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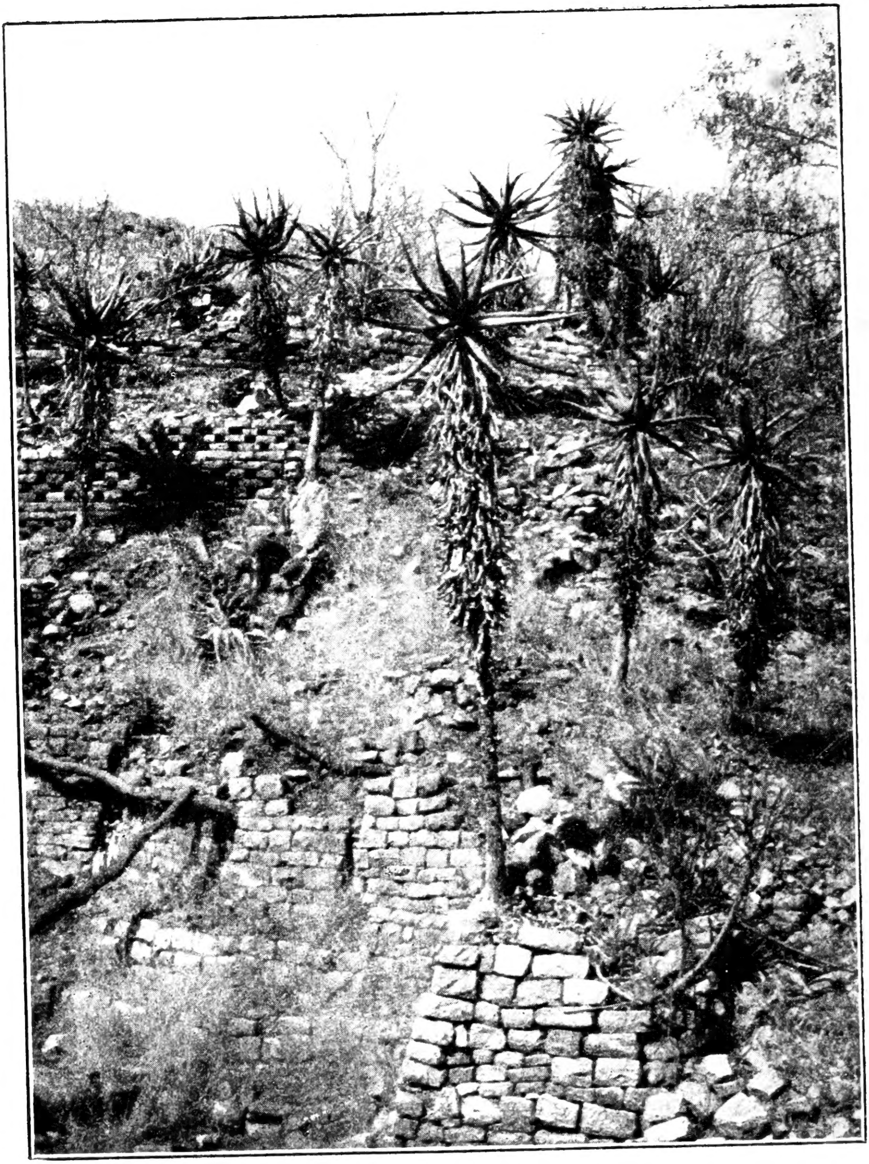
PLANTS AND THEIR WAYS IN SOUTH AFRICA



ALOES ON KHAMI RUINS
(Twelve miles from Buluwayo).

Photograph by the courtesy of J. D. Cartwright, Esq., M.L.A.

PLANTS AND THEIR WAYS IN SOUTH AFRICA

BY

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INTRODUCTION

WITH the introduction of microscopes into the secondary schools, the early superficial study of plant "analysis," which aimed at finding the names of plants, gave place to a study of minute anatomy and the lower forms of plant life. The microscopical method is of undoubted educational value, but the student, who confines his attention too exclusively to minute structures and forms of plant-life, is in danger of losing that living interest which a wider outlook into the science alone can afford.

There is yet a third method which considers plants as living things, and the study of their life relations becomes the new standpoint from which they are approached. The influence of light, air, and moisture on the form and position of stems and leaves, and how the conditions of soil affect the development and distribution of plants, are questions not only of interest in themselves, but likely to stimulate the reasoning powers of even young children; and children are most interested when they can be led to think for themselves.

This book has been written with a view to suggesting how some of these conditions are met by plants in South Africa. Some of the chapters, as, *e.g.*, IV., VII., and XVIII., are intended as reading lessons. The object of others is to furnish outlines for the study of plant forms, while there is little, except, possibly, the names of the parts of the flower in Chapter XIV., which should be committed to memory.

Plants can be brought to the schoolroom and studied in window-boxes. It is not enough to see the plants through the stage of germination merely; they should be watched until their life story has been told.

With the generous aid of the Education Department, it is possible to add each year some simple, well-constructed apparatus as a means of increasing interest in the work. It is poor economy to use implements so crude as to give inexact and unsatisfactory results, when, for a slight outlay, the correctness and consequent value of an experiment may be insured. Glass jars, flasks with rubber stoppers, retort stands, porous flower-pots of various sizes, wire, thread, scissors, cork-borers, glass and rubber tubing, U-tubes, glass funnels, and thermometers are indispensable.

