of special purposes. In the form of cast iron, it is easily fusible and hence adapted to be cast into various shapes. Steel is distinguished by great elasticity, hardness and strength. It is, therefore, used for making tools, cutlery, etc.

Wrought iron is also extremely strong and tough, but it is inelastic, and is soft enough to be bent, twisted, hammered and rolled into the most varied forms without cracking or breaking. All the forms of iron can be rendered magnetic and, for this reason, it is much used in the manufacture of magnetic and electrical apparatus.

The methods by which iron is extracted from its ores and converted into the three forms that have been mentioned, are fully described in another part of this volume and need not be detailed here. Nothing has been said about the ores of iron, however, and they will now be described.

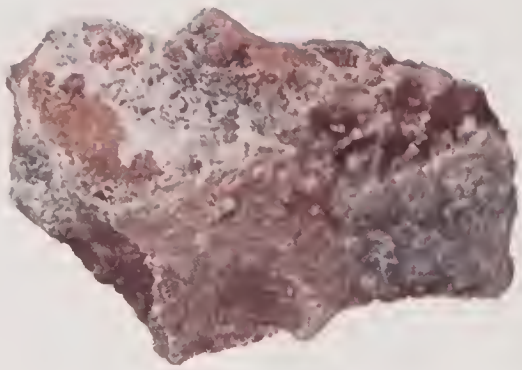
Iron is very rarely found in the pure state, for the reason that it enters readily, into combination with other substances especially with oxygen. Its most important ores may be divided into three classes, first, those containing iron in combination with oxygen, forming oxides; second, those in which it is combined with oxygen and carbon, forming carbonates; third, its compounds with sulphur, or sulphides.

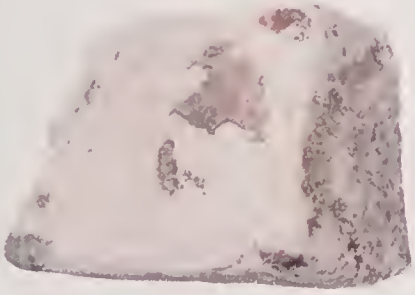
The ores of the first class contain a larger proportion of iron than the others — about seventy per cent — and the iron obtained from them is usually of excellent quality. The most important ores of this class are known as *Magnetite*, *Red Hematite*, *Specular* and *Brown Hematite*.

Magnetite is an ore which has the property of attracting iron and steel, or, in other words, it is magnetic, and for this reason it has received its name. The lodestones of ancient times, about which many remarkable stories are told, were no doubt fragments of this ore. Magnetite is usually found in compact, heavy masses of black or dark gray color, and it has considerable luster. Its specific gravity varies somewhat, but is never far from 5. It is found in great quantities in Norway, Sweden, Russia and, in this country, on the shores of Lake Superior. Magnetite contains a little higher proportion of iron than any of the other ores of its class.

Red Hematite is so called from the Greek word for blood, the name having been bestowed on account of its dark red color. In appearance, it is one of the most striking of the ores of iron. It is often found in rounded masses of brownish red color, having considerable luster, and made up either of layers resembling the thick shell of some large fruit, or of fibers, like petrified wood. These masses have a specific gravity of 5 and are very hard. Occasionally this ore is found in much softer earthy-looking masses of brighter color, with which clay is sometimes mixed. Red Hematite is found in Great Britain, many parts of Europe and in the southern part of the United States. Iron Mountain and Pilot Knob, in Missouri, are composed almost entirely of this ore.

Specular Iron Ore has the same chemical composition as Red Hematite, but is found in crystals of steel-gray color and brilliant luster. It is the





ORES.

Cholcopyrite
Cerussite coating Galenite
Galenite

Ang'esite
Native Copper
Chalcocite

CARBONS.

Anthracite Coal — Bituminous Coal — Graphite

most lustrous of the iron ores, and from that fact it has received its name, which is derived from the Latin word *speculum*, a mirror. This ore is found in Germany, Russia, Spain and Nova Scotia.

In *Brown Hematite* we find the same compound of iron and oxygen that is found in Red Hematite and Specular Iron, but it is chemically combined with water. For this reason it is sometimes known as *hydrated* iron ore. Its appearance varies considerably. It is sometimes found in large, rounded masses and sometimes in small grains, called *pea iron ore.*

Other forms of this ore, are soft, brown, earthy minerals called *ochers* and *umbers.* Brown Hematite is abundant in some parts of England and France, and, in the region around Pittsburg, it is the most important iron ore. From the fact that it is sometimes found in marshy places it is also known as *Limonite* or *Bog Ore.*

The important ores of the second class are *Spathic Iron Ore* and *Argillaceous Iron Ore.* The former consists of nearly transparent, shining crystals, which are of the same form as those found in marble. Almost invariably, it contains the metal manganese, and for this reason it is especially adapted for use in the manufacture of certain kinds of steel.

Argillaceous Iron Ore is ore containing a carbonate of iron, of the same kind as that found in Spathic Iron Ore, mixed with clay. It appears in masses of varying size, which are hard and strong in consistency and of a gray, blue or brown color. It is the most important of the iron ores found in Great Britain.

The only iron sulphide found abundantly in nature is *Iron Pyrites.* It has very little value as an iron ore, but it is of interest from the fact that it is often mistaken by ignorant persons for gold, and is sometimes called "Fool's Gold." It is a heavy mineral, of yellow color and considerable luster, and is often found in coal.

Gold, the next metal to which we will turn our attention, is one that is exceedingly useful for many purposes, but its scarcity makes it too precious for use, in many of the ways in which it would be employed if it were less valuable. It is, as you know, a very heavy metal, of rich yellow color and brilliant luster. It is the most malleable and ductile of all the metals, and is an excellent conductor of electricity. It is one of the most sonorous of the metals, and when struck it yields a clear, ringing sound. It is too soft to withstand much wear and has very little tenacity. The properties of gold that make it especially useful for money and for ornaments, are its rich color and its resistance to almost all the agents that tarnish other metals.

In nature, gold is almost always found in the free state, either pure, or mixed with other metals, usually silver or copper. It is practically never found in chemical combinations with other substances, but nearly always it has mixed with it some silver, copper or lead. The chief natural deposits of gold are of two kinds, namely, *Alluvial Gold* and *Gold Quartz.* By Alluvial Gold, is meant gold found in the sands or gravel beds formed by streams, and it is usually in small grains, or "dust," thin flakes and small lumps, or "nuggets."

The gold which is found in these beds came originally from deposits of Gold Quartz, a transparent crystalline mineral, which has gold scattered through it in fragments of varying size. Under the influence of the weather, the quartz crumbles and is washed into streams, which carry along the fragments by the force of their currents. As the currents grow weaker, near the mouths of the streams, the gold and crumbled quartz lodge at the bottom, forming beds of gold-bearing sand and gravel.

Silver is a metal that we always think of in connection with gold, and in nature it is almost always found with gold. It has a brilliant luster, a bright, white color, a clear metallic ring, and, in its ductility, malleability and conductivity of heat and electricity, it strongly resembles gold. Silver is much more abundant than gold, however, and consequently is not nearly so precious. Like gold, it is not readily tarnished by exposure to the air, and is much used for coin and for ornaments.

When found mixed with gold, silver is usually in the metallic state, but it is not always found in this condition. It is commonly found in combination with sulphur, as a sulphide, or with chlorine, as a chloride. *Silver Sulphide*, or *Silver Glance*, are the commonest forms in which silver is found. It is a mineral of dull gray color, of slight luster, and is so soft that it may be cut with a knife. *Silver Chloride*, or *Horn Silver*, is. as its name implies, similar to horn in appearance. It is pearl gray in color and turns dark, on exposure to air and light.

Copper is a metal whose chief uses in modern times are as electrical conductors and in alloys with other metals. It is a soft metal, of rich, reddish color and has considerable luster when polished. It is tolerably malleable and ductile and is the best conductor of electricity that we have. When exposed to the air, it becomes tarnished upon the surface in a short time, through the action of the oxygen of the air, which forms two compounds with it, known as the red and black oxides.

The two richest ores of copper are the oxides, that have just been mentioned. *Copper Pyrites*, or yellow copper ore, is the most abundant of the copper ores, and contains copper, sulphur and iron. Two carbonates of copper form valuable ores; they are known as *Malachite* or *Green Carbonate of Copper*, and *Azurite* or *Blue Carbonate of Copper*. The former is more prized for ornamental purposes than for the copper it contains.

Tin is now used in the manufacture of many utensils for which copper was formerly employed. It is a soft, white metal, which is malleable and ductile to a considerable degree and does not tarnish readily in air, or when exposed to weak acids, like those of fruits. On account of its softness, tin is not used alone in the manufacture of household utensils. Instead, they are made of thin sheet-iron which, is coated with this metal, and known as tin-plate. Tin is rarely found free in nature, but is usually found in the form of an oxide called *Tin-stone*, or *Cassiterite*. This is a heavy brown or black mineral, of considerable luster.

Lead is a metal that resembles tin in many respects, but its color is darker, its luster less brilliant, and it tarnishes more readily. It is used in a number of alloys, one of the commonest being *Solder*, which is

composed of lead and tin. It is also used largely for water pipes, because, after the formation of a thin film of oxygen on the inner surface of the water pipes, no further change in them takes place.

The only important ores of lead are the sulphide, which is known as *Galena*, and the carbonate, or *White Lead*. The former, which is the more abundantly found, is a mineral that looks much like pure lead. It is, however, crystalline in form and harder than the pure lead. *Lead Carbonate* is usually found mixed with Galena, or in streaks running through it. When pure, it is white and crystalline in form, but it is usually dark, from the presence of impurities.

The most abundant of all the metals is one which has come into use only within comparatively recent years, namely, *Aluminum*. This is by far the lightest of the common metals, having a specific gravity of only 2.5. It is a white metal, about as hard as zinc, and its fusing point is slightly lower than that of silver. It has a brilliant luster, closely resembling that of silver, and is not readily tarnished, being superior to silver in that respect. When struck, it yields a remarkably clear, ringing sound. The strength of aluminum is great, in comparison with its weight, and this fact, together with its resistance to tarnishing agents, has caused it to be used in many places in which steel was formerly employed.

The ores of aluminum are a mineral known as *Cryolite* and *Common Clay*. As clay is extremely abundant, you might expect aluminum to be one of the cheapest of metals, but this is not true, for it is very difficult to extract it from either clay or cryolite, and none of the processes of extraction can be carried on cheaply.

FERMENTATION AND ITS PRODUCTS

FERMENTATION is mentioned in connection with the action of yeast in "Bread-making." It is, however, a process of too great importance to be passed by with a mere mention, and herein it will be described more fully, and an account given of some of the industries in which it plays a leading part.

The name *Fermentation* is applied to changes brought about in a number of substances, of which sugar is the chief, by the action of certain chemical compounds that have the power of bringing about chemical changes, without being altered themselves. The living organisms that bring about fermentation are plants which are so small that they are visible only through a microscope; these are variously known as *germs*, *microbes*, *bacteria*, *ferments*, etc.

The chemical compounds that have a similar action are known as unorganized ferments, or *enzyms*. The action of the *enzyms* usually takes place within the substance of plants during the processes of growth, and, therefore, has but little direct bearing upon human industries. The fermentations that are of most importance are brought about by living plants, the most common varieties being the alcoholic, acetic and lactic fermentations.

Alcoholic fermentation, the most important of the three varieties, is that which is brought about when the yeast plant is introduced into a liquid containing starch or grape sugar. The products of this chemical action are alcohol and carbonic acid gas.

Lactic fermentation is that which causes the formation of lactic acid, from the sugar contained in milk. Acetic, or acetous, fermentation is due to the vinegar plant, which acts upon alcohol and transforms it into acetic acid. The manufacture of vinegar depends upon this action.

Alcoholic fermentation takes place in a number of natural processes, such as in bread-making, and in the manufacture of wine and beer. It is in the making of the two last named, that alcohol fermentation finds its most valuable commercial application, and the manufacture of those beverages will now be described.

The term wine has been applied to the fermented juice of a large number of different fruits, such as currants, blackberries, oranges, gooseberries, cocoanuts, etc., but ordinarily it means the liquid obtained by the fermentation of grape juice. In the manufacture of wine from grapes, the bunches of ripe grapes are cut from the vines, cleaned, and then put into the wine press, in which they are crushed

to squeeze out the juice. The presses are sometimes nothing more than large tubs having holes for the juice to drain through, and the mashing is accomplished by men treading the grapes with their bare feet. Mechanical presses, however, are more frequently used.

The juice pressed from the grapes, which is called *must*, is put into vats or barrels and set aside to ferment. It is not necessary to add any yeast to cause fermentation, for yeast germs are present in the air, and there are present in the grape juice all the substances necessary to their growth.

By the fermentation the sugar in the grape juice is partially or wholly changed into alcohol. When there is much sugar present only part of it is changed, and the resulting wine is sweet. If the grape contains but little sugar, it is all changed to alcohol, and a *dry* wine is produced.

The wine may be bottled before the fermentation process is complete, or it may be allowed to remain in the vats until fermentation stops. Wines that are bottled before fermentation ceases always contain some carbonic acid gas, which escapes when the wine is poured from the bottles. These are called *sparkling* wines, in contradistinction to those bottled after fermentation is complete, which are known as *still wines*. Champagne is an excellent example of a sparkling wine.

Beer is an alcoholic beverage made from some grain, usually barley. The first step in its manufacture is to steep the barley in water and keep it warm until it sprouts. It is then dried in kilns to check the growth that has begun, and the substance obtained is called malt. The malt is crushed, and is then placed in vats partly filled with water, and kept in a temperature of from 120° to 170° F. This treatment is called *mashing*, and it is done to permit the conversion of the starch and dextrin of the grain into sugar through the agency of a substance called *diastase*, which is formed in the grains when they sprout. Diastase is one of the organized ferments or enzymes, which have already been mentioned.

The liquor obtained by the mashing is called *wort*, and it contains a large proportion of sugar. If it were fermented, however, the liquor resulting would have a very disagreeable flavor. To avoid this, hops are added to the wort, and the mixture is then boiled. After the boiling, the wort is cooled rapidly to prevent the formation of lactic acid, which is apt to occur when the cooling process is slow.

The wort is now ready for the last stage in the manufacture of beer — the fermentation. This, like that in wine, might take place by the aid of the air, but the process is more successful when yeast

is added. When the fermentation is complete, the beer may be run into casks without further treatment, but it is generally filtered after it has ceased fermenting.

BREAD

BREAD-making is an art that has been known and practiced by mankind so long, that we have no record when it was begun. In the Bible, Bread is mentioned as the food of people who lived and died more than three thousand years ago; and Bread, very much like some we see nowadays, was recently found in the ruins of Pompeii, where it had lain nearly two thousand years.

Notwithstanding its age, Bread making is still a very important art, for Bread is to-day, probably, the chief article of food to the human race. It is well worth our while to trace the steps by which the grain is converted into loaves of Bread.

First we must pay some attention to the grain itself, the wheat that furnishes the flour of which the bread is made. An account of this cereal is given in our article on Wheat.

No doubt you know, that the very first step in Bread-making, is to mix water or milk with flour. If we added nothing else, however, and then baked the dough, we should have a kind of Bread that is very solid and firm, and on that account is much used by soldiers, who have to carry their food with them in knapsacks. Perhaps you have seen such Bread, and know how hard and solid it is. On account of its hardness it is called "hardtack," and if you have ever eaten any you know that the name is a good one. To most people such hard Bread is not pleasing, so we add a little yeast, or baking powder, to our mixture. We shall have occasion to refer again to the subjects of yeast and baking powder, and just now we need only say that they cause fermentation to take place in the dough.

When the bread is first mixed it is sometimes left in the form of a batter, which, when the yeast has been added, is called the *sponge*. After fermentation this becomes very spongy indeed. More flour is then added, and the mixture is kneaded or "worked" into a smooth, elastic mass called *dough*. Another method, is to add sufficient flour at the first mixing to form a dough. In either case, the dough is left in a warm place, and the fermentation soon begins.