Valuable suggestions may be obtained from Prof. Atkinson's "First Studies of Plant Life," from the "Elementary Textbook," by Prof. L. H. Bailey, and the accompanying Lessons, the Plant Physiologies of Darwin and Acton, MacDougal, and Ganong. "The Teaching Botanist," by Ganong, and "Plant Geography," by Schimper, are excellent books. "Flowering Plants and Ferns," by J. C. Willis, of the Cambridge Biological Series, is a valuable guide in the study of morphology, geographical and economic botany. To this list may be added Maud Going's charmingly written book, "With the Trees and with the Wild Flowers."

My thanks are due to the generous advice and assistance rendered by Dr. Marloth, Dr. MacOwan, Dr. Bolus, and the Rev. Dr. Kolbe.

It is also a pleasure to express my deep indebtedness to my present and former students who have kindly assisted me in illustrating the book, in particular to Miss Lucette Creux

and Miss Hannah Albertyn for the illustrations furnished by them, and to Miss Ethel M. Doidge for those bearing her initials, to Miss A. V. Duthie for numerous drawings, and to the untiring interest of Mrs. G. A. Bottomley, to whom the greater number of the original pen-and-ink drawings are due.

The author is indebted to the publishers (Messrs. Longmans, Green, and Co.) for the privilege of using from Edmonds and Marloth's "Elementary Botany of South Africa," Rev. Prof. Henslow's "South African Flowering Plants," Thomé and Bennett's "Structural and Physiological Botany," and Farmer's "Practical Introduction to the Study of Plants," the illustrations acknowledged in the text.

This work is the second of "The South African Science Series," the first being Mr. Rogers' "The Geology of Cape Colony," designed by Dr. Muir to promote the study of natural science in South Africa.

HUGUENOT COLLEGE, WELLINGTON,
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February, 1906.

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PLANTS AND THEIR WAYS IN SOUTH AFRICA

CHAPTER I

PLANT LIFE

WHO has not watched and enjoyed growing things? The baby is carefully weighed and measured; the kitten, the garden, and the flowers of the veld in turn absorb our attention.

Growth means life; and every living thing has something of interest to tell if our eyes have been trained to see and we have learned to think about what we see.

In studying plants we find great differences in the plant kingdom, and how as living things they can change their form and habits of growth so as to fit themselves to widely differing conditions of life, for plants cannot choose where they would grow. In doing so, the members of one plant family come to look so unlike one another that it becomes difficult to detect any family resemblance; while members of different families look enough alike sometimes "to be brothers and sisters," for plants that have come from the same parents in past years are grouped together in a family or order.

We are surprised to find that dodder, which fastens its threads upon lucerne and chokes it and robs it of its food, belongs to the highly respectable family of the sweet potato.

When lavish Nature sows her seed, some, it is true, "fall upon stony places and wither away," but some lay hold of the rocks and change them into soil, so that one dainty pink-and-white *Crassula* which grows on our hillsides rejoices in the name *Saxifraga*, the rock breaker.

It would be difficult to say where plants are not found; on the heights of the Drakensberg, and even higher ranges, flowers blossom and die, where no eyes but their Maker's behold their beauty. Plants are found, beautifully white and delicate, deep down in the darkest mines. They are able to withstand the heat of boiling springs, and explorers from the frozen Antarctic return with mosses and lichens. Germs of plants kept in liquid air for six months at a temperature of $-190°$ have suffered no injury, while others have remained for ten hours in a bath of liquid hydrogen, 60° colder still, and have then come forth and flourished. Plants are quite at home on cheese and canned fruit, and an old shoe cast upon a refuse-heap may boast its botanic garden. These are the moulds, and against them the housekeeper is waging constant warfare.

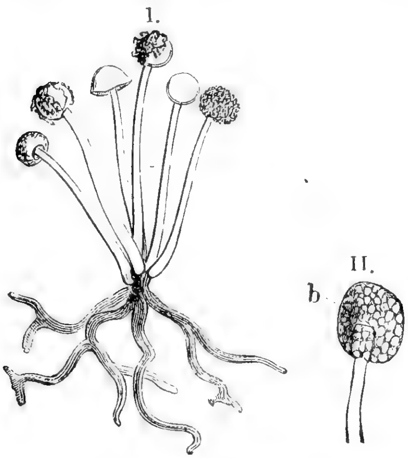


Fig. 1.—Common mould (*Mucor mucedo*): I. An entire plant with six sporangia in different stages of development (strongly magnified). II. Single sporangium with spores *b* (× 200). (From Thomé and Bennett's "Structural and Physiological Botany.")

Some plants are so small that the sharpest eyes cannot see them without powerful microscopes. Of these, some grow in the human body better than anywhere else. We call them **germs**. Several kinds grow on the teeth and cause their decay, unless the teeth are carefully brushed. One kind, which passes part of its life in impure milk or water, lodges in the throat and causes diphtheria; and another produces enteric fever, so that eternal vigilance is the price of health.

Others of these minute plants are as useful as some are harmful. When the housekeeper is mixing "sponge" for bread, she is putting in as she stirs germs known as yeast plants. If the sponge is set in a warm place, the moisture causes them to grow rapidly. The growth changes a part of the starch of the flour into alcohol and carbonic acid gas, which, rising in bubbles, makes the bread light. A sudden chill prevents their growth, and the bread is heavy. Some germs are necessary to cause milk to become sour. Flies are great scavengers, eating from the walls germs that might cause sickness. They are not at all particular about their food, and the day often comes when the fly dines upon one germ too many. It grows and multiplies rapidly, and before the day is over it completely fills the fly and sends out little sticky threads, which fasten it to the wall or window. You may often see them in wet weather. Upon these threads little bodies—spores—are borne, which blow about to tempt other unwary flies. Some serve locusts and grasshoppers in a similar manner. It would be a good way of getting rid of these

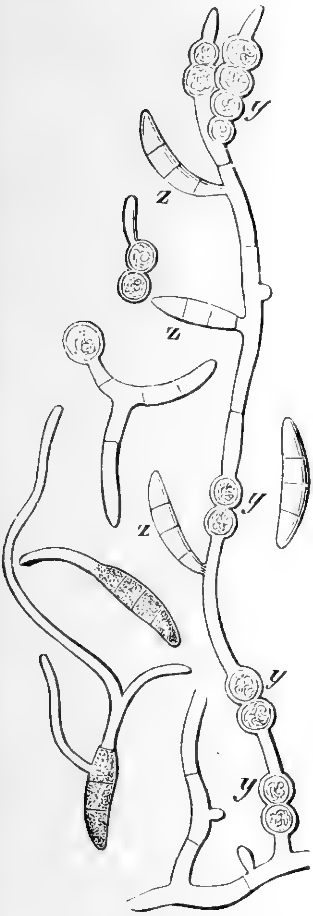


FIG. 2.—Fungus-filaments from a rotten potato. (From Thomé and Bennett's "Structural and Physiological Botany.")

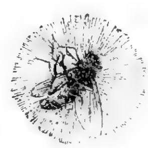


FIG. 3.—Fly killed by mould. (From Thomé and Bennett's "Structural and Physiological Botany.")

plagues were it not that, for these spores to multiply rapidly, moisture is necessary, and the locusts are not particular to time their visits to our gardens during the wet seasons.

Lichens grow on rocks, where they look like splashes of paint in many shades of red and brown, grey and green. They, too, have their place in the plant-world, and do their share of the world's work. For ages they had been performing their part long before flowers made the world beautiful. Small as they are, they can dissolve and absorb small portions of the rocks on which they dwell. Gradually these plants crumble to dust, which may be used to nourish some less humble plant.

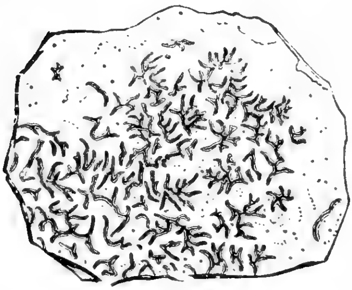


FIG. 4.—*Graphis elegans*, a pictorial Lichen (natural size). (From Thomé and Bennett's "Structural and Physiological Botany.")

Mushrooms "that spring up in a night" bear their fruit and die. Contrasted with these small short-lived plants are those that grow to immense size and live through generations. We owe the oaks and the fir trees that beautify the western part of the Colony to the earliest European settlers, to whose unselfish foresight they stand as lasting monuments. The historical oak of French Hoek has blossomed and shed its fruit for two hundred years, but no date in history records the planting of the famous "Wonderboem" of Pretoria. As its branches have spread out they have sent down their stem-like roots, which support the branches like columns.

The life histories of the moulds, yeasts, and disease germs have been learned only in recent years, since microscopes have been improved; but the old Hebrew poets, who watched the paths of the stars as they tended their flocks, studied the trees and flowers; and we know our Saviour cared for them, for He often spoke of them in teaching His beautiful lessons. We, too, may study them without books and without knowing their long Latin names, though these have their uses. How unfortunate it would be if Johannesburgh or Springfontein had no names when we wished to book our luggage for those places. The long names of plants are not so formidable either, when stripped of their Latin endings. Thus deprived, *Macowani* reveals our friend-in-need, Dr. MacOwan, and how better could South Africa's authority on orchids be honoured than by naming a new Disperis, *Bolusiana?* The paired leaf of *Bauhinia* reminds us of the twins, Bauhin, who long ago devoted themselves to Botany. When we have found the two forms of fruit on one head of flowers, *Dimorphotheca* (two-formed capsule) seems a most appropriate name, and once having seen the little crown of pappus hidden among the long

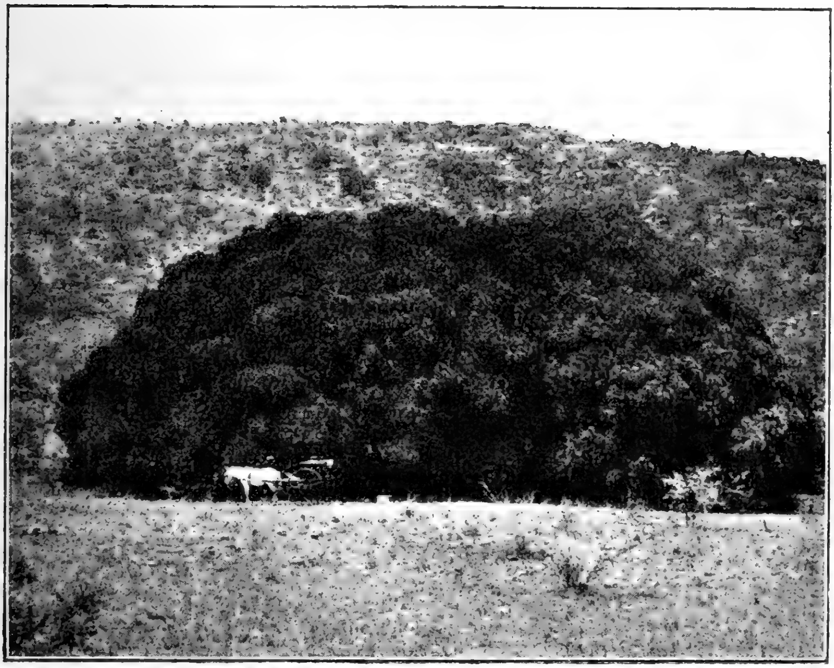


FIG. 5.—"Wonderboem" near Pretoria.

hairs of the ovary, we shall never forget *Cryptostemma*, which means **hidden crown**. If you have not studied Latin or Greek, ask help from your brothers and sisters who are in college. To speak of plants and their parts, we must have names, and no name in this book will be longer than Hermanuspetrusfontein.