As a result of the fermentation, small bubbles of carbonic acid gas are formed in the dough, which begins to rise because the bubbles of gas that form all through it force it upward. If the dough be now put into a hot oven, the fermentation is increased for a time; the heat causes the small bubbles of gas to swell, and the dough

rises rapidly; but when it has become nearly as hot as boiling water the fermentation is suddenly stopped, and further baking keeps the mass in its expanded form.

When the baked Bread is cut, it is found to be full of small holes, formed by the carbonic acid gas that was produced in the fermentation. The whole loaf is light and spongy, instead of being hard and solid, like the hardtack made without yeast. The yeast, therefore, plays a very important part in Bread-making, and its action is worth still further study.

Its first effect is produced upon the starch granules, some of which it changes to sugar, and the sugar in its turn is changed into alcohol and carbonic acid gas. As the gas cannot escape from the dough, it causes it to swell, and on being heated the bubbles expand and make the bread still lighter. Meanwhile the starch on the outside of the loaf, which heats more rapidly than that on the inside, has been converted into a pasty substance called *dextrin*, which hardens and forms the crust. As the heat becomes greater on the inside of the loaf, the yeast is "killed," as we say, and the fermentation is stopped; most of the alcohol evaporates, leaving only two parts of alcohol in a thousand parts of Bread; the unfermented starch granules burst, and the cooking is complete.

Bread formed in this way is more suitable for food than the grain in its natural state would be. It has three distinct advantages — first, it is more palatable; second, it is easier to chew and to mix thoroughly with the fluids in the body that must do the work of digestion; third, the grains of starch have swollen and burst, and may be readily converted into sugar in the body, while in the raw state they cannot be acted upon so easily.

Bread made with yeast is open to two criticisms. In the first place, it takes an hour or more for the yeast to produce the necessary fermentation before the dough can be put into the oven; and, in the second, the Bread loses some of its value as food in the fermentation process. As we have seen, some of the starch is converted into alcohol and carbonic acid gas; the greater part of the alcohol escapes, and the gas has no nourishing effect. On account of these objections to the method of making Bread with yeast, various substances have been used to produce the carbonic acid gas in the dough without destroying any of the starch by fermentation.

These agents are known as baking powders, and, when mixed with the dough and put into a hot oven, they decompose and give off carbonic acid gas in the dough in little bubbles, like those produced in yeast fermentation. Baking powders act more quickly than the yeast, and do not cause any of the starch of the flour to be destroyed; but

some of them leave injurious substances in the Bread, some are uncertain in their action, and many are expensive.

There is another method of making Bread light that has been used only a few years, which seems free from these objections, but its use is practicable only in baking houses, where many loaves are made at one time. In this method no yeast or baking powder is required. The dough is made light by forcing carbonic acid gas into it by machinery, and there is no waste of starch by fermentation, nor is there any objectionable substance left in the Bread.

A cheap substitute for the baking powders that are sold ready for use is the mixture of bicarbonate of soda (baking soda) and sour milk, which is so much used in some parts of the country. The effect of this mixture in "raising" the dough is brought about by the action of the lactic acid, always present in sour milk, upon the soda. The acid and the sodium present combine to form *sodium lactate*, and the carbonic acid gas is set free.

Though yeast and baking powder were unknown to the Ancients, they had learned that when flour and water were mixed and allowed to stand for some time, fermentation took place, and a gas was formed. They also knew that when a lump of dough, in which fermentation was going on, was mixed with fresh dough, the whole mass was made to ferment. This knowledge enabled them to make light Bread, for it was easy to keep a small quantity of flour and water fermenting, and to mix some of it with more flour and water to make Bread. Bread made in this way is known as *leavened* Bread, from the fermenting dough called *leaven*. Bread made without leaven is unleavened Bread, which is referred to so often in the Bible; it contains nothing to make it light, and is much like hardtack.

The *salt-rising* Bread, that is made in the northern and western parts of the United States, is a kind of leavened Bread, the leaven of which contains salt. The term *salt-rising* is misleading, for the salt has nothing to do with the rising of the dough.

Crackers and wafers are made in various ways, but they never contain yeast or leaven, and very seldom contain any soda or baking powder. Their flaky structure is due chiefly to the greater amount of kneading that is given the dough.

GLASSWARE

GLASS-MAKING, which has been mentioned as one of the arts in which soda is used in large quantities, is by no means a purely modern industry. On the contrary, it is one of the oldest arts practiced by mankind to-day. Beads of glass, some of common clear glass, and some very richly colored, have been found in the wrappings of mummies that were buried in the Pyramids of Egypt more than three thousand years ago. Glass lenses, thousands of years old, have also been found in the buried ruins of Nineveh, in the valley of the Euphrates and Tigris rivers.

Examination of these ancient pieces of Glass seems to show that they were made in much the same way in which similar articles are manufactured to-day. It is true that our modern tools and machinery enable us to make Glass much more rapidly, and with much less labor, than our ancestors did, and we use it for many purposes that were unknown to them; but, in the main, the Glass they made so long ago is the same as that made by us to-day.

All Glass consists of a mixture of certain substances called *silicates*, which are formed by the chemical combination of sand and certain metallic compounds, when these are fused together. Pure sand, the chemical name of which is *oxide* of *silicon*, or *silica*, is a compound of oxygen with an element called *silicon*. When *silica* is heated with certain compounds of some of the metals, they melt and combine chemically with the *silica*, to form compounds called *silicates*. The different kinds of Glass are mixtures of various *silicates*.

When sand is heated with soda or potash, the Glass formed is found to be completely soluble in hot water, and is known as "soluble glass" or "water glass," but when lime (*calcium oxide*), or red lead (*lead oxide*), is added to the mixture of sand and soda or potash, the Glass formed on heating is much less soluble and, in fact, is the glass we use every day.

The uses to which Glass is put nowadays are so many and so different, that numerous varieties have been produced that have different properties and vary somewhat in composition. Sometimes the manufacturer's chief object is to make Glass very hard; sometimes it must be extremely soft; again perfect transparency and freedom from color are desired. In common bottle Glass and that which you see in skylights, cheapness is especially sought, and the maker puts into it the cheapest materials he can obtain.

It would take much too long a time to tell you how all the various kinds of Glass are made, and to describe the differences in their

properties; but there are two common varieties that are used in making most of the Glass articles with which we are familiar, and it is worth our while to know wherein they differ. These two kinds are "Crown Glass" and "Flint Glass."

Crown Glass is that used for windows, and may be either Common Blown Glass or Plate Glass. In making it, sand, soda, and lime or chalk are used. These are generally mixed with a certain amount of old, broken Crown Glass, which is called *cullet*. The addition of the *cullet* makes the other ingredients melt more easily.

Flint Glass differs in composition from Crown Glass, in containing potash instead of soda, and red lead instead of lime. It is sometimes known as Lead Glass. Flint Glass is not very hard, as you might think from its name. It is really much softer than Crown Glass. The name of Flint Glass was given to it, because the sand used in its manufacture is made by crushing flint.

The qualities of Flint Glass, that have caused its general use, are its transparency and its freedom from air bubbles. It is also readily melted, and this has led to its use in many ways, in which harder Glass could not be employed. It is more nearly free from all color than any other Glass yet produced, and for this reason it is employed in making lenses for spectacles, and other optical instruments, as well as for dishes, goblets and other household articles.

The making of Glass is, in principle, a very simple matter, and one that is easily understood; but there are many details in its manufacture that require constant attention, and great skill and dexterity are absolutely necessary in handling it.

The first step in the manufacture of Glassware is the making of the Glass. For this purpose, a large furnace, with a number of small doors around it, is located in the center of the Glass-house, and in this furnace are placed a number of pots, or crucibles, as they are frequently called. Each of these crucibles can be easily reached, through one of the many small doors in the wall of the furnace.

After the crucibles have been *charged* with the sand, and other materials to be used, the furnace is heated to a very high temperature, and the mixture soon begins to soften into a pasty mass, which finally becomes a liquid that will flow like water. This gradual softening of the Glass is of the greatest value to the Glass-worker, for it enables him to mold the Glass into almost any form desired, before it becomes cold and hard.

Before the Glass in the crucibles becomes perfectly fluid, the workmen collect masses of it around the ends of long tubes, and, after removing these from the furnace, they rapidly convert it into the shapes desired, by blowing, cutting, molding, bending, and twisting.

The making of so common an article as an ordinary wine-glass requires a number of these operations, which are performed with wonderful quickness and are extremely interesting to see; but to describe them here would require too much space.

After the articles have been shaped by the workmen, they must go through another very important process before they are ready for the market. This is a very slow cooling, known as *annealing*. The object of it is to make the Glass durable, for Glass that has not been annealed is exceedingly brittle and easily broken. In carrying out the annealing process, the Glass is simply drawn very slowly through a long oven, one end of which is heated quite hot, while the heat decreases gradually toward the other end, which is only slightly warm. By this operation a change is brought about in the Glass, that makes it much less liable to break from slight blows.

Another method of treating the Glass, which makes it tougher even than does annealing, is to heat it for some time in oil. This method is known as the *De la Bastie method*, and the Glass treated by it is wonderfully tough, and will withstand remarkably heavy blows and shocks.

All Window Glass is now manufactured by one of two processes, one of which produces *Plate* Glass, and the other the common sort of Window Glass. These two kinds may always be distinguished by the difference in appearance. Plate Glass is made by pouring molten Glass upon large tables and rolling it out with heavy rollers until it is perfectly flat and of uniform thickness. The common Window Glass, however, is made by taking a ball of molten Glass from the crucible on a pipe, blowing it into a hollow cylinder, and then, before it has cooled, cutting the cylinder along one side and spreading it out into a sheet. By this method it is impossible to make the sheets so flat, and the thickness so uniform, as in Plate Glass, and, in consequence, objects are seen through Plate Glass with much less distortion, than through common Window Glass.

Thus far, nothing has been said of the production of the many beautiful colors that are found in various kinds of ornamental Glassware, without mention of which, our account of Glass and its manufacture, would not be complete. All of these colors are due to the addition to the materials used in making clear Glass, of small quantities of certain compounds, generally oxides, of a number of metals. These have the property of melting with the Glass, and of diffusing through it very readily, so that a small quantity of coloring matter is often sufficient to give a deep, rich color to a large quantity of Glass. A red color in Glass is often due to the addition of gold, or in some cases of iron or copper compounds. Blue is produced by compounds of cobalt. The richest greens are obtained by

using chromium, though some shades may be produced with copper. The beautiful amethyst or purple tint, sometimes seen in Glass, is due to the presence of manganese, and a very rich yellow is produced with uranium.

EARTHENWARE

If the art of Glass manufacture can boast of great age, this is certainly none the less true of Earthenware and pottery. In the far Eastern nations of China and Japan, the art of making porcelain was developed long before the beginning of the Christian era, and it is questionable whether any of the Earthenware produced in the world to-day is equal in beauty to some of that produced thousands of years ago. Modern improvements in the art have resulted in cheaper methods of manufacture, and all kinds of Earthenware are now produced in much greater abundance. Some of the colors imparted to their porcelain by the Chinese and Japanese of long ago, however, seem beyond the skill of modern manufacturers.

Earthenware, as you already know, and as the name indicates, is made for the most part of earth, or, to speak more accurately, of clay. The peculiar property of clay that renders it fit for use in this way is the readiness with which it can be converted into a paste by mixing with water, and with which this paste can be converted by heat into a hard, solid substance, that is no longer acted upon by water. While in the pasty condition, the clay is molded into various shapes with as much ease as mud pies are made, and when the clay is heated, these shapes are made permanent.

All clay consists mainly of a silicate of the metal *aluminum*, and it is this compound that is of most value to the maker of Earthenware. When the clay is almost pure silicate of aluminum, it is white in color and is known as *kaolin*. This is used in making the finest grades of china and porcelain. Other clays, such as potter's clay, pipe clay, and blue clay, are mixtures of aluminum silicate with various substances, that can be melted with comparative ease. Kaolin will not melt, and in making china it is necessary to mix with the kaolin a certain quantity of other material, to form what is called a *flux*. This flux softens in the furnace and binds the particles of kaolin firmly together.

After the Earthenware has been baked, or *fired*, to use the technical term, the clay is fixed in shape, and is no longer acted upon by water; but the surface is slightly rough and somewhat porous. If moistened when in this condition the surface changes color, because the water soaks into it. To make the vessels more suitable for holding

liquids, it is necessary to make the surface nonporous and perfectly smooth, by giving it what is called a *glaze*. This is done in fine china by drawing the vessels slowly through tanks of water, in which have been mixed some kaolin and a larger proportion of the same kind of flux that was used in the original manufacture of the vessels. A thin layer of the flux, together with a little kaolin, is thus deposited on the outside of the vessels. When they are put into the furnace and fired again, this layer melts, and, on cooling, forms the smooth, glazed surface, that we are accustomed to see on china and porcelain.

In the cheaper forms of Earthenware, such as earthen jugs, jars, and sewer pipe, the glaze is often imparted by simply sprinkling on the surface of the vessels, while in the furnace, some substance that will cause the materials on the outside to melt and run together, so as to close the pores. Sometimes these materials are mixed with the clay of which the vessels are made. Common salt, borax, sand, and oxide of lead are some of the substances used for this purpose.

When china is painted or gilded with the paints used in ordinary painting on wood, paper, or cloth, the figures are apt to disappear at the first washing. In order to make the colors permanent, the paint is made by mixing the metallic compounds that form the colors with some flux like that used in the manufacture of china. After the painting has been done, the vessels are again fired and the colors *burned in*, that is, the flux melts and forms a kind of glaze on the surface of the china.

GUNPOWDER AND OTHER EXPLOSIVES

By EXPLOSIVES are meant substances that can be made to give off a large quantity of gas in an exceedingly short time, and the shorter the time required for the production of the gas, the greater will be the violence of the explosion. Many substances, that ordinarily have no explosive quality, may be made to act as Explosives under certain circumstances.

Water, for example, has caused very destructive boiler explosions when a quantity of it has been allowed to enter an empty boiler that had become red hot. Particles of dust have occasioned explosions in sawmills, where the air always contains large quantities of dust. A flame, introduced into air that is heavily laden with dust, may cause a sudden burning of the particles near it, and, from these, the fire may be conveyed so rapidly to the others that the heat will cause the air to expand suddenly, and this, together with the formation of gases from the burning, will cause an explosion.

It must not be thought, however, that fine sawdust or water would ordinarily be classed as Explosives. The term is generally applied only to those substances that may be very easily caused to explode.

The oldest, and most widely-known Explosive that we possess is Gunpowder, the invention of which is generally credited to the Chinese. It is a mixture of *potassium nitrate*, or *saltpeter*, with powdered *charcoal* and *sulphur*. The proportions in which these substances are mixed vary somewhat in different kinds of powder, but they usually do not differ much from the following:

Sulphur	10 per cent
Charcoal	16 " "
Saltpeter	74 " "

The explosive quality of Gunpowder is due to the fact that it will burn with great rapidity without contact with the air, and that in burning, it liberates large volumes of gas. When a spark is introduced into it, the carbon, charcoal, and sulphur combine with a portion of the oxygen contained in the saltpeter to form *carbonic acid* gas, and *sulphurous acid* gas, and, at the same time, the nitrogen contained in the saltpeter is set free in the gaseous form. This action takes place very suddenly, and the volume of gas set free is so much greater than that of the Powder that an explosion follows.

In the manufacture of Gunpowder all that is absolutely necessary is to mix the three ingredients thoroughly, and in the proper proportions. But to fit the powder for use in firing small arms and cannon it is made into grains of various sizes, the small size being used for the small arms with short barrels, and the large sizes for cannon. The reason for this is, that if the Powder is made in very small grains, it all burns at once, and the explosion takes place so suddenly that an exceedingly strong gun is required to withstand the explosion, while, if larger grains are employed, the burning is slower and continuous until the projectile has traveled to the muzzle of the gun. In this way, the projectile is fired from the gun with as much force as if the explosion had taken place at once, but there is less strain on the gun.

Powder of this latter kind always produces a considerable quantity of smoke, when it is fired, because there is a quantity of fine particles formed from the breaking up of the saltpeter and from some of the charcoal, which are not completely burned. This smoke forms a a cloud that takes some time to clear away, which is a very objectionable feature. In order to get rid of it efforts were made to produce a substance that would explode without leaving any solid residue, and

that could be used in guns. These efforts were finally successful, and there are now a number of *Smokeless Powders* in use.