CHAPTER II

SEEDS AND THEIR GERMINATION

Besides maintaining its own life, a plant's activity is directed toward reproducing its like in the lives of others. One of the most usual means of reproduction with which we are familiar is the seed. Seeds may be very small, like those of orchids, heaths, or *Streptocarpus*, or large, like the acorn and cocoa-nut. In each seed there is a tiny plant, the **embryo.** Before the parent plant sends her offspring out into the world to fend for themselves, the seeds are well provided with a nicely fitting coat and a generous supply of food, to serve them until they are able to make their own. The pine seed is provided with one thick hard coat, but most seeds have two, which fit so closely that when the seeds shed their coats the two come off together.

When seeds are put into the soil and watered, the coats begin to swell, if there is warmth enough. In the bean they become wrinkled. As the water soaks in farther the rest of the seed swells and fills the coat until it bursts, and the embryo begins to make its way out. The seed is said to **germinate.** This shows that the seed which was so hard and dry is alive. It was alive all the time, but did not grow.

What made it begin to show life?

One of the simplest seeds to understand is the bean. It is an old and useful friend. In order to make out the different parts of seeds, it is well to compare them with some which have just begun germinating, for then the parts separate more easily. For this purpose seeds may be put into a box of clean sand. A biscuit-tin is good, but care should be taken first to make holes in the bottom to insure drainage.

Plant broad and narrow beans, Indian corn, water-melon or pumpkin seeds, and any others which you may have gathered.

As soon as the bean plant begins to make its appearance above the soil, an examination will reveal two thick leaves placed opposite to one another. Between them there is a small leaf-bud with one leaf folded within another. They are attached to the stem, which extends below the first pair of fleshy leaves and joins the root. It may be difficult to say where the stem ends and the root begins. Now compare a seed which has been soaked in water a few hours. Before removing the seed-coat notice the scar or **hilum** by which the bean was attached to the pod.

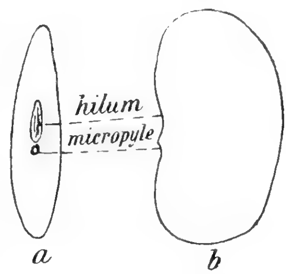


FIG. 6.—Bean seed before removing the coat.

At one end of the hilum is a small hole, the **micropyle.** The seed-coat comes off easily and the seed splits into two parts, which you will see correspond to the two fleshy leaves.

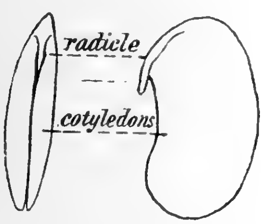


FIG. 7.—Bean seed with coat removed.

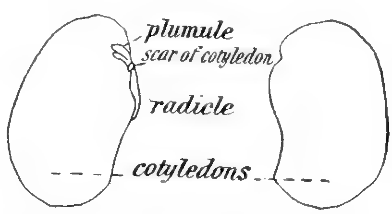


FIG. 8.—Bean seed with one cotyledon removed.

They are called **cotyledons.** Between these two halves there lies a small curved body, at one end of which may be seen the two small leaves the **plumule.** The other end, which will make the root, is called the **radicle.** So a seed contains a whole plant, very small and compact, ready to develop into a large plant when warmth and moisture are supplied. The small plant folded away in the seed is called the **Embryo.**

Instructions for Work.—Make a drawing of the outside of a bean seed. Carefully look to see how the parts are placed within. At which end of the seed is the plumule with reference to the micropyle? On which side of the seed? Compare the arrangement of the narrow bean with that of the broad bean. Make drawings of all that you see. Keep these drawings in a book which you will use for plants.

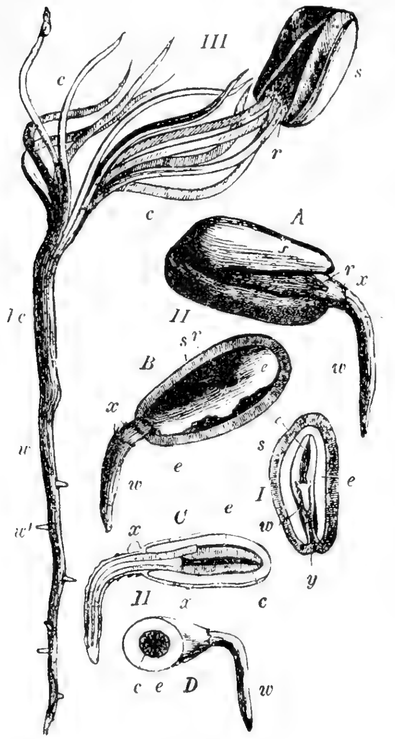


FIG. 9.—Seeds of *Pinus Pinea* in different stages of germination. *I.* Ripe seed in longitudinal section: *s*, testa; *e*, endosperm; *w*, radicle of embryo; *c*, the cotyledons; *y*, the micropyle end of seed, with the rootlet directed towards it. *II.* Germination commencing: *A*, Testa; *s*, ruptured, and rootlet; *w*, protruding; *r*, red membrane inside testa; *x*, ruptured embryo sac: *B*, portion of testa removed; *e*, endosperm: *C*, longitudinal section; *c*, cotyledons: *D*, transverse section. *III.* Germination complete, the cotyledons, *c*, unfolding, and the hypocotyledonary part of stem, *hc*, elongated, the main root, *w*, developing lateral rootlets, *w'*. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

A loquat seed will separate into two parts, the cotyledons; but the plumule and radicle cannot be so plainly seen.