The most satisfactory forms of Smokeless Powder are all made from Guncotton, or *nitrocellulose*. This substance, which is made by treating cotton with a mixture of *nitric* and *sulphuric acids*, is a chemical compound, not a mixture like Gunpowder; and when it is exploded it is all converted into gases, of which the chief ones are carbonic acid gas, nitrogen and water vapor. To cause the explosion of Guncotton it is not necessary to burn it, but a mere shock or jar will cause it to decompose with explosive violence. Of course, such a violent Explosive as this could not be used either in small arms or in cannon, but Guncotton can be converted into less explosive forms which are suitable for use in guns, and the majority of Smokeless Powders are made in this way. The methods used in producing the Smokeless Powders are kept secret by the various countries that use them.

Another very powerful Explosive, which is closely related to Guncotton, is *Nitroglycerin*. This compound is made by treating *glycerin* with the same sort of acid mixture that is used in making Guncotton. It explodes in the same way that Guncotton does and yields the same products. It is an oily liquid of yellow color, and on account of its liquid form, it is difficult to handle and use. The difficulty in handling Nitroglycerin led to the plan of mixing it with a quantity of very fine sand, called *infusorial earth*. When mixed with this, a solid mass, called *Dynamite*, is formed, which is easier to handle and more difficult to explode, but which has almost as much explosive force as Nitroglycerin.

A more powerful Explosive than either Nitroglycerin or Guncotton is obtained by mixing them together. When this is done, the Guncotton swells up by absorbing the Nitroglycerin, and becoming a brownish, jelly-like substance that is known as *Blasting Gelatin*. This is generally considered the most powerful Explosive obtainable.

Let us now consider for the moment what it is that makes Guncotton, Nitroglycerin and Blasting Gelatin explode so readily. The explanation is found in the presence in them of Nitrogen. As you remember from what you learned about air, Nitrogen is an extremely inactive element. It has no strong tendency to combine with other elements, and when it does enter into a combination with them, the compounds formed are almost always easily decomposed. In the compounds that have just been described, a shock causes a loosening of the bonds that hold the Nitrogen, and the whole compound goes to pieces, just as an arch falls when the keystone is removed.

THE CHEMISTRY OF PHOTOGRAPHY

IT HAS long been known that when certain chemical compounds, namely the chloride, bromide, and iodide of silver, are exposed to the light, they undergo a change that causes them to darken. This change forms the basis of Photography, as it is practiced to-day. Glass plates and strips of celluloid, that are coated with a thin layer of gelatin containing a quantity of bromide of silver, form the photographic plates and films, which the photographer exposes to the action of light in his camera.

After the exposure, no change can be seen in the plate; but if it is removed from the camera without being again exposed to the light, and is then treated in a "dark room" (one lighted with weak red light only) with certain substances known as *developers*, an image will appear on the plate, in which the dark parts correspond to the bright parts in the object photographed. On account of this last peculiarity, the image is called a negative. The image on the plate is formed by the decomposition of metallic silver at the points where the light acted on the plate. This is the result of a chemical change that takes place in the silver bromide, when the plate is exposed.

Just what the nature of the change is has not been discovered; but we know that a change takes place, for silver bromide that has been exposed to light is easily decomposed by developers, while silver bromide that has not been so exposed is unaffected by them. Since the greatest change in the silver bromide occurs at the points where the light is strongest, the greatest deposits of silver on the plate, and the darkest parts of the image, must correspond to the brightest parts of the object.

After the image has been fully developed, the unchanged bromide of silver on the plate must be removed, or the whole plate will darken as soon as it is exposed to the light again. The removal of the unchanged silver compound is accomplished by soaking the plate in a solution of hyposulphite of soda. This dissolves the bromide of silver and fixes the image. If, however, any of the hyposulphite of soda is left on the plate, other changes will follow that will finally destroy the image, so the plate must now be washed in water until every trace of hyposulphite is removed. It is then dried and used for printing.

In printing from a negative, a piece of paper having some compound of silver on its surface is placed under the negative, and is exposed to the action of the light. An image then forms upon the paper, in which the dark parts correspond to the light parts of the negative, that is to the dark parts of the object photographed, for the image is now reversed a second time.

The image formed in this way is not permanent, for if we continue to expose it to light, the whole surface of the paper will darken, and the image will disappear. To prevent this, the image must be fixed, as was done with the one on the plate, by soaking in hyposulphite of soda, and finally washing the paper to remove the hyposulphite. An image that is tolerably permanent will be formed in this way; but it is of an ugly, yellowish color that is not at all desirable. If, however, the print is put into a weak solution of chloride of gold, after the fixing is complete, the gold will replace the silver in the image, and will cause its color to change from the undesirable tint first obtained, to a rich purplish brown. This process is called *toning*, and besides improving the appearance of the picture, it makes it more lasting, for an untoned print will always fade gradually, while one that has been properly toned is quite permanent.

INDIA RUBBER

This interesting and useful substance is obtained from the sap of several varieties of trees which grow in Central America, the East Indies, and the valley of the Amazon in South America. Most of the Rubber used in the United States is obtained from the Amazon region, where the largest variety of Rubber trees is found. The small Rubber trees that are sometimes seen growing in pots in this climate, are of the same species as those of South America, but their growth has been dwarfed by the cold.

The sap of the Rubber trees is collected by the natives of tropical countries, in much the same way that we collect maple sap for making maple sugar. As it exudes from the incision made in the bark of the trees, the Rubber sap is a milky fluid and is so viscid that only a few ounces flow from a tree in a day. In the course of the collecting season, however, a large tree yields about twenty gallons of sap, from which forty pounds of Rubber are obtained.

To convert the sap into Rubber, it must be dried in the sun or over a fire. The latter method is most frequently used, and it is done by dipping a broad-bladed wooden paddle into the sap, and holding it for a few minutes in the smoke that arises from the fire; this operation is repeated as soon as a layer of Rubber forms on the paddle. In this way a ball weighing ten or twelve pounds is soon formed on the paddle, and in that form the Rubber is ready for market.

The manufacture of articles of all sorts from Rubber begins with the purification of the crude Rubber. For that purpose, the lumps of Rubber are first boiled for some time to soften them, and are

then torn to shreds by cylinders armed with knives. The tearing is done in a stream of water that washes away the impurities and leaves the Rubber ready for the subsequent processes of manufacture, the nature of which is determined by the character of the articles to be made.

Formerly all Rubber articles were made from the pure Rubber, but now almost all the Rubber that we see has been treated by a process, known as vulcanizing, by which its fitness for most purposes is greatly increased. This process consists in mixing the shreds of Rubber with varying quantities of sulphur, and heating it for varying lengths of time. By using a small proportion of sulphur and heating for a short time, soft Rubber is obtained, and by using a larger proportion of sulphur and heating for a longer time, hard Rubber is produced.

The uses to which Rubber is put are so numerous that many pages would be required for the mention of them; only a few, therefore, of the most important will be spoken of here. The use of Rubber in waterproof garments, for the tires of vehicles, for hose and belting, and to form the handles of implements, is, of course, well known; but there are two other extremely important uses of Rubber, of which you may never have heard. One is its use by dentists to form the plates in which artificial teeth are imbedded, and the other is as an insulator for wires and cables which carry electric currents. The discovery of the process of vulcanizing Rubber almost revolutionized dentistry; and it made the construction of ocean telegraphs possible. Before the days of vulcanized Rubber, the plates for artificial teeth were made of gold, which was not only expensive, but hard to work into the desired form; and no insulating material used before the discovery of the vulcanizing process was capable of successfully resisting the corroding effect of sea water.

SUN, MOON AND STARS

By PROF. MILTON UPDEGRAFF
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"TWINKLE, twinkle, little star,
How I wonder what you are!
Up above the world so high,
Like a diamond in the sky."

THIS familiar little nursery rhyme, which we have all heard so many times, expresses a feeling that most of us have often experienced. It is almost impossible for anyone who has not studied the heavenly bodies, to gaze up into the sky on a cloudless night and not to wonder what is the real nature of the little specks that sparkle, like diamonds, against the dark background of the night-sky. No doubt you have asked yourself what they are, how far they are from the earth and what causes them to shine as they do.

Perhaps you have learned that these twinkling Stars are Suns like our own, but there are many other things which you ought to know about them. You ought to know more, too, about our own Sun, which gives us light and heat, and about the pale, beautiful Moon, which at times seems almost to transform night into day.

There are also in the sky other objects, about which you will be deeply interested to learn. There are the planets, which in some ways, resemble the Stars, but which shine with a clear, soft light, instead of twinkling, and which seem to move about among the groups of Stars, instead of occupying fixed positions. Then there are the comets, which look like Stars with long

tails. Sometimes one appears that is of such size and brilliancy as to be the most conspicuous object in the sky as long as it remains visible. Meteors, or "shooting stars," as they are sometimes incorrectly called, are frequently seen, rushing like rockets among the Stars and then suddenly vanishing. These, too, we all ought to know about.

Long before the time of Christopher Columbus, astronomers knew that the earth was a large, round ball, hanging in space, without material support. But the fact that the earth revolves about the Sun once in a year, thus causing the seasons, and rotates on its axis once in twenty-four hours, thus causing the Sun to rise and set, and producing day and night, became known only about three hundred and fifty years ago. Not all the secrets of the heavens have been unfolded, but many things that were once mysteries, have been made plain. In the following pages, you will be told some of the main facts that have been discovered concerning the heavenly bodies, and will so be given a glimpse of the science of Astronomy.

If this science simply taught us the truths about all the wonderful works of nature of which we have spoken, it would be a noble science and well worth our study; for to learn the great truths of the universe will help us to be better and wiser men and women. But Astronomy has other very practical uses, besides simply increasing the sum of human knowledge. For one thing, it helps the sailor. Some of the principal observatories in the world, among them the United States Naval Observatory and the Royal Observatory at Greenwich, were founded for this express reason.

Ships on the ocean, out of sight of land, depend upon the Stars and the Sun to guide them over the trackless waters. Astronomers have accurately calculated the places of the heavenly bodies in the sky, and captains of ships are provided with instruments and charts which enable them to determine the positions of their vessels, whenever the sky is clear. Another use of Astronomy is in finding the size of the earth and in making accurate maps of its surface. Those who carry on this important work depend upon the place of the Stars as a basis for all they do.

THE CELESTIAL SPHERE

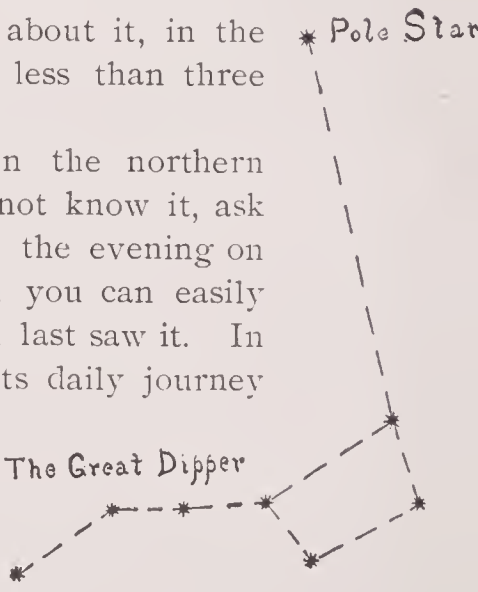
The sky seems to spread over us like a great dome, upon whose inner surface the stars are sprinkled in groups. Some of the stars are very brilliant, others seem mere specks, and still others are so faint and are crowded so closely together, that they appear like far-distant clouds. Wherever we go on the earth's surface we still see the dome-like shape of the sky, as though the earth were surrounded

by a great hollow sphere, which, however, we know is apparent, not real. Astronomers speak of the heavens, or sky, as the *Celestial Sphere.*

The stars are really at enormously unequal distances from the earth, but they are all so very far away that they appear to be equidistant from us. To count the stars that we see is not such a hard matter as it appears to be. The number we can really see at one time with the naked eye is not very large, being between two thousand and three thousand. Unless the sky is very free from clouds and haze, we see an even smaller number. If we use an opera glass, many more stars appear, and when great telescopes are used, millions of stars may be seen. With telescopes, too, it is possible to learn many things about the stars and to measure their distance from each other on the Celestial Sphere.

We have all observed the fact that the sun rises and sets each day. In the morning, we see it shining in the east; at noon, it is nearly over our heads; and in the afternoon, it is slowly setting in the western sky. We have noticed, too, that the moon rises and sets, although its times of doing so seem less regular than those of the sun. It may be that some have failed to note the fact that the stars also seem to move from east to west. Not all of them rise and set, for some are always in the sky, and if it were not for the clouds and sunshine we might always see them. But all move in circles about what are called the *poles* of the Celestial Sphere.

A large part of those seen by people living in the United States move in circles about the northern pole. Most of us know where the *pole star* is. It lies near the pole, and moves daily about it, in the sky, in a small circle, the radius of which is a little less than three times the diameter of the moon.

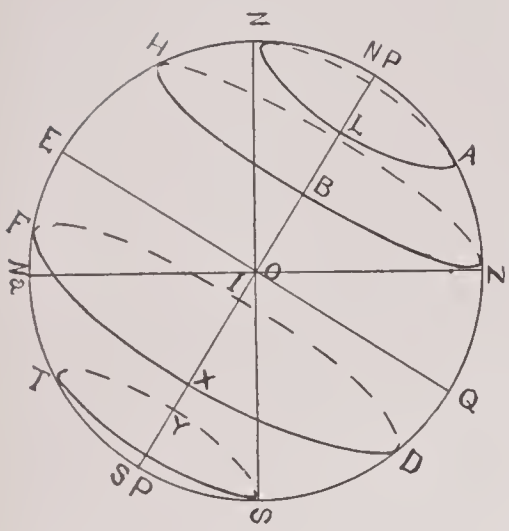


(Fig. 1.)

The *Great Dipper* (Fig. I.) is a group of stars in the northern sky with which most of us are familiar. If you do not know it, ask some one to point it out to you. Look at it early in the evening on the next clear night, and again three hours later, and you can easily see that the whole group of stars has moved since you last saw it. In fact, during the three hours it has gone one-eight of its daily journey around the pole.

All stars that are nearer to the pole than the pole is to the horizon, which is the line at which the earth and sky seem to meet, describe their daily circles entirely above the horizon and so never set. (Fig. II.) Stars that are farther from the pole than the pole is from the horizon, describe part of their daily circles above the horizon and part below it; that is to say, they rise and set like the sun. Midway

between the north and south poles of the Celestial Sphere lies the celestial equator, and stars north of it describe their daily circles around the north pole. Stars south of the equator describe their daily circles around the south pole.

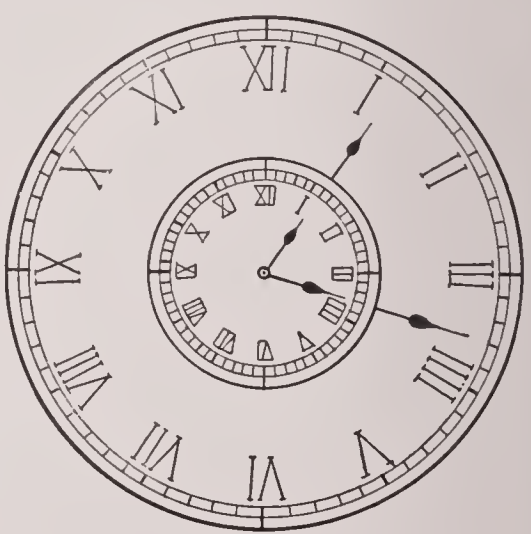


(Fig. II.)

Before going on to learn of the sun, moon and stars, and of their positions in the heavens, it is important that you should understand how angles are measured, for all distances upon the Celestial Sphere are measured as angles.

Every circle, no matter what its size, is divided into three hundred and sixty equal parts, which we call degrees. If the circumference of a circle is divided into degrees, and lines are then drawn from the points of division to the center of the circle, three hundred and sixty equal angles will be formed at the center, each of which will correspond to one of the degrees into which the circumference has been divided. Each of the angles is said to be measured by the part of the circumference which lies between its sides. Consequently, each of the angles formed in the manner just described is said to be an angle of one degree, or 1°. The term Degree is used, therefore, in reference both to angles and to parts of the circumference of circles, or arcs. A degree in the sky is equal to about twice the apparent diameter of the moon. The length of a degree in feet varies with the size of the circle, but the angle that a degree measures is always the same. You may understand this better by thinking of the dials of a watch and a large clock. (See Fig. III.)