Now make out the parts in the seeds of a pumpkin, watermelon, or calabas seed.

In all these seeds the little embryo has stored all the food which the mother plant provided, within the two plump cotyledons. But there are seeds in which the food is stored outside the embryo. The pine seed shows this nicely. Remove the thick, hard seed-coat and cut the contents across. A ring of white food will be seen, the **endosperm**, surrounding a central part. If another is cut lengthwise, this central part will be recognized as the little pine tree, with the radicle pointing to the smaller end of the seed. Instead of two cotyledons, several will be found. The plumule is too small to be seen.

When drawing a pine seed, draw the seed-coat around the endosperm. A thin papery bag will be found between the two. It once contained food. Draw it by a light line inside the seed-coat.

In the Hottentot fig or T'gaukum (*Mesembryanthemum*) the embryo is curved around the endosperm.

Examine some seeds of "mealies" or Indian corn (*Zea mais*). Notice a small raised place on one side toward the smaller end. By soaking the seed and removing the coat this

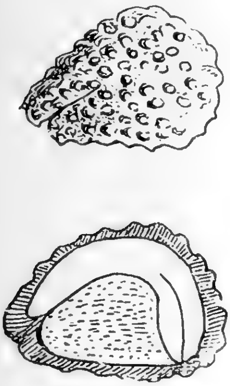


FIG. 10.—Seed of *Mesembryanthemum* with curved embryo.

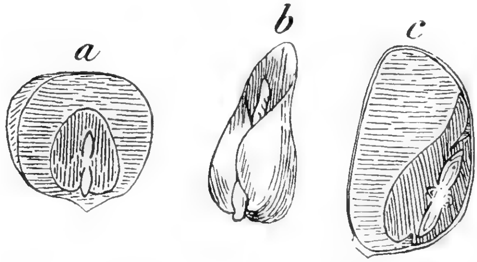


FIG. 11.—Seed of *Zea mais*. *a*, embryo at one side of endosperm; *b*, embryo removed; *c*, seed cut through, showing plumule, radicle, and side roots.

little body may be removed. It is the embryo. The greater part of the seed is filled with endosperm. The embryo has but one cotyledon, which lies close to the endosperm on one

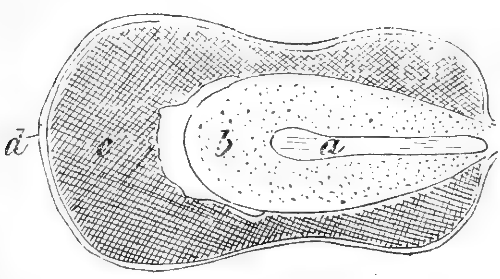


FIG. 12.—*Hæmanthus* seed. *a*, embryo; *b*, endosperm; *c*, food outside the endosperm partly used; *d*, seed-coat.

side, and on the other is joined to the plumule and radicle. They are so covered by the folded cotyledon that only the tips can be seen.

The large seeds of the "April Fool" (*Hæmanthus*) have but one cotyledon. The embryo is a small rod-shaped body lying in the centre of the endosperm. Around the endosperm is more stored food (perisperm). It can be seen plainly, and will remind you of the empty bag in the pine seed.

Examine a date and compare the seed with that of Hæmanthus.

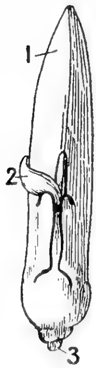


FIG. 13.—Seed of "Water Uintjes" (*Aponogeton*). 1, large fleshy cotyledon; 2, plumule; 3, small radicle.

"Water Uintjes" (*Aponogeton*) has one large green cotyledon, a thin plumule, and a very small radicle. Its food is all stored in the cotyledon.

Plants which have two cotyledons are called **Dicotyledons,** those with only one are **Monocotyledons.** It is an important distinction. Most monocotyledons have endosperm. "Water Uintjes" (*Aponogeton*) is an exception. The plants in each group have other characters in common which we shall find out later.

In the *Hæmanthus* and date the embryos are so very small that the food supply seems unnecessarily generous; but it takes a long while for the date to get a firm footing in the soil, and the "April Fool" is always liable to be overtaken by drought. Nature provides her children generously, and we all know, when it comes to a question of food, it is better to have too much than not enough.

By this time we have examined enough seeds to find evidence of foresight for the future of the little plants, and as we follow their life histories we shall find this wise provision all along.

FIG. 14.—*Zea mais* (Indian corn).

HOW SEEDLINGS BEHAVE WHEN THEY WAKE UP.

Zea Mais comes up Head Foremost.—You may mistake the little pointed object for a stem, but in a few days you will find it to be a hollow, pointed leaf containing another leaf rolled up within it. This pointed roll easily pushes up through the soil. After it is safely up, watch the outer leaf split open and the next leaf unroll.

The calabas seed has by this time backed out of bed. Here the stem grows faster than the leaves. It makes a loop above ground, and as it gradually lengthens it pulls out the leaves. A little thought will show that this is the better way for the calabas or pumpkin, as the leaves are not rolled, and would have hard work to push up through the soil.

FIG. 15.—The Calabas backs out of bed.

Now pull up some of the pumpkin seeds to see what has been happening below. The point at the lower end of the cotyledons has grown out to form a small root. The seed-coat has split open, and there is a little peg where the root is coming out. Plants a day or two older will show that the arching stem is splitting the seed-coat, and that the peg is holding the lower edge firmly in the soil. How did the peg come to be just there? There is nothing like it on the other side, where it would

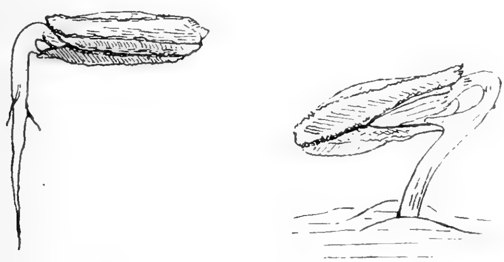


FIG. 16.—The peg is spreading open the seed-coats.

be of no use. What if the seed had been planted with the other side down?