Each dial has its circumference divided into sixty parts. The points that separate these parts are much closer together on the watch than on the clock, but each division marks a minute as truly on the watch as on the clock. When the minute hand is at XII and the hour hand is at III, they are separated from each other by an angle which is in each case one-fourth of the circumference of the dial, or by 90°, which is one-fourth of the 360° into which the circle is divided.



(Fig. III.)

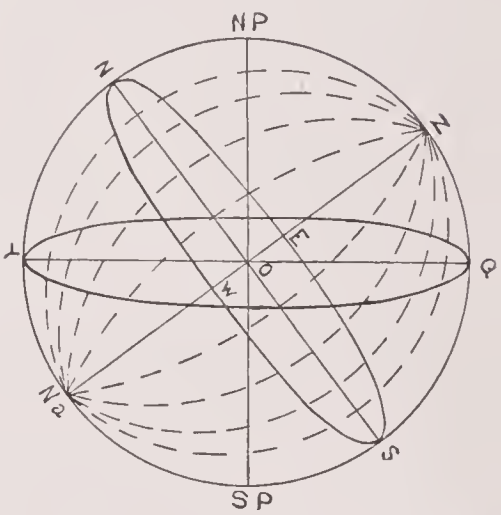
In astronomical measurements we have to deal with circles of all sizes, but usually we are not concerned with miles, feet, etc., but only with angles. If we know that a certain part, or arc, of a circle is one degree in length, and we can measure the length of the degree

in miles, it is plain that we can thus learn the entire length of that circle in miles. This is the principle that is used in determining the size of the earth, and in many other such problems.

There are certain imaginary circles and points on the Celestial Sphere which we should keep firmly fixed in our minds. The *zenith* is the point in the sky directly over the observer's head. The *nadir* is the point on the Celestial Sphere directly under the observer's feet. The nadir is on the opposite side of the earth from the observer, and is, of course, invisible.

The *celestial horizon* is a great circle around the sky, midway between the zenith and the nadir. This is not to be confused with the term *horizon*, as commonly used to designate the line which bounds our view, and which depends in extent upon the height from which we look and the nature of the country about us. At sea the horizon is a circle.

Any number of great circles can be imagined as drawn from the zenith to the nadir. In every one of these circles the zenith and nadir will be separated by half the circle's circumference, or one hundred and eighty degrees. The horizon is everywhere ninety degrees from the zenith and ninety degrees from the nadir. An angle of ninety degrees is called a right angle. The great circles drawn through the zenith and nadir are, therefore, said to cut the horizon at right angles, and are called *vertical* circles. That particular vertical circle which passes through the north and south points of the horizon is called the *meridian*.



(Fig. IV.)

In Fig. IV. the observer is supposed to stand at O. His circular horizon is represented by N E S W, N and S being, respectively, its north and south points. N. P. represents the north pole, and S. P. the south pole, of the Celestial Sphere. Y E Q W represents the celestial equator. Z is the observer's zenith, and Na his nadir. The great circle N Z S Na represents the observer's meridian.

THE EARTH

Among the subjects that interested the early astronomers were the shape of the Earth, and its position and importance with respect to the heavenly bodies. The most common belief was that the Earth was flat and supported by some unknown means in the midst of the universe, while the sun, moon, and stars revolved around it. The

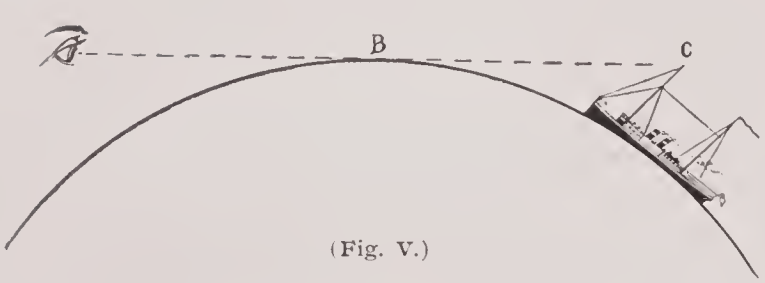
idea that the Earth was round gradually became accepted, and about three hundred years ago it began to be understood that there was a resemblance between the Earth and the heavenly bodies. We know that instead of being the center of the universe, the Earth is one of a number of bodies called *planets*.

These planets all revolve about the sun in paths, called *orbits*, which are nearly circular. A number of the planets have *moons*, or *satellites*. Wherever one of these exists it revolves around its planet and moves with it in its orbit around the sun. The sun, the planets, and their moons together form what is called the solar system.

There are eight large planets, and there are also several hundred small ones, called asteroids. The members of the solar system are our nearest neighbors in the heavens, and are near enough for us to be able to learn a good many things about them. Later, we shall take up some of the more important facts about the sun and the planets. For the present, let us give our attention to the planet on which we live.

The Earth is shaped like a ball and is slightly flattened at two opposite points called the *poles*. There are a number of ways of proving that the Earth is round, some of which may be known to you from your study of geography. The fact that men can sail around the world and return to their starting point is sometimes called a proof of this fact, but it is not really so. If the Earth were cheese-shaped, as was once thought, men could still sail around it. The shadow of the Earth that is thrown on the moon when it is eclipsed, is always circular. This could not be true if the Earth were not round.

If there are no hills, trees or buildings to interfere with our outlook, we always find the horizon circular. On the ocean, for instance, the sky and water seem to meet in a circle, of which the observer is the center. This circular horizon is another proof that the Earth is round. When we watch a ship sailing away from us over the ocean, the top of the mast is the part we see longest. (Fig. V.) Now the hull of the ship is its largest part, and if the earth were flat, it would be the part we should see last; but since the Earth is round, the lower part of the outward-bound ship is lost to sight first, while the highest parts are the last to disappear. This is one of the most convincing proofs that the Earth is round.

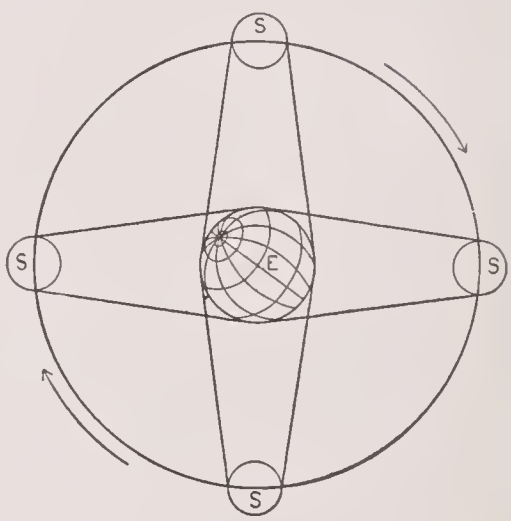


(Fig. V.)

The power which the sun has to hold the planets in their orbits is called *gravitation*. This is simply the attraction of matter for matter,

which was discovered by Sir Isaac Newton, about two hundred years ago. So far as we know, gravitation exerts the same power throughout all the universe, and every particle of matter attracts every other particle.

The sun is the largest mass of matter in the solar system, therefore it has the greatest power of attraction for us. The laws that govern the attraction of matter for matter are known, and by the application of these laws, and by careful observations of the different members of the solar system, astronomers have been able to find the weight and size of each one of these bodies. As stated before, the Earth's diameter is known to be about eight thousand miles. Its weight has been found to be greater in proportion to its size than would be the case if it were no denser, at great depths, than it is on the surface. We are sure, therefore, that the interior of the Earth is very dense — as dense, perhaps, as the heavier metals.



(Fig. VI.)

Day and night are the result of the Earth's rotation on its axis. As the Earth turns from east to west, one part of it after another is exposed to the sun's rays. In Fig. VI., it may be seen that the apparent daily motion of the sun around the Earth, which is really the Earth's rotation on its axis, causes different portions of the Earth to receive the sun's rays at different times, and thus, while it is night in one place, it is day in another. Let us think of the different cities, London, Chicago, and San Francisco.

As the Earth rotates so as to bring London into the sunshine, the people there will first see the dawn; then the sky will grow lighter and lighter, until they are brought where they can actually see the sun and, as we say, the sun rises in London. The Earth continues to rotate, and London is brought more and more directly under the sun, until, at noon, that body occupies the highest point it will reach in the London sky that day. Then, as the Earth still rotates, London will be gradually moving out from under the sun. The appearance is that of the sun moving from the highest point in the sky, lower and lower, until it reaches the horizon, and the sun sets; that is to say, London is carried out of sight of its rays. For some little time after sunset a faint light, called twilight, remains in the sky, but the Earth continues to rotate, and gradually London is carried entirely out of the sunlight.

Chicago is about six hours behind London, as to the time of sunrise, noon, sunset, etc. When it is noon in London, it is about the

time of sunrise in Chicago. As we go farther west and reach San Francisco, we find that it is almost two hours behind Chicago, and that when it is noon in San Francisco, it is two o'clock in the afternoon in Chicago. If we try to set our clocks and watches exactly by the place of the sun in the sky, we shall have to keep changing our time as we travel east or west. For instance, there is a difference of twelve minutes between the time of noon in New York and in Washington. To be constantly changing the reading of our timepieces in this way would be very inconvenient, and it is not now necessary.

The United States has been divided, from east to west, into four sections, in each of which the time of a point near its center is used. Thus, four different kinds of time are used throughout this country. These four kinds of time are known as Eastern Time, Central Time, Mountain Time and Pacific Time. Eastern Time is about the correct time for Utica and Philadelphia; Central Time is nearly correct at St. Louis; Mountain Time is nearly right at Denver, and Pacific Time is ten minutes faster than the correct or local time at San Francisco.

The sun crosses our meridian every day, and when it is on the meridian, we say it is noon. From noon one day until noon the next, is an interval that we divide into twenty-four hours. We call this interval of time a sun day, or solar day. As the length of time from noon to noon varies a little during the year, it has been found convenient to adopt a standard day, which is the average in length of all the three hundred and sixty-five days of the year. This standard day is called the *mean solar day*. All clocks and watches that we use in daily life are regulated to keep mean solar time.

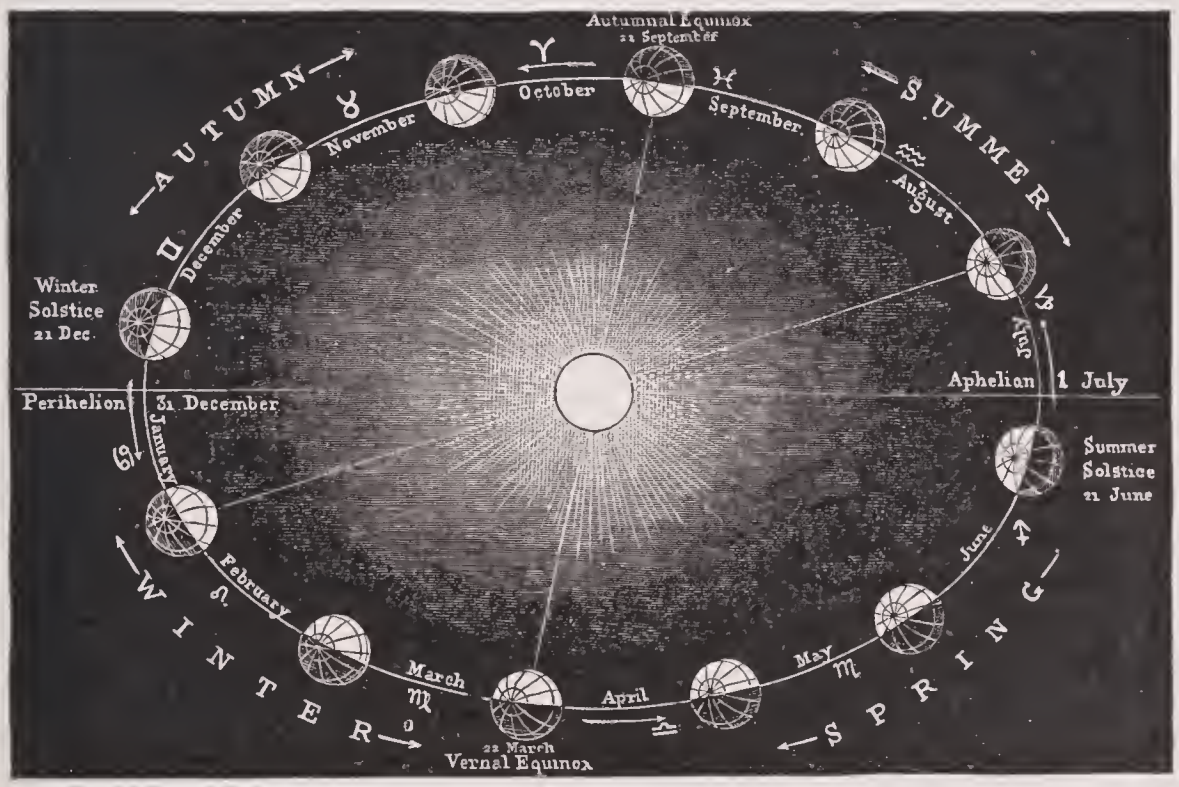
There is another kind of time in use in observatories called star time, or *sidereal time*. The length of a sidereal, or star day, is found by observing the interval between the times at which a certain star crosses our meridian, on two successive days. The star day differs in length from the sun day, because the sun does not remain in a fixed position among the stars, but is constantly moving eastward. It moves far enough every day to make the difference between the sun day and the star day amount to about four minutes.

Star days are all of exactly the same length. Each one is as long as the time which it takes the Earth to rotate on its axis. The star day, like the sun day, is divided into twenty-four hours, each star hour being a little shorter than a sun hour. There are three hundred and sixty-six star days in the year. Every large observatory has a sidereal clock, as well as a mean solar clock. The two clocks read exactly the same at only one time during the year, about the twenty-first of March, which is called the *Vernal Equinox*.

We have been using the word day as meaning an interval of twenty-four hours. When we speak of day and night, however, we mean by day the length of time that the sun is above the horizon and it is light. The length of this kind of day, as you know, varies greatly during the year. Twice a year, about March 21 and September 21, the days and nights are of equal length. These times are called the *spring equinox* and the *fall equinox*. After the spring equinox, the days gradually grow longer, until about June 21, which is generally the longest day in the year. After this date the length of the days slowly decreases until, at the time of the fall equinox, day and night are again equal.

The days continue to grow shorter after the fall equinox, until about December 21, when we have the shortest day of the year and the longest night. After this date, the days again gradually grow longer, and day and night are again equal about March 21.

Fig. VII. illustrates the way in which the seasons are caused by the motion of the Earth in its orbit.



(Fig. VII.)

The length of day and night is the same all over the world at the times of the equinoxes. At other times there are great differences in the length of the day at different places, the differences at any time depending upon the distances from the equator of the points of reckoning. At the equator, all days and nights are equal; but the

farther we go either north or south of the equator, the shorter become the short days of the year and the longer become the long days. June days are appreciably longer in Minnesota than in Louisiana.

At the poles, the year consists of but one day and one night, each six months in length. No one has as yet reached either pole, but arctic explorers have gone so far north as to find the nights several months in length. There are a number of places in the far north of Europe where the sun does not set for a number of days in midsummer. These places are often visited by tourists, for the sake of enjoying the strange sight of the sun shining at midnight,—the so-called "midnight sun."

Besides rotating on its axis, the Earth, as you have been told, moves in its orbit. We can see the effect of this motion in the change of the sun's position among the stars. This change was noted by early astronomers. They, of course, could not see the stars that were close to the sun at any time, for the sunlight quite hides the stars near it. But they would naturally observe what bright stars appeared in the west soon after sunset, what stars were near the meridian at midnight, and what stars were in the east before sunrise.

By noticing the positions of the stars, at different seasons of the year, they were able to calculate with a fair amount of accuracy the sun's yearly path among the stars. This path they called the *ecliptic*, because eclipses of the sun or moon always took place within it. The ecliptic passes through various groups of stars and near many bright ones, and the early astronomers noticed that the planets and the moon are always found within a short distance of the ecliptic.

From what you know about angular measurement, you will understand what is meant when you are told that the planets are never found farther than 8° from the ecliptic. The sun's apparent motion in the ecliptic is due to the real motion of the earth in its orbit. The apparent paths of all the planets lie within a part of the celestial sphere that is only 16° in width. This forms a sort of narrow belt, or zone, upon the surface of the celestial sphere, and in it the planets move along paths inclined to each other at small angles.

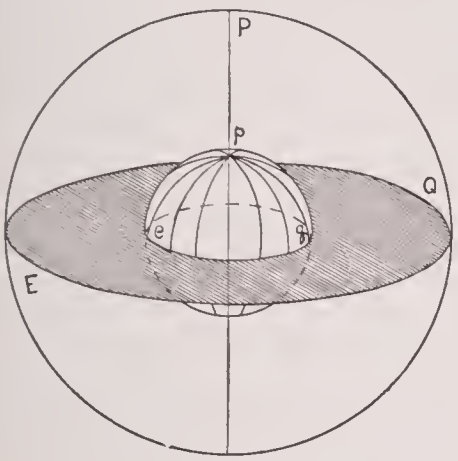
The planets all lie in nearly the same plane, hence the solar system may be described as circular and flat. A special name was long ago given to that part of the heavens that lies between 8° north and 8° south of the ecliptic. It is called the Zodiac. There are twelve important star groups, or constellations, lying either entirely or chiefly in this belt.

The Zodiac is sometimes said to be divided into twelve signs, each sign being named for one of these constellations. It might be well to learn these signs of the Zodiac, for it is often convenient to

know them. Here is a rhyme by Watts, the English hymn writer, which gives them in convenient form:—

"The Ram, the Bull, the Heavenly Twins,
And next the Crab, the Lion shines,
The Virgin and the Scales;
The Scorpion, Archer and He-goat,
The Man that bears the watering pot,
And Fish with glittering tails."

The Earth's equator, as you know, is an imaginary line which passes around the Earth midway between the poles, and is everywhere 90° distant from each of them. If we suppose the plane of the Earth's equator to be extended until it cuts the celestial sphere, the circle thus described will be what is called the *celestial* equator. (Fig. VIII.)

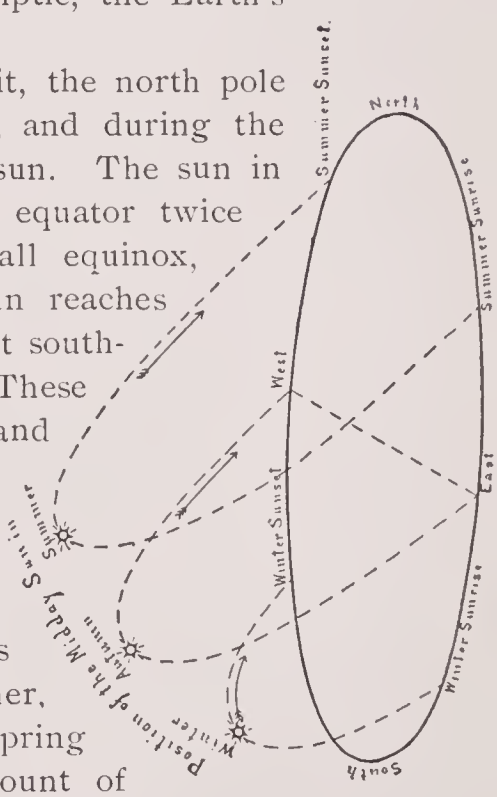


(Fig. VIII.)

The ecliptic is another great circle on the celestial sphere, and is formed by the intersection of the plane of the Earth's orbit with the celestial sphere. The angle between these two great circles, the celestial equator and the ecliptic, is twenty-three and one-half degrees. As a result of this angle between the equator and the ecliptic, the Earth's axis is tilted toward the sun.

As the Earth moves around the sun in its orbit, the north pole tips toward that body during one-half of the year, and during the other half it is the south pole that tips toward the sun. The sun in its apparent motion around the ecliptic crosses the equator twice each year. These are the times of the spring and fall equinox, of which we have already spoken. In June the sun reaches its most northern position, and in December its most southern position, as seen from the Earth. (Fig. IX.) These two periods are spoken of as the *summer solstice* and the *winter solstice*.

The accompanying figure shows the sun's apparent daily paths above the horizon at the times of the equinoxes and the solstices. By looking carefully at this figure, we can see from it two reasons why we receive the most heat from the sun in summer, least heat in winter, and a moderate amount in spring and fall. One reason for the difference in the amount of heat that we receive at different seasons is the variation in the length of time that the sun is above the horizon. The other

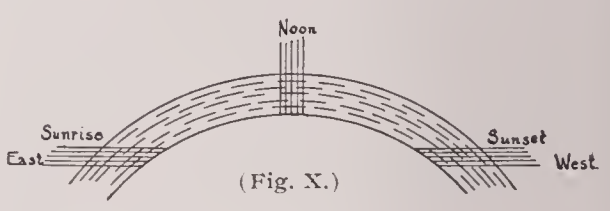


(Fig IX.)

reason is, that the direction of the sun's rays also varies with the seasons.

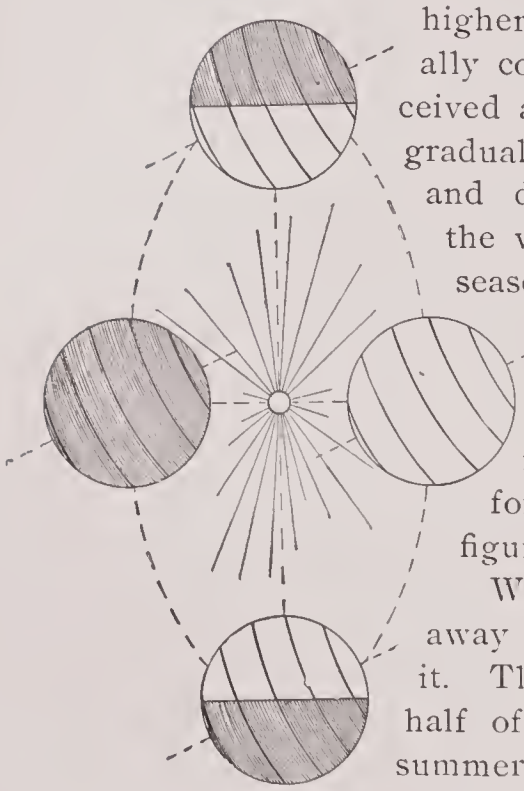
You have doubtless noticed that in midsummer the sun is above the horizon much more than half of the twenty-four hours, while in midwinter the opposite is true. The summer nights are so short, that the air and land do not have time to lose much of the day's heat, before the sun is again in the sky. In the winter, the nights are much longer than the days. The Earth has hardly time to warm itself in the sun's rays, before the sun sets, and the heat that has been received begins to disappear.

In summer, the sun at midday is almost directly overhead. Now the more vertically the sun's rays strike a surface, the warmer that surface becomes, simply because more rays fall upon it. We see evidence of this daily. At night and morning, when the sun is near the horizon, we receive much less heat than we do at midday, when the sun is more nearly over our heads. The reason for this is apparent from the accompanying figure. (Fig. X.)



(Fig. X.)

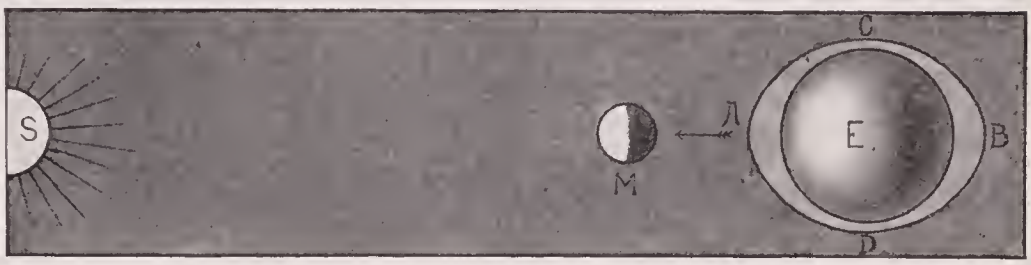
In general, the day becomes warmer as the sun rises higher and higher in the sky, is warmest at about noon, and gradually cools off toward nightfall. Similarly, the heat received at noon, at any place in the United States, increases gradually from the winter solstice to the summer solstice, and decreases gradually from the summer solstice to the winter solstice. In the southern hemisphere, the seasons occur in the same order as in the northern hemisphere; but there is six months difference in the time of the seasons in the two hemispheres, so that when it is winter in the former, it is summer in the latter, and so on. The reason for this difference is shown in the accompanying figure. (Fig. XI.)


(Fig. XI.)

When it is winter with us, the north pole is tilted away from the sun and the south pole is directed toward it. The sun's rays fall more vertically on the southern half of the Earth than on the northern half, and it is summer in the southern hemisphere. When our summer time comes, it is the north pole that is tilted toward the sun, while the south pole is tilted away from it. The northern half of the Earth then receives the more nearly vertical rays, while the southern hemisphere receives the more oblique ones.

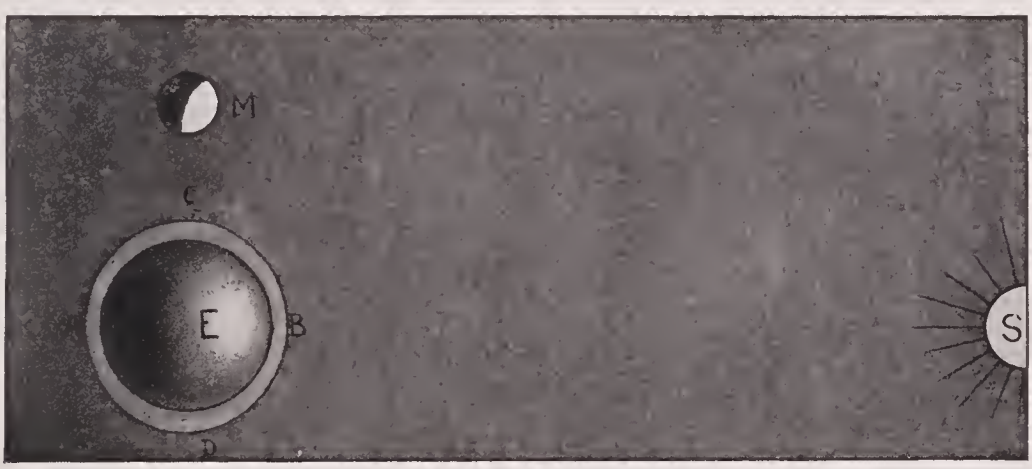
That remarkable property of matter known as gravitation, which has already been mentioned as the force that keeps the planets in their orbits, manifests itself in another way. Its largest and most important effect is its action in retaining the planets in their orbits around the sun, and the moons in their orbits around their planets; thus controlling all the motions of the solar system.

Another and smaller effect of gravitation is seen in the tides, which continually rise and fall on the shores of the oceans, and other large bodies of water. The tides are caused by the attractions of the sun and moon. At new moon and full moon the sun and moon act together, and produce very high tides, which are called *Spring Tides.* (Fig. XII.)



(Fig. XII.)

At the moon's first and third quarter, the sun and the moon act in opposition to each other, and the lowest, or neap, tides are produced. (Fig. XIII.) The sun, although much larger than the moon, is so far away, that its tide-producing power is less than one-half that of the moon. For the sake of simplicity, let us consider the tides produced by the moon, as they would be, if not modified by those produced by the sun. Let us remember that while the Earth attracts



(Fig. XIII.)

the moon with sufficient force to retain it in its orbit, the moon also attracts the Earth. The power of this attraction at any part of the Earth depends upon the distance of that part from the moon. The attraction is strongest on the side of the Earth nearest the moon, and least on the opposite side. If the Earth were soft, it would be pulled out of shape; but since it is rigid, its shape is not distorted, and it is only the water on the surface of the Earth that is noticeably affected

by the attraction of the moon. Since water is fluid and responds readily to any force that acts upon it, the water on the side of the Earth toward the moon, is drawn toward that body. The Earth, being nearer the moon than the water on the opposite side, is drawn away from the water.

In this way two tides are produced at the same time, one on the side of the Earth toward the moon, and one on the opposite side. The rotation of the Earth on its axis, from west to east, causes the tide to move westwardly over the ocean. Out in the open ocean the rising and falling of the water twice a day is not seen by people on board a ship, because the ship itself rises and falls with the water; but on the shores of the sea the rise and fall of the water is something familiar to all who have lived near the ocean. The height to which the tide rises varies in different places, being higher on the eastern coast of the continents than on the western. The tide rises higher in bays and estuaries, than it does on capes and headlands.

In the Bay of Fundy the tide sometimes rises to a height of seventy feet or more. The tides also run up rivers to great distances, and this, too, often in spite of a strong current. This matter of the tides is an interesting subject, which can only be treated very briefly here, but there are many curious things about the tides which you may learn later on.

They have produced a great impression upon the human mind, and are often referred to in literature, and used as a means of illustration. For example, ships often come into port at high tide when otherwise the water would be too shallow. Shakespeare may have had this fact in mind when he wrote these words, which should be remembered by everyone: —

"There is a tide in the affairs of men, which, taken at its flood, leads on to fortune."

THE SUN

THERE is nothing in the sky that compares with the Sun in magnificence. In fact, it is the most striking object in nature. Its splendor is too great to permit of its being watched with the naked eye, unless it is hidden by clouds or haze. But even if we cannot look directly at it, we are always conscious of its presence or absence. Stars may rise and set without our being interested in the fact, but when the Sun rises, it becomes light, we can see each other's faces, and can safely go about and undertake many tasks that are impossible in the darkness.

When the Sun sets it becomes dark and all activities must cease, except such as can be carried on by artificial light. In the summer we try to shield ourselves from the Sun's rays, for the heat, which is so necessary to ripen corn and other grains, is greater than we can easily bear. In winter, we try to spend what time we can in the direct sunshine, and we find its warmth most grateful.

It is hard to realize that the fixed stars are all suns, many, perhaps most of them, larger than our own Sun, but so far distant from us that we see them only as points of light. Just as the Sun, when seen from the earth, outranks all other heavenly bodies in beauty and brightness, so its importance to us also outranks that of all the others. As has been said before, the Sun is the center of the solar system, and is by far its most important member, since it is the attraction of the Sun that retains the planets in their orbits.

Almost all the light and heat that we receive come from the Sun. The light of the stars is very faint, and moonlight is merely reflected sunlight. We know of no form of life that does not depend on the Sun, in some way, for its very existence. Plant life thrives with sunshine and rain. It receives both of these from the Sun, for rain falls from the clouds, and it is the heat of the Sun that has caused the moisture to rise from the sea and form clouds. Animal life depends for its food on plant life, so we can easily see that it is the Sun that keeps everything alive.

In ancient times men worshiped the Sun. They were impressed with its splendor and partly understood how much they owed to it. We now know that there are many benefits that we receive indirectly from the Sun which are as important as the more apparent ones. The winds that blow, and the snow that covers the grass like a blanket and protects it in winter from the most severe cold, are due to the Sun, just as truly as are the light and warmth that we receive directly from the Sun's rays.

The wood that we use for building material, for furniture and for fuel, grew with the Sun's aid. Coal, as you know, is useful to us in very many ways, in warming our houses, in furnishing the power for railway trains, steamships and many forms of manufacture,—in fact, it would be hard to imagine the world of to-day without coal. It, too, we owe to the Sun, since it was formed from forests that grew ages ago by the aid of the Sun's rays.

Let us see what are some of the most important facts that have been discovered about the Sun. The surface that sends out the light that we receive is called the *photosphere*. In looking at the photosphere with the telescope, we should, perhaps, expect to see a smooth, shining, golden surface. That which is really seen appears like brilliant

grains scattered over a background that is less brilliant. This appearance is sometimes described as like snowflakes, scattered over a gray cloth, and the brilliant grains are often referred to as *rice grains*.

Although they appear very small when seen in the telescope, we know that they are really of considerable size. Two of them, laid side by side, would extend from New York to Chicago. Here and there over the Sun's surface appear streaks, called *faculæ*, which are even more brilliant than the rice grains. These are probably masses of the same material as the rest of the photosphere, extending higher than the general level. The rice grains and the faculæ are probably luminous or shining clouds, floating in an atmosphere that is less luminous.