Let us find out by planting more, taking pains this time to plant them flat. The pointed end, toward which the radicle always points, is a little one-sided. The point is not quite in the centre, and the micropyle is beside it. We can place the seeds in one row with the point at the right, and those in another row with the point at the left.

The peg is an odd little body. It is made for a purpose, and grows only where it is needed. Sometimes the stem below the peg grows too rapidly, or the seed coat is not held firmly enough by the soil. Then the peg fails to hold the seed coat in place and the plant has to get out as best it can. Do such seedlings look as thrifty as others? In Fig. 17 the peg has done its work, and the coat has been left underground.

Why has the cotyledon of the mealie not made its appearance? It remains down where the supply of food was stored, which it has been absorbing and passing on to the plumule and radicle. By the time these parts are able to make their

FIG. 17.—Calabas. The peg has done its work for the little calabas plant.

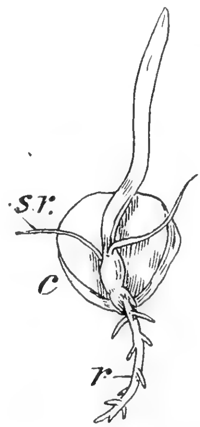


FIG. 18.—Germinating embryo of *Zea mais*. *c*, cotyledon; *r*, radicle; *sr*, first side shoots growing from stem.

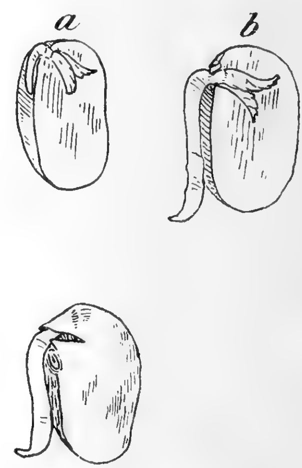


FIG. 19.—Germinating bean seeds. *a* and *b* with one cotyledon removed.

own food the seed will feel quite soft. If you cut a seed through the centre from front to back, and look at it with a hand lens, you can see the little channels through which the food passes. The radicle was protected in the seed by a little pocket, as was the leaf. The cap does not grow as much as the leaf-cap does, and the radicle soon pushes through it.

In the Indian corn the first side roots come from the stem just above the cotyledon. They are a part of the embryo. In the pumpkin they come from the radicle which forms the tap root; they are not formed until after the root begins to grow.

Compare the germination of a common bean and that of a broad bean. Both come up with a loop. Does the same part of the stem form the loop? How do the cotyledons behave in the narrow bean and in the broad bean? The cotyledons do not grow as in the calabas or pumpkin. Notice how they wither as the food they contain is given up to the

FIG. 20.—Bean seedlings.

growing parts. When the loop pulled up the cotyledons in the narrow bean, the tender leaves of the plumule folded between them were also safely brought up. How is the plumule brought above ground in the narrow bean? The plumule grows out into two pretty leaves. Notice carefully the little cushions near the lower end of their stems. Were these found in the calabas seeds?

"April Fool" seeds (*Hæmanthus*) may not wait to be planted. The juicy berries within which they grow supply moisture, and when the right time comes they germinate of themselves. As growth begins the root is pushed out by the cotyledon, the tip of which, remaining in the seed, absorbs the stored food until the root is old enough to reach the soil and do its work. After a few days the plumule thrusts up its head through a slit in the base of the cotyledon. Does the tip of the cotyledon come above the soil?

While studying the germination of April Fool seeds, compare them with germinating seeds of onion and date. The

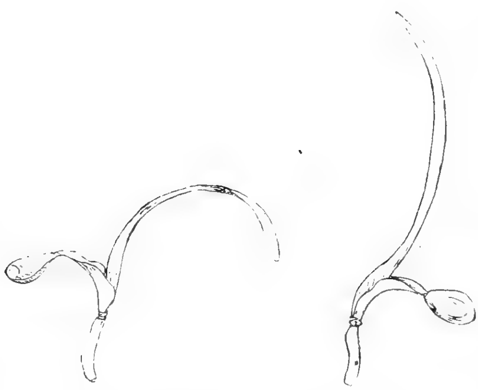


FIG. 21.—Little "April Fool" plants (*Haemanthus*)

FIG. 22.—Growing seed of *Aponogeton* ("Water Uintjes").

latter germinate very slowly. Plant them early in the year. A place may be left in the notebook for them.

Watch for acorns that have been left on the ground for several weeks after falling. Notice how the plant splits the hard shell, and how the root pushes down and anchors the seed.

Plant other seeds that are about your home. The Silver Tree has large seeds which germinate readily. Arum "lily" seeds may be compared with those of Hæmanthus. Aponogeton seeds may be found soon after flowering. Notice how little the radicle develops. A stem soon appears at one side of the cotyledon which bears roots below and leaves above.

Kafir corn may be germinated with Indian corn. In studying germination, take plenty of time to make simple drawings of each plant. Drawings should be made to show the plumule unfolded.

In the seeds we have studied **the cotyledons have their special work to do.**

The cotyledons of the broad bean simply yield up their food to the growing plant.

In *Zea mais* the cotyledon not only gives up its own store, but absorbs and passes on the food in the endosperm.