Dark spots often appear on the Sun's surface. These differ greatly in size, and the largest spots can sometimes be seen without a telescope. When seen thus, they look like very small, dark specks.

As seen with a telescope, they are very interesting, since they change in appearance from day to day. When fully formed, and before they begin to break up, they are usually circular in shape. They have very dark centers, and around the center is a sort of fringe that is less dark. By watching these spots in their different positions on the Sun's surface, it has been found that many of them, at least, are hollows in the photosphere. When a spot is at the edge of the Sun, we can sometimes see plainly that it is cup-shaped. The hollows are probably filled with gases that are less hot than the photosphere itself, and consequently they appear dark in comparison with its brilliancy. Sometimes weeks will pass without a sun spot being visible, while at other times they can be counted by hundreds.

It cannot be foretold just when and where a new spot will be found on the Sun's disk, but it is known that there is a certain regularity in the times of their coming. Every eleven years the spots are very numerous. Sun spots usually last several weeks, or even months. By watching the spots from day to day, it has been found that the Sun, like the earth, revolves on its axis. Wherever a spot may appear on the Sun's disk, each succeeding day finds it somewhat nearer the Sun's western edge, or limb. When it reaches the limb, it disappears from view.

After about two weeks, the same spot may be seen reappearing upon the Sun's eastern limb. By observing the rate at which the spots move, it has been found that the Sun rotates on its axis once in about twenty-five days. Strange to say, the Sun does not seem to revolve as a whole, but the part near its equator appears to revolve more rapidly than the rest.

Outside the photosphere, the Sun is surrounded by an envelope of gases, called the *chromosphere*. This is never seen with the naked

eye. Neither can it be seen with a telescope, except during the time of a total eclipse of the Sun, for at other times it is hidden by the bright light of the photosphere. It is of a brilliant scarlet color, and is described by those who have been fortunate enough to see it as a "sea of flame."

Out of this chromosphere rise irregular jets of flame called *prominences*. These are extensions of the chromosphere, or clouds of the same gases. With an instrument, called the *spectroscope*, you can see the prominences in full daylight, without waiting for a solar eclipse.

The Sun has another gaseous envelope of great beauty, called the *corona*, a Latin word that means "crown." The corona can only be seen when the Sun is entirely eclipsed, but it can then be seen with the naked eye. It shines with a pearly light, and surrounds the darkened disk of the Sun in such a way as to suggest the halo that early artists placed around the heads of the saints. When seen in the telescope, the contrast between the corona and the scarlet prominences is very striking. It is not yet very clearly known what the corona is, or what purpose it serves.

We have learned that the Sun is surrounded by envelopes of gases and luminous clouds, but nothing has, as yet, been said of the constitution of the Sun itself. Although no one has ever been able to look through the photosphere and see what is beneath it, there is every reason to think that the ball, or *nucleus*, within is also made up of gases at a very high temperature. We know enough of the nature of the photosphere to be sure that no cool or solid matter could exist within it.

By examining the Sun with the spectroscope, we have learned that many substances known to us on the earth exist on the Sun as gases. Among these are the metals, iron, silver, copper, and platinum. Those of you who have ever visited a foundry know something of the great heat necessary to melt iron into a liquid, and can faintly imagine how intense the heat must be at the Sun's surface, where iron exists as a vapor.

The earth receives only a very small part of the Sun's heat, and it is well for us that this is so. Astronomers estimate that if all the Sun's heat were collected on a mass of ice as large as the earth it would melt the ice in two minutes, boil the water thus produced in two minutes more, and turn it all into steam in less than a quarter of an hour from the time the heat was first applied. The only light with which we are familiar that at all approaches the brilliancy of sunlight is the electric arc light. The central part of an arc light is something like one-third as bright as the Sun's surface.

The Sun is about ninety-three million miles from the earth. This is an important number to remember, as it is called the *unit of celestial*

measurement. All other distances of planets, stars, and other heavenly bodies are first found in terms of this unit. The Sun and moon as we see them in the sky appear to be of about the same size. This is because the moon is so very much nearer to us than the Sun is. In reality the moon is much smaller than the earth, while the relative sizes of the Sun and the earth are something like those of a bushel basket and a pea.

The fires that we are familiar with on the earth are apt to burn themselves out in time. At all events, fresh fuel frequently has to be added. It would be a serious matter for us if the Sun's fires were to die out and its surface grow cold. We receive now just about enough heat from the Sun for the world as a whole to exist in comfort. We could still exist were this heat a little less. But if it should become very much less, the higher forms of life would disappear from the earth.

You see we are much interested in the question of the Sun's heat, and would like to know whether it is likely to remain the same indefinitely and what the causes are that maintain it. Although it is possible that the amount of heat we receive from the Sun may vary a little from day to day and from hour to hour, we are quite certain that there has been no great change in the amount since the earliest times of which we have any record. Judging the future by the past, then, we need not fear any change in conditions as they now exist for a very long time.

Astronomers have given much study to the question of the origin of the Sun's heat. For want of a better explanation, it was for a long time supposed that the Sun was really burning. But now, strange as it may seem, it is accepted as a scientific fact that the Sun's heat is maintained by shrinkage due to its own cooling. As has been said, the heat of the Sun is so intense that no known substance can exist there, except as a gas.

It is also true that the Sun's weight is so small in proportion to its bulk, that we have another reason for thinking it must be gaseous. The great gaseous globe of the Sun is constantly giving out heat or cooling. In the process of cooling, the Sun shrinks, and this shrinkage produces heat in such great quantities that the sun remains as hot as ever, but becomes somewhat smaller. But how can this shrinkage produce heat? In the same way that a blacksmith's hammer is made hot by striking it on a cold anvil.

Heat is only a form of energy and may produce mechanical force, or be produced by it. We see this every day in the locomotive steam engines on the railways. The heat of the burning coal produces the mechanical energy which causes the engine to move, and

the mechanical energy thus produced may again become heat. An example of this is the "hot box," where great heat is produced by friction when an axle of an engine or car is not properly oiled. When the gaseous Sun gives out heat and shrinks, each particle moves toward the center, and in so doing strikes other particles, is stopped by them, and heat is thus produced.

The amount of mechanical energy needed to produce a given amount of heat is known, and it has been calculated that if the Sun shrinks enough so that its diameter becomes every year three hundred feet shorter, the amount of heat thus produced will be enough to make up for the heat that the Sun gives out during the year. This amount of shrinkage is too small to be detected by any measurements we can take at our great distance from the Sun, but there is every reason to think that this is the true explanation of the Sun's heat.

Of course if the Sun is thus shrinking, a time will come when it will no longer be mainly gaseous, and will send out less and less heat. When this time comes the earth's summers will grow cooler, and its winters will become more intensely cold, until at last it will be too cold for life to exist here any longer. This prospect, however, is nothing that need make us unhappy, for we have no reason to fear important changes in the Sun's heat for millions of years.

THE MOON

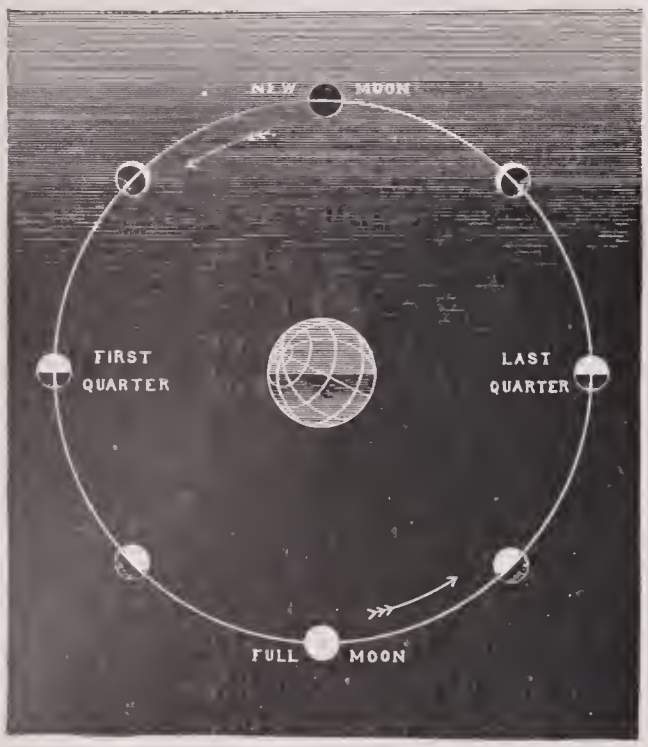
After the sun, the Moon next claims our attention. It is the only object regularly seen in the heavens, which can at all compare with the sun in apparent size and in interest. It appears as large as the sun, although, as has been mentioned, it is in reality much smaller than the earth. It is, in fact, our nearest neighbor in the heavens, and stands in somewhat the same relation to the earth, that the earth does to the sun.

True, the earth does not furnish the Moon with heat, and sends it only a small amount of light, but the earth's attraction causes the Moon to revolve about it as the earth revolves about the sun. Since it revolves about the earth, the Moon is, of course, carried with the earth in its yearly journey around the sun. The amount of reflected sunlight that comes from the Full Moon is very small, when compared with the light of the sun itself. Astronomers tell us that six hundred thousand Full Moons would be required to equal the sun in brightness. The Moon is often visible in the daytime, and we can

then compare its brightness to that of floating clouds. Both Moon and clouds reflect the sun's rays and neither of them has light of its own.

Besides the light it furnishes us, the Moon gives us aid of an entirely different kind, in causing the tides. If there were no Moon, the tides, which, as has been said, are chiefly due to the Moon, would then be due to the sun alone, and would be smaller than they are. Evidently, we should feel the loss of the Moon more than that of any other heavenly body, except the sun.

While the sun always appears as a huge round disk, the Moon changes its appearance from night to night. Sometimes it appears in the western sky as a silvery bow, or crescent, which we call the New Moon. From night to night the bow increases in width, until the Moon appears semicircular in shape, and is said to be in its *first quarter*. After the first quarter, the Moon continues to increase in size, until we finally see a round disk, which we call the *Full Moon*.



(Fig. XIV.)

These different shapes which the Moon assumes are called its *phases*. (Fig. XIV.) The Moon is said to be *gibbous* when the phase it presents is more than the quarter and less than the Full Moon. After Full Moon comes a gradual decrease in size. All the phases that appear between New Moon and Full Moon are repeated, but in exactly the opposite order. First the Moon is gibbous until the third quarter; then it becomes *crescent* and grows narrower and narrower, until at last it is again only a silvery bow. After the last phase, the Moon is invisible for a few days, when it again appears as the New Moon, in the western sky, soon after sunset.

The crescent New Moon, however, faces in a different direction from the crescent Old Moon. When the Moon is new, the outer edge of the crescent, which is part of the outline of the Moon's disk, is turned toward the west. Through all its phases until the time of Full Moon, this edge or limb of the Moon continues to point westward. After Full Moon, it is the eastern limb of the Moon that remains in view, while the changes take place from the western limb, so that when the crescent Old Moon appears, its outer edge is turned eastward.

The reason of the different phases of the Moon is not hard to understand. That half of the Moon that is turned toward the sun is brilliantly lighted up, while the half that is turned away from the sun is dark. As the Moon moves around the earth, it assumes, each day, a different position, relative to the earth. Whether we see all or part of the brilliant half of the Moon, depends upon the positions of the earth and the Moon with reference to each other. If we see the whole of the brilliant half, we say the Moon is full. If we see but a quarter, the Moon is in either its first or its third quarter, and so on.

Often when the Moon is new, we can see, besides the silver crescent, the dark part of the Moon very faintly illuminated. This curious appearance is often called "the old Moon in the young Moon's arms." The part of the Moon that is so dimly lighted up is not illuminated by direct sunshine, but by light reflected from the earth. The sun shines on the earth, the earth reflects some of this light to the Moon, and the Moon reflects it back again to the earth. No wonder the light is dim, after all this passing back and forth.

The interval from one New Moon to the next, is a natural division of time that was observed very early in the history of mankind, and we find that it is observed even by savage peoples. We see traces of the word Moon in our word *month*. And although the twelve months into which we divide our year, do not strictly agree with the length of time from New Moon to New Moon, we often use the words *lunar month*, meaning four weeks.

The real length of a lunar month is twenty-seven and one-third days, instead of twenty-eight days. Like the sun, the Moon seems to move north and south among the stars, as well as from east to west. By measuring the angular distance between the Moon's position when farthest north and farthest south, we can find the angle its orbit makes with the equator and also the angle it makes with the ecliptic. The angle between the Moon's orbit and the ecliptic is about five degrees. This means that when the Moon is in its most northern position among the stars, it is five degrees farther north than the sun ever is, and that its most southern position is five degrees south of any point on the celestial sphere ever reached by the sun.

To find our distance from any of the heavenly bodies, may seem at first a hopeless task. In reality, it is one of the simpler problems of astronomy. The distances of all the principal members of the solar system are known. There are even a number of the fixed stars whose distances have been learned. The methods used are so simple, that they can easily be understood by anyone who has studied trigonometry.

The distance from the earth to the Moon is about two hundred and forty thousand miles. We have already learned that the earth's diameter is eight thousand miles. So we see that it would take thirty globes of our earth, piled one on top of another, to reach from the earth's surface to the Moon. The Moon's diameter is a little greater than one-fourth that of the earth. If the earth were divided into fifty equal parts, each part would be about the size of the Moon.

(Fig. XV.)

Astronomers are sure that there are no living creatures on the Moon, for it has neither air nor water, and we know of no form of life that can exist without these. The surface of the side of the Moon that we can see has been carefully examined with telescopes, and accurate maps have been made of it. (Fig XV.) Any object on the Moon with a diameter as large as half a mile can easily be seen in a telescope of moderate size.

Not much variety appears on the Moon's surface. There are no forests, lakes, rivers or oceans. There are, however, many scattered mountains and craters and some mountain ranges. The craters resemble the volcanic craters on the earth's surface, but are very much larger. The largest of the Moon's craters are more than a hundred miles across, while the largest craters on the earth are only six or seven miles in width.

Most of the Moon's craters are circular in shape and are surrounded by mountain ranges. At the center of the crater there often rises a group of mountains as high as the surrounding range. The origin of these so-called craters is unknown. No change appears in them from day to day, or from year to year. There is reason to think that they were once volcanoes, but if so, they have long been dead. If there has ever been life of any kind on the Moon, either vegetable or animal, it has left no trace.

The surface of the Moon is very cold. Since the Moon rotates on its axis once in four weeks, its days and nights are each two weeks in length. Each part of the Moon, in turn, goes fourteen days without a ray of sunshine to warm it. Then, for fourteen days the sun shines upon that side without interruption, but as there is no air to retain the heat, it is lost almost as soon as it is received. Astronomers think that even in the middle of the Moon's long day, its surface becomes only as warm as melting ice. In the middle of its nights, the cold is more intense than we can imagine. (Fig. XVI.)

The material of which the Moon is made is much lighter than that which composes the earth, and thus its power of attraction is less than that of the earth, even in proportion to its size. If it ever

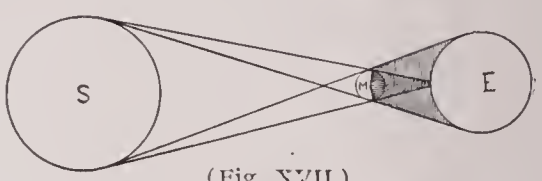
(Fig. XVI.)

had an atmosphere, like that which surrounds the earth, it may have gradually lost it through the lack of attractive power to hold it.

Among the most interesting things that occur in the sky are the eclipses of the sun and Moon. Doubtless most of you have seen a partial eclipse of one of these bodies. Some may even have seen a total eclipse. Whenever the sun is shining, we can notice the shadows cast by different objects that are in its light. Like smaller objects, the earth and Moon cast shadows that point directly away from the sun, which causes them. At the time of New Moon, the Moon is between the earth and the sun. If it is exactly between them, so that the three bodies are in a straight line, and if the Moon's shadow

is long enough to reach the earth, the sun will be hidden from that part of the earth where the shadow falls. (Fig. XVII.)

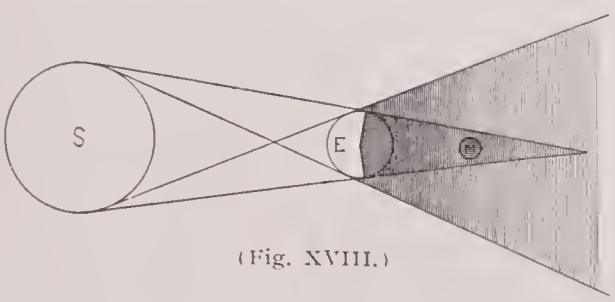
This hiding of the sun by the Moon's shadow is called an eclipse. If the shadow entirely hides the sun, the eclipse is total; if it hides only a part, the eclipse is partial. If the round shadow of the Moon lies exactly over the sun's disk, but is too small to cover it entirely, a ring of the sun's surface will appear around the black disk of the Moon's shadow, and the eclipse is described as annular. The kind of eclipse depends upon the relative position of the sun, Moon and earth. Eclipses of the Moon are caused by the passage of the Moon through the earth's shadow. You will see at once that they can occur only when the earth is between the sun and Moon. That is, at the time of Full Moon.



(Fig. XVII.)

A total eclipse of the sun can be seen only on a small portion of the earth. In any one place it is seldom seen oftener than once in a lifetime. Eclipses never remain total longer than eight minutes, and seldom more than two or three minutes. But they are of such interest to scientists and others that whenever a total eclipse of the sun occurs, many people make long journeys to see it. Total eclipses of the Moon can be seen more frequently, for the earth's shadow is large, in comparison with the size of the Moon, and a total eclipse of the Moon often lasts several hours and can be seen wherever the Moon is visible. The Moon is, usually, not entirely hidden at its time of total eclipse, but shines with a dull, faint, copper-colored light. It is probably illuminated by light that passes near the earth and is deflected in passing through our atmosphere. The light becomes red, because it has to travel so far through the air, on account of its oblique direction. These rays fall on the surface of the Moon and are reflected back to us.

It is a peculiarity of our atmosphere that it gives a reddish hue to light that passes through a great deal of it. We see this at sunset, when the sun's rays appear red, because the sun is on the horizon and its rays have to pass through a great depth of air before they reach us.



(Fig. XVIII.)

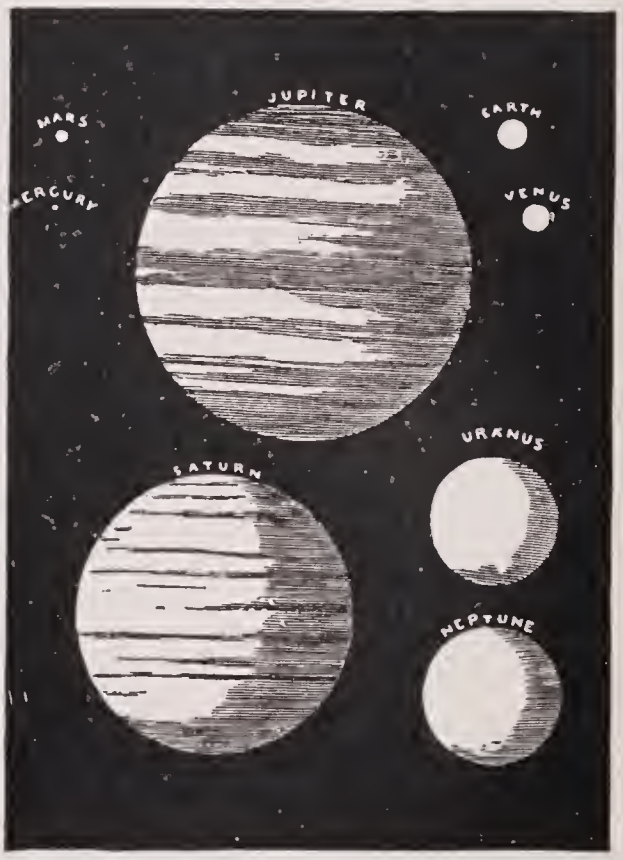
The time when eclipses will occur can be calculated with the greatest accuracy. There are at least two eclipses of the sun every year, and in some years there are as many as five. Figure XVIII. illustrates a total eclipse of the Moon. There are never more than two eclipses of the Moon in one year, but as they can be seen over so

much of the earth at one time, they can, perhaps, be seen at any one place more frequently than eclipses of the sun. You can find the times of eclipses given in reliable almanacs.

The next time that an eclipse occurs which is visible at your home, be sure to see it, for it is very interesting to watch the shadow growing over the sun or the Moon. In watching an eclipse of the sun, use a piece of smoked glass; for an eclipse of the Moon use opera glasses. If you are so fortunate as to have an opportunity to see a total eclipse of the sun, do not neglect it, for the greater part of mankind live and die without this privilege.

THE PLANETS

As HAS been said, there are eight large Planets, as well as many small ones. They all revolve about the sun, in the same direction. The names of the eight large ones are here given and it would be well for you to learn them, in the order given, which is the order of their distances from the sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. You will notice that two Planets are nearer the sun than the earth is. (Fig. XIX.)



(Fig. XIX.)

As stated before, there are two ways in which Planets can be told from fixed stars by the naked eye, namely, by their changes of place among the fixed stars, and by their shining steadily without twinkling. Mercury, Venus, Mars, Jupiter and Saturn are all bright objects in the heavens and naturally attracted the attention of early astronomers.

Long before the historical era began, it was known that these five bodies were different from the fixed stars, and they were given the names of Planets, or wandering stars. Uranus can with difficulty be seen with the naked eye, and to see Neptune and the smaller Planets or asteroids without a telescope is quite impossible. So, it is not strange that none of these bodies was discovered until quite recent times. Uranus was discovered accidentally in 1781 by Sir William Herschel, the greatest astronomer of his day.

Neptune was not discovered until 1846. It is smaller than some of the other Planets, being only eighteen times as large as the earth. As it is also very far distant from us, its light appears exceedingly faint. It might have remained unnoticed many years longer, if the only way of making its presence known had been by its light. You remember that, according to the law of gravitation, every particle of matter attracts every other particle. Uranus is near enough to Neptune to move a little irregularly in its orbit, on account of Neptune's attraction. Astronomers noticed this irregularity of Uranus and became convinced that it must be caused by the attraction of some unknown Planet. They were even able to tell in what part of the heavens this Planet must be, and with the aid of a telescope Neptune was found at once.

Mars is, in many respects, the most interesting of the Planets. As seen without the telescope, it looks like a bright star, but can be distinguished by its red color. Its orbit is of such shape that the planet is much nearer to us at some times than at others. Consequently, there are periods when it appears decidedly larger than it does at others, so that a better examination of it can be made with the telescope.

At these favorable times it is carefully studied by astronomers. Its atmosphere seems less dense than that of most of the Planets, and permits the discovery of many markings on the Planet itself. Around each pole appear white patches, which remind us of the ice fields around the earth's poles. There are bluish-gray patches, that are thought to be bodies of water, and orange-colored regions generally supposed to be land. If this view is correct, five-eighths of the surface of Mars is made up of land and three-eighths of water.

It is the orange-colored patches that give Mars its red color. The markings give evidence of changes of seasons, like those of the earth. The supposed ice caps vary in size according to the time of year, and the orange-colored portion takes on a more reddish hue, in what we suppose to be the summer. The Martian day is about half an hour longer than our own, or, to be more exact, Mars rotates on its axis once in twenty-four hours, thirty-seven minutes and twenty-three seconds.

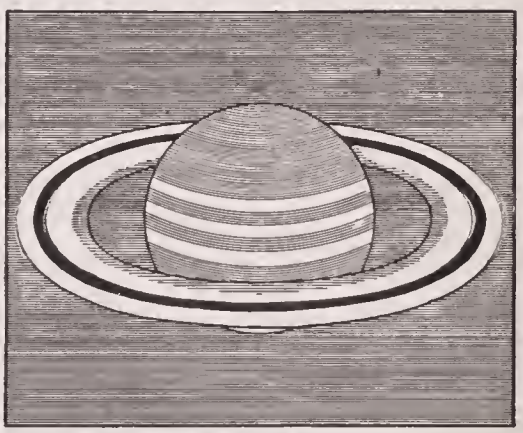
You will notice that there are many points of similarity between Mars and the earth. The question whether there are beings like men living upon Mars is one that has been much discussed. The only answer that can as yet be made is that we do not know, but there are many conditions that may make it possible. Perhaps proof will some day be discovered that intelligent beings exist there, but on the other hand, perhaps it will be found that there are reasons that make this impossible.

Although the two moons belonging to Mars are very small, they are so near that body that they would seem of large size if seen from it. Both revolve with great rapidity around the Planet. Instead of requiring twenty-eight days, as our moon does, to travel around in its orbit, the larger one makes the journey in a little more than thirty hours, while the smaller one goes once around its orbit in the short time of seven and one-half hours. As a result of this rapid motion, the smaller moon seems to rise in the West and set in the East, and its month is shorter than the Martian day.

Jupiter is the largest of the Planets; in fact, it is as large as all the rest of them united. As we see it with the naked eye, it appears less brilliant than Venus, which, though much smaller, is very much nearer the earth. When looked at through the telescope, beautiful markings appear on the Planet, the principal ones being known as belts. It is thought that these belts and other markings are in the Planet's atmosphere.

There is reason to think that Jupiter is not a cool, solid globe like the earth, but is a mass of hot, molten matter that is growing smaller and keeps itself hot by so doing. You will see, that in this, it seems to resemble the sun. It is not, however, thought to be hot enough to have light-giving powers of its own. Like the other Planets, it shines by reflected sunlight. The shadows of one or more of Jupiter's moons are frequently seen in the telescope, moving like dark spots across the face of the Planet.

Mars is interesting, because of its likeness to the earth, but Saturn is interesting, because it is so unlike every other object in the heavens. As seen with the naked eye, it is simply a bright object resembling a star. As seen with the telescope it is a wonderful body. It seems to be a globe like the other Planets, but it is surrounded by three rings of great width. (Fig. XX.)



(Fig. XX.)

It looks as though rings cut from immense sheets of paper have been slipped over the Planet and are kept in place by some unknown means so as to encircle, but not touch it. The rings are probably made up of numberless, small particles of matter, each revolving in a separate orbit around the Planet. Saturn has belt-like markings somewhat like those of Jupiter. It is nearly eight hundred times as large as the Earth, and is thought to be in much the same condition as Jupiter, though not quite so hot. Both Uranus and Neptune have a greenish appearance when seen through a telescope. Faint traces of belts appear on Uranus.

COMETS AND METEORS

Comets are objects that sometimes make a very startling appearance in the sky. They appear suddenly, and sometimes in a few days' time grow from a small object to one of astonishing size. There are a few Comets that travel in closed orbits, like the planets, and return regularly after a certain number of years. The greater number, however, make one visit to this part of the universe and then disappear forever. A Comet (Fig. XXI.) has a head or *nucleus*, which is surrounded by a sort of bright, cloud-like mass, which is called the *coma*. Spreading back from the coma is the *tail*. This tail is sometimes very short, and in some small Comets is absent altogether. In some cases, however, it is as long as the distance from the earth to the sun.

(Fig. XXI.)

In all the large Comets, the tail is the most noticeable feature. It is cloud-like in appearance and is often very brilliant. A Comet's tail has many peculiarities. One strange thing about it is that it is always turned away from the sun. Another strange thing is, that often no tail appears on the Comet until it is near the sun. The nearer the Comet comes to the sun, the larger its tail generally becomes, and it continues to point away from the sun.

The Comet moves faster as it approaches the sun, and as it passes that body the tail sweeps around with startling swiftness. Another wonderful thing is that the Comet's tail does not hide even the faint stars behind it. Stars that a passing cloud would prevent our seeing, shine plainly through the Comet's tail. Whatever the material of which this tail is composed, it is evidently thinner than the thinnest cloud. It is repelled by the sun, while the nucleus of the Comet is attracted by it.

The last Comet of great size appeared in 1882. Small Comets, which can be seen in telescopes, are very frequent, but those large enough to be seen without a telescope are less common. Perhaps once in ten years a bright one appears. Comets used to be looked upon as signs of disaster. To an ignorant people there would naturally be something terrifying in the sudden appearance of the gleaming brush

of a great Comet's tail. They are not now looked on with terror, but with great interest, as visitors from a distant part of the universe.

Meteors, or shooting stars, are so frequently seen that doubtless you are all familiar with their appearance. Usually we see a flash, as though a star were really shooting across the sky, and that is all. Sometimes we see a number of such objects in a short time. On several occasions, so many Meteors have appeared at one time that the appearance is well described as a *meteoric shower*. One of these beautiful showers occurred in November, 1833, and one in November, 1866. Another was looked for in November, 1899, but it did not take place then, neither did it come in 1900.

There are always numerous Meteors seen on the nights of November 12 and 13. The delayed shower may never come, or it may occur on these dates in November any time within a few years. It is well worth watching for, as it would be one of the most impressive spectacles of a lifetime.

Meteors are simply small masses of matter rushing through space so very swiftly that, as they enter our atmosphere, its resistance raises their temperature to such a degree that they immediately become red-hot. The smaller ones are at once burned up, and some of the larger ones fall to the ground. These are called Meteorites. Many of them have been seen to fall, and nearly every large museum has at least one specimen of this kind.

THE STAR-CLOCK

By DANIEL BATCHELLOR

THERE is always a charm for the human mind in marking off the divisions of time. The little child is greatly interested in the swing of the pendulum, and it is this which first interests him in the clock. At a later period he likes to trace the movement of the hands round the dial, and so he learns to "tell the time."

Although this soon becomes commonplace to him, there are other ways of telling the time, which never lose their charm. To one who has learned to trace the passage of time by means of the great star-clock, there is always a sense of awe and mystery, as the stars follow in their courses to tell him of the passing hours in the night, and of the progress of the seasons.

One serious drawback to a city life is that it shuts us in from the starry dome. The city child can have no adequate conception of

"This brave o'erhanging firmament
Fretted with golden fire."

He sees nothing but strips and patches of sky by day, and looking up at night through the glare of the city lights, he sees an occasional star dimly shining here or there. What can he know of the constellations, or of the silent sweep of the great star-clock? If all of our children could be brought up to recognize the stars as familiar friends, there would be less of littleness and fret in their lives, and less of nervous prostration later on.

No one can look up at the heavens, on a clear starry night, without a sense of awe; but to most persons there is also bewilderment. To them, the stars seem to be jumbled together in a confused mass. The first thing is to get order out of this chaos. They must learn to distinguish the more prominent stars, and to see their relation one to another. This may be considered as the anatomy of astronomy.

But it is still more important that they should get an idea of the movement of the stars, in order that they may see the universe as a living organism. This physiological aspect will make a stronger appeal to their vital sympathies.

Let them begin by seeing how the sun rises in the east and goes down in the west. They may then trace his journey across the sky, through the hours of the day. If possible, get a sun-dial whose shadow will mark off the time.

Get them to realize that the sun is a star, which is very large and bright, because it is much nearer to us than the other stars. It is our star. Then let them see, that, in like manner, the far off suns—which we call stars—rise in the east, pass overhead and go down in the west.

Now teach them that it is not the sun and stars which move, but ourselves, just as when we are riding in a train, the houses and trees seem to rush by us. The earth is a large ball spinning in space. It turns upon its own axis once every day. This is called its diurnal, or daily, motion. As the earth turns to the east the sun seems to rise in that quarter, and as it turns from the west the sun seems to set there.

But after awhile, the children will find that we do not always see the same stars in any particular part of the sky. For instance, if they look toward the south at a certain hour of the evening in the spring, and then look in the same direction and at the same hour in the summer, other stars will be found there. Again in the autumn they look there and find still other star groups. It seems, then, as if the stars on the horizon are passing before us like a great panorama. But here again "things are not what they seem." It is we who, on our earth-ball, are swinging around the sun. This is called the annual, or yearly, motion of the earth. In our long journey we come opposite the different star groups in succession.