A third form is found in the date seed, where only the tip of the cotyledon remains within the seed to absorb the food, while the lower part pushes the radicle down into the soil, where it is safe from drying up.

The onion does nearly the same as the date. The cotyledon (*a*) absorbs the endosperm, (*b*) places the radicle, (*c*) comes up with a loop and brings the delicate plumule safely above the soil, (*d*) finally escapes altogether, becomes green, and behaves like a foliage leaf.

The pine and castor-oil seeds have a different habit. Instead of remaining within the seed-coat where the food is stored, they pull themselves out, bringing the food with them as little caps, which they consume on the way up, and gradually become good-sized foliage leaves.

Black wattles and the narrow bean cotyledons come above the ground to yield up their food, then wither and fall off.

The gourd family keeps the cotyledons, which grow and become green.

Here are seven ways, and you may find others. If you live in the East or near a botanic garden, you should study the seeds of Encephalartos (Kafir bread tree). Which type does it resemble?

We have found that cotyledons (1) store food, (2) absorb and pass on food from the endosperm, (3) surround and protect the radicle and plumule, (4) bring them into position, (5) act as foliage leaves.

In no case have the cotyledons looked like the next leaves. Have you found any more showy than the next leaves?

In order to watch the growth without injuring the seedlings, seeds may be planted in a frame having glass sides. Ask the tinsmith to cut two pieces of galvanized iron the shape of Fig. 23. Bend them along the dotted lines. Nail the piece *a-b* to a board for support, and slip in on either side a piece of glass. Discarded photographic plates are just the thing.

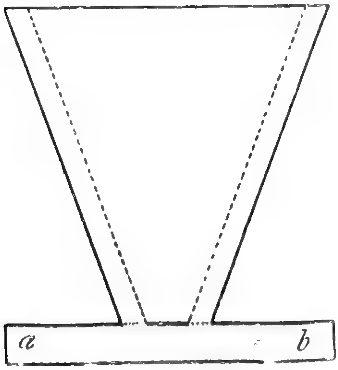


FIG. 23.—Diagram for ends of glass germinator.

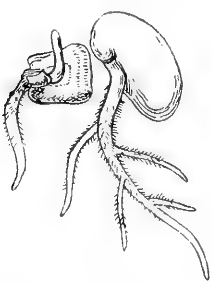


FIG. 24.—Seedlings showing root hairs.

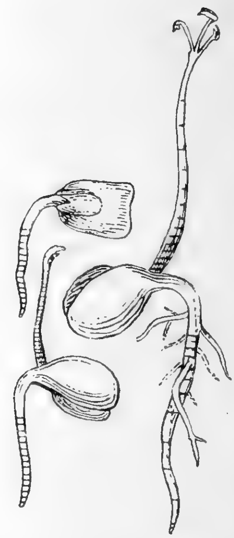


FIG. 25.—Seedlings marked to show the place of greatest growth.

We will call this the Glass Germinator. Fill with moist sand. Thin cloth may be placed between the sand and the glass.

Place the seeds in different positions. Notice how quickly the roots will turn down and the stems bend upward. The work of the roots is to be done down in the soil, and that of the stems up in the light; so the sooner they get into their proper positions the better.

Fine white hairs may be seen on the root and its branches to within a short distance from the tip. As the root pushes on, the oldest ones are worn off, but new ones are constantly formed toward the tip. They make their way in between the fine particles of soil in search of water.

Fasten some seeds, which have germinated until the roots are about an inch long, to strips of wood. Place them in an inverted flower-pot, in which the water stands to a height of two inches. Let the roots in one dip into the water; place the second lot higher, taking care that they are some distance above the water. After they have grown an inch or two, note the absence of root hairs in one lot of roots. If there is an abundant supply of water, there will be no need to provide special growths to obtain it.

CHAPTER III

GROWTH OF ROOTS, STEMS, AND LEAVES

Do all parts of the root continue growing as it pushes down into the soil?

To answer this we must have the roots where we can examine them. Let us take a fruit-can rim. Make holes about half an inch apart around the edges, and weave strong cord across above and below. Fill with chopped moss or cotton wool, in which place germinating bean or pumpkin seeds, and suspend in an inverted flower-pot over a saucer of water. When the roots have grown below the germinator about an inch and a half, mark off equal distances on the roots with ink (waterproof ink is better). Place the germinator under cover, and observe the next day. The spaces toward the upper end nearest the seed will be the same distance apart they were the day before. The root has not grown there nor at the tip. Growth in length is greatest just at the back of the tip.

In a similar way examine the growth of stem and leaves. Mark off equal distances as before; they may be a little farther apart on the stem. The place on a stem from which leaves are given off is called a **node**. The part between two nodes is called an **internode**. Notice that the stem grows both below and above each internode, but the greatest elongation is in the upper half of an internode. How does a leaf become larger?

Now compare the results with the stem growth of monocotyledons.

Place *Zea mais* seedlings where they are warm. When the first blade is about two inches above ground, or as soon as the leaf which it is protecting has burst through, separate carefully with a fine needle, and strip from the sheath to expose

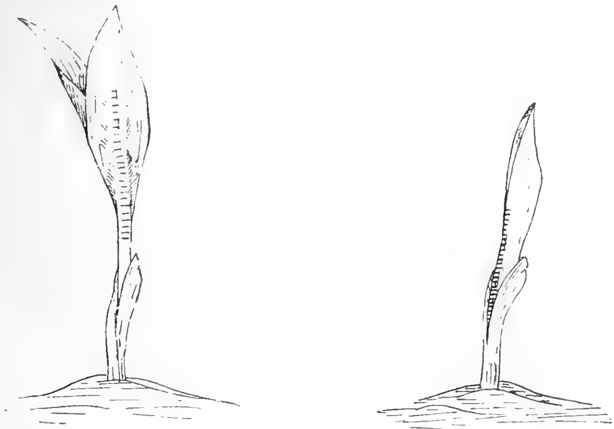


FIG. 26.—Showing basal growth in *Zea mais.*

the base of the leaf within. Mark off lines on the part exposed, carrying them across on to the sheath. When growth has taken place, so that the marks appear above the sheath, it will be seen that, unlike the dicotyledon, growth has not caused the marks to spread apart, but the place marked has been pushed up by the growth at the base of the leaf.