There are twelve of these constellations, called the Signs of the Zodiac, which we pass in the annual round. Given in their successive

order, they are: 1, *Aries;* 2, *Taurus;* 3, *Gemini;* 4, *Cancer;* 5, *Leo;* 6, *Virgo;* 7, *Libra;* 8, *Scorpio;* 9, *Sagittarius;* 10, *Capricornus;* 11, *Aquarius;* 12, *Pisces.* Dr. Watt's jingle will serve both to interpret the Latin words, and to fix their order in the minds of the children:

"The *Ram*, the *Bull*, the Heavenly *Twins*,
And next the *Crab* the *Lion* shines;
The *Virgin* and the *Scales*,
The *Scorpion*, *Archer*, and the *Goat*,
The *Man that pours the Water out*,
And *Fish* with glittering tails."

When the twelve constellations have thus been memorized, the children will watch with interest for their panoramic unrollment in the heavens, as the seasons pass by.

In studying the great star-clock, the first thing necessary is to get our bearings. Fortunately, there is one star in the sky which holds its place, and forms a center around which the other stars perform their revolutions. It is called the *Pole Star*. This star is not quite stationary, but the circle in which it revolves is so small that it always seems to be in the same place. Whenever we look at that, we know that we are facing the north. Although the *Pole Star* is not by any means one of the brightest, it can be readily found, because there is no other bright star in its neighborhood.

(Map 1.)

Closely connected with the *Pole Star* is the most widely known of the star groups — the Dipper. In England it is better known as the Plough or Charles's Wain. These seven stars form the tail and loins of the *Great Bear* (Ursa Major).

The Dipper swings around the *Pole Star*, once every day, and in such a way that the two foremost stars are always pointing toward it. Hence they are called "The Pointers." Draw an imaginary line between these two stars, and then extend it about six times as far, and just a little back of this line you will find the *Pole Star*. (See Map 1.) In the United States and Canada, and in all countries north of 40° North Latitude, this constellation never sets, being too high up ever to go below the horizon.

See if the children can find the fainter companion which lies close to the star in the bend of the Dipper's handle. Looked at through an opera glass, or better a field glass, it stands out clearly. By the aid of a powerful telescope another beautiful star makes its appearance just above the companion star.

(Map 2.)

Measure the distance from the pointers to the *Pole Star*, and let the eye travel about as far beyond almost in a straight line until it comes to a beautiful constellation, in which five bright stars form an irregular W. This is *Cassiopeia*, about which more will be said presently. *Cassiopeia* and the *Great Bear* are always opposite each other as they revolve around the *Pole Star*. In the spring, when the *Great Bear* is high overhead, *Cassiopeia* is low down on the northern horizon. In the autumn, their relative position is reversed. (See Map 2.)

Now look on either side of the *Pole Star*, between these two constellations, and you will find two stars of the first magnitude. One is *Capella*, in the constellation of *Auriga* (The Charioteer), and the other is *Vega*, the chief star in *Lyra*. *Capella* is in the space toward which the *Great Bear* is moving, while *Vega* is in the opposite space from which the *Great Bear* is moving. They can also be at once distinguished by their color. *Vega* shines with a white light, whereas *Capella* sparkles with different colors. (See Map 2.)

(Map 3.)

Now that we have got our bearings with the *Pole Star* and its nearer attendants, it will be easy for us to get the relative positions of the other star groups.

There are some stars lying very near to the *Pole Star* which also revolve around it. These constitute the *Little Bear* (Ursa Minor). Indeed, the *Pole Star* is in the tip of the tail, so that the *Little Bear* swings around on his tail! (See Map 3.)

Let us return to *Cassiopeia*. This is one of a group of constellations sometimes called The Royal Family. They are associated with one of the finest of the Old-World stories.

Cassiopeia was the wife of Cepheus, king of Egypt. They had a beautiful daughter, named Andromeda. Her mother boasted that she was more beautiful than the Nereids, or Sea Nymphs, and Neptune, the sea god, was so angered by this presumption that he sent a sea monster named Cetus to devastate the country. To appease the anger of Neptune, Andromeda was chained to a rock in the Mediterranean Sea, and left for the monster to devour.

At this time there was a Greek hero named Perseus, who was believed to be the son of Jupiter. He was sent to slay the Gorgon Medusa, who was such a dreadful object, that whoever looked at her was turned into stone. Perseus avoided this fate by looking at her reflection in a mirror, while he struck the fatal blow.

He was returning in triumph, with the head of the Medusa, when he saw the beautiful maiden, Andromeda, chained to the rock. Cetus, the sea monster, was just foaming along through the water to devour her, when Perseus held aloft the Gorgon's head, and Cetus was turned into a rock. After this Perseus married the beautiful princess, amid great rejoicing at the Egyptian Court.

Now let us see how this story is illustrated in the star groups.

Cassiopeia is seated in her chair. Some day you may have a chance to look through a telescope, and see the beautiful diadem of stars around her head.

(Map 4.)

The two right hand stars of *Cassiopeia* point to the constellation of *Cepheus*. There is nothing very striking to the naked eye in this group,

but it contains some very interesting objects for telescopic study, among them the famous "garnet star." (See Map 4.)

(Map 5.)

Below the two left hand stars of *Cassiopeia* in the direction of *Capella* is the constellation of *Perseus*. This region is very rich in stars, and it lies right in the path of the *Milky Way*. On a clear night you will be able to see a small luminous cloud, which forms the apex of a triangle with the two left hand stars of *Cassiopeia*, already mentioned. This luminous cloud is somewhat brighter than the hazy light of the *Milky Way*. Looked at through a field glass, it is seen to have two centers, and when examined through a good telescope these are found to be star clusters of wonderful beauty. They are known as the *Great Double Cluster*. They furnish the jeweled hilt of *Perseus's* uplifted sword.

One other star in this constellation, well worth noting, is *Algol*, "the winking demon." It is considerably below the stars already pointed out, and forms a right angle with two other bright stars above it. The strange thing about *Algol* is, that it becomes very dim for a short time every sixty-nine hours. It is believed that *Algol* has a dark companion revolving around it, and that this dark body comes between the star and ourselves every third day, thus shutting off most of its light. (See Map 5.)

(Map 6.)

To the right of *Perseus*, and lying along below *Cassiopeia*, are three bright stars, at equal distances apart. These show *Andromeda* chained to the rock. Her feet stretch away toward *Perseus*, and the star in her head is also one of the four stars in the great square of *Pegasus*. (See Map 6.)

(Map 7.)

There is one object in this constellation which is noticeable. Take the middle star of the three, and then let the eye slowly travel up toward *Cassiopeia*. If the weather is clear, you will see a star which is less bright than the one we have left. Still let the eye move upward, and, if your sight is good, you will see a still fainter star. Now if you look through a field glass, this star will appear much more distinct and, a little off to the right, you will see a faint wisp of light. This is the famous nebula in *Andromeda*. When you know just where to look for it, you may see it with the naked eye, but that gives no hint of the real nature of this wonder of the heavens. The beautiful photograph of it shows that it is a system of worlds in the course of formation. (See Map 6.)

(Map 8.)

Some distance below *Perseus* and *Andromeda*, and separated from them by two groups to be noticed presently, is the constellation *Cetus*, the sea monster. It has eight bright stars in two unequal curves, and somewhat resembles a chair tipping backward. (See Map 7.)

And so by these constellations we see the old story pictured in the heavens.

(Map 9.)

Let us now take a rapid glance at the twelve constellations of the Zodiac which we pass in our annual journey around the sun.

THE TWELVE CONSTELLATIONS

1. *Aries* (The Ram)

THIS is the first of the Signs of the Zodiac. It comes between *Andromeda* and *Cetus*. If we look carefully in this region we shall see three stars in a crooked line, of which the two highest are the brightest. This is a winter constellation, visible in the evening, from October to February.

2. *Taurus* (The Bull)

The best-known group of stars in the constellation of the *Bull* is the *Pleiades*, which rises on the eastern horizon about the same time as *Capella*, but much farther to the right.

The *Pleiads* were seven daughters of Atlas, whom the gods placed among the stars. At first all seven were visible, but one faded away from some secret sorrow. You will recall Tennyson's famous lines:—

> "Many a night we saw the Pleiads, rising through the mellow shade,
> Glitter like a swarm of fireflies tangled in a silver braid."

Looked at through a field glass, many beautiful stars can be seen in this cluster, and with a large telescope they can be counted by thousands. Curiously enough, in the photograph of them which has been taken recently, we see that all of the larger stars are enmeshed in nebulous matter, as if they are not yet completed, so that the poet was not far wrong when he spoke of them as "tangled in a silver braid."

A second group in this constellation, which rises soon after the *Pleiades*, is the *Hyades*. It is a V-shaped cluster, and contains a bright, reddish star called *Aldebaran*. This is the angry eye of the *Bull*. There is a second bright star at some distance from the *Hyades*, in the direction of *Auriga*. This is at the tip of the *Bull's* upper horn, and a third star below is at the tip of the other horn. This constellation only shows the head of the *Bull*. (See Map 8.)

Closely associated with the foregoing constellation is *Orion*, although it does not lie within the path of the Zodiac. (See Map 9.) This is perhaps the

grandest of all the constellations. It rises after the *Bull*, and can easily be located, for *Capella* is half-way between the *Pole Star* and *Orion* in a straight line. When once recognized there will never be any trouble in knowing it again. There are four bright stars which mark the shoulders and limbs of the mighty hunter. The brightest of them are *Betelgeux* in the right shoulder, and *Rigel* in the left foot. The three bright stars in a line across the center form the belt of *Orion*, and the line of faint stars just below constitutes his sword. Look at this sword through a field glass, and you will see that some of the stars are enveloped in a hazy light. This is the most famous of the nebulæ. From its photograph we see that it is a world system forming, somewhat like the *Pleiades*, but not so far advanced.

(Map 10.)

The belt of *Orion* points downward on the left hand to *Sirius*, which is much the brightest of all the stars. This is sometimes called the *Dog Star*, because it lies in *Canis Major*, one of the hunting dogs of *Orion*. Not far from *Sirius* is *Procyon*, the *Lesser Dog Star*.

(Map 11.)

In the evenings of the late autumn, *Orion* rises in the east, and moves gradually overhead through the winter months until he slopes westward, after the setting sun, in springtime. Hence Tennyson was true to nature when, in describing the spring, he said: —

"Many a night from yonder ivied casement, ere we went to rest,
Did we look on great Orion sloping slowly to the west."

3. *Gemini* (The Twins)

Draw a line from *Aldebaran*, between the horns of the *Bull*, and you will come to two bright stars not far apart. The upper one is *Castor*, and the brighter one below is *Pollux*. These are the names of two youths famed in Roman mythology, who, at the battle of Lake Regillus, suddenly appeared on milk-white horses to aid the Romans, who were being worsted in the fight. After the battle they disappeared, and not till then did the Romans know that it was the Heavenly Twins themselves who had helped them.

(Map 12.)

The less conspicuous stars belonging to *Gemini* reach away in three parallel lines toward *Orion*. (See Map 10.) This constellation is seen in the evenings from December to May.

4. *Cancer* (The Crab)

This is not a conspicuous group, but it can be located by a triangle of faint stars, lying between *Procyon*, the *Lesser Dog Star*, and *Regulus*, the brightest star in *Leo*. (See Map 11.)

5. *Leo* (The Lion)

This fine constellation can be seen from October to the end of June. A straight line from the *Pole Star*, passing through the pointers in the Dipper, will lead directly to *Leo*. The front of the *Lion* is shaped like a sickle, of which the bright star *Regulus* forms the handle. Two stars behind the sickle represent the loins, and one star behind them, called *Denebola*, is in the tip of the tail. (See Map 12.)

(Map 13.)

From the center of the sickle the showers of November meteors seem to radiate. Hence they are called "Leonids."

6. *Virgo* (The Virgin)

This is the next in order, and its place can be readily found by a bright star, named *Spica*, which shines with a white light, like *Vega* and *Sirius*. Above *Spica*, the chief stars of the *Virgin* branch out like the letter Y. (See Map 13.) *Virgo* can be seen to best advantage in the late spring and early summer.

7. *Libra* (The Scales)

This is not at all a conspicuous group. Let the eye travel along to the left of *Spica*, and not far from the head of the *Scorpion* you will see a triangle of faint stars. (See Map 14.)

(Map 14.)

8. *Scorpio* (The Scorpion)

This constellation at once attracts attention. It can be seen in June, rising on the southern horizon, and night after night it gets a little higher, until late in July, when its whole length can be seen for a little while, before it sinks again into the underworld. (See Map 15.)

Antares, in the shoulder of the *Scorpion*, is one of the most splendid of the stars. To get a better idea of the glory of its sparkle, you should look at it through a field glass, or a telescope. It seems as if Robert Browning must have had this star in mind when in his pretty little poem, "My Star," he speaks of

(Map 15.)

"My star that dartles the red and the blue,"

especially as the path of Saturn lies just above *Antares*.

(Map 16.)

9. *Sagittarius* (The Archer)

Next in our star panorama comes the *Archer*. He is represented as having the head and shoulders of a man, and the body and legs of a horse. He is shooting an arrow at the heart of the *Scorpion*. (Map 16 will show the arrangement of these stars.) The four stars in a somewhat crooked line form the bow, and the small triangle to the right of them shows the point of the arrow. *Sagittarius* belongs to the late summer and early autumn.

On the right of *Antares*, three bright stars in a curved line form the head of the *Scorpion*, while the body is well represented by a fine curve of stars below, and rather to the left, of *Antares*. If you have a field glass to trace down this curve, you will come across a beautiful pair of stars shining side by side like twin gems.

At the lower end of the body the tail curves sharply upward, and the sting or pincers is shown by two stars a little distance apart. Around this region a search with the field glass will reveal some very interesting star clusters and nebulæ which cannot be seen with the naked eye. It is at this point, too, that the *Milky Way* rises above our horizon and stretches away overhead to the northwest, when it sinks again into the southern hemisphere.

(Map 17.)

10. *Capricornus* (The Goat)

Look to the left of *Sagittarius* until you see two stars close together with a line of fainter stars curving round to the left. (See Map 17.)

11. *Aquarius* (The Water Carrier)

Some distance above *Capricornus*, we find *Aquarius*. A zigzag line of four stars close together with another star some distance to the right and lower down, are the chief stars of this, the eleventh of the Zodiacal groups. (See Map 17.)

12. *Pisces* (The Fishes)

A long stream of faint stars, which represents the water being poured forth from the *Water Carrier's* urn, reaches down to a bright star in the south, called *Fomalhaut*. This is conspicuous, because there are no other bright stars about it. *Fomalhaut* is in the mouth of one of the fishes. This is the last of the Signs of the Zodiac, which brings us round again to the starting point in the *Ram*.

(Map 18.)

(Map 19.)

Before we leave the subject let us take one more look at the Dipper, but instead of turning to the *Pole Star* let us look about the same distance off from the handle, and at any time from April to September we shall see a brilliant star of an orange hue. Low down on the horizon it is sometimes almost red, but as it ascends, it loses some of its color. This star is named *Arcturus*. It is one of the giant suns of the Universe,

being thousands of times larger than our sun. It is the principal star in the constellation of Boötes the Bear driver, who is chasing the *Bear* around the *Pole Star*. (See Map 18.)

Draw an imaginary line from *Arcturus* to *Vega* and in passing over that line we cross two important constellations. About one third of the distance from *Arcturus*, we reach the *Corona Borealis*, the Northern Crown, and when we have traveled two thirds of the way to *Vega*, we come to an irregular square, something the shape of a pail or tub. (See Map 19.) This belongs to the constellation of *Hercules* — a most interesting character in mythology.

(Map 20.)

When we have reached *Vega* we are in the neighborhood of other interesting things. In one thing if you look at *Vega* through a field glass, you will probably see a pretty pair of stars just to the north of it. Then, too, you can find the Cross in the *Swan*, which lies just above and to the left of *Vega*. (See Map 20.) The Cross lies in the path of the *Milky Way*.

So we have traced some of the figures on the great star-clock. We have only just begun to take note of its many wonders; but enough has been shown to give us some little idea of what the poet meant by the "harmony of the spheres." We see a wonderful order and harmonious working running through all.

"In reason's ear they all rejoice,
And utter forth a glorious voice,
Forever singing as they shine,
'The hand that made us is divine.'"