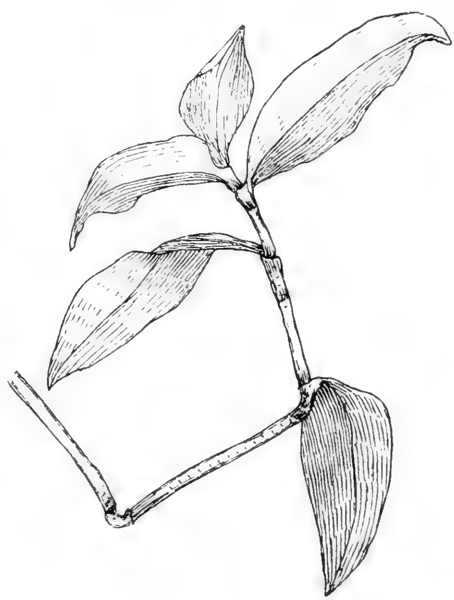


FIG. 27.—Growth of the stem of *Commelyna.*

Commelyna will be a good plant for studying the growth of a monocotyledonous stem. It is found wild, and in cultivated places. Split the sheathing base of the leaf and mark the stem. Mark other plants—*Flagellaria*, or any of the species of *Asparagus*

(*Waacht-en-beeche*). Mark the stems in Spring, when they are growing rapidly.

Direction of Growth of Roots and Stems.—We have seen that the root tends to grow toward the centre of the earth. The side roots extend obliquely in several directions, to be as well placed as possible for obtaining their food. Pinch off a tip of the main root. One of the side roots now bends down to take its place. Which root does this? Is more than one root affected?

How does the root curve?

Mark the roots of seedlings in the circular germinator as before. When the roots are an inch or two in length, suspend the germinator from the side. Now observe where the bend occurs. How does the shortest curve compare with the position of greatest growth?

Mark other roots, and with a sharp knife cut off the extreme tips of some. Early the next day notice the difference between the cut roots and the uninjured ones. None of the cut roots have bent downward. They have lengthened, so that we know the growing region or **motor zone** has not been injured. The root grows down because it is stimulated by gravity. But from our experiment we have seen that the tip is the part which is sensitive to this stimulus. It is called the **perceptive zone.**

The Direction of the Stem.—The stem has as strong an upward growth as the root has a downward tendency. Place seedlings that have grown in pots or in the circular germinator in a horizontal position. In three or four hours a decided change of direction has taken place. In Fig. 28 notice that the one at *a* is curving, although the end was cut. Observe the stem curvatures of monocotyledons. Where does curvature take place in the jointed stems of grasses? In *Commelyna?*

After the seedlings have become upright, turn the pot half-way around. Note how soon a change of direction may be observed. It will be made more apparent by thrusting into the soil two slender wire rods, one on either side of the stem.

Growth Curvature affected by Water.—We have been studying growth curvatures affected by gravity. While the tendency of the main root is downward and that of the stem is upward, both are sensitive to other influences. Food material which roots absorb must be dissolved in water, in search of which they often go a long distance. The roots of a tree growing by a stream will reach far out on the side toward the water. Young plants show this curvature. Cover the outside of the glass germinator with several thicknesses of flannel. Fasten seeds which have just germinated by means of a narrow strip of flannel to the upper edge of the glass. Keep the flannel moist, and the roots will follow on

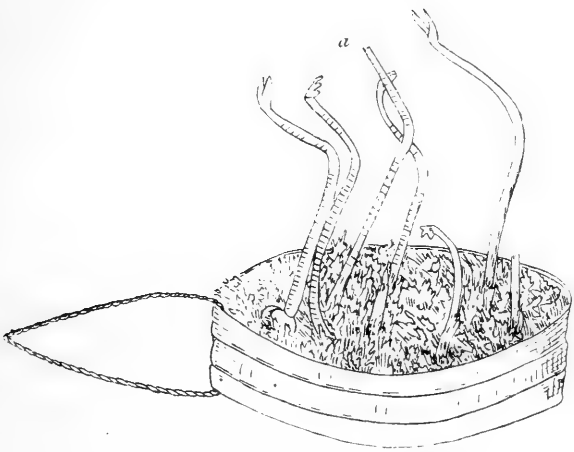


FIG. 28.—Stem curvature induced by gravity.

the inclined face of the germinator instead of growing vertically. The flannel must not be too moist, or the roots will turn from it. Another good way to show this curvature is by fastening a pointed bag of butter-cloth to the germinator; fill it with moss or cotton-wool, and fasten the seeds around the upper part of the bag. Suspend the bag in a jar. It should be well drained, and no water should stand in the jar.

Growth Curvatures caused by Light.—Place the germinator in a box lighted at one end. Notice the seedlings in a day or so. The stems will bend toward the lighted end. Will the roots show a turning away from the light?

The seedlings of sunflower are very sensitive to light.

Place some in a bright light and cover with black paper, leaving an opening at one side. Notice how the cotyledons turn their flat surfaces to the light. As soon as the next pair of leaves appear, reverse the position, so that they turn directly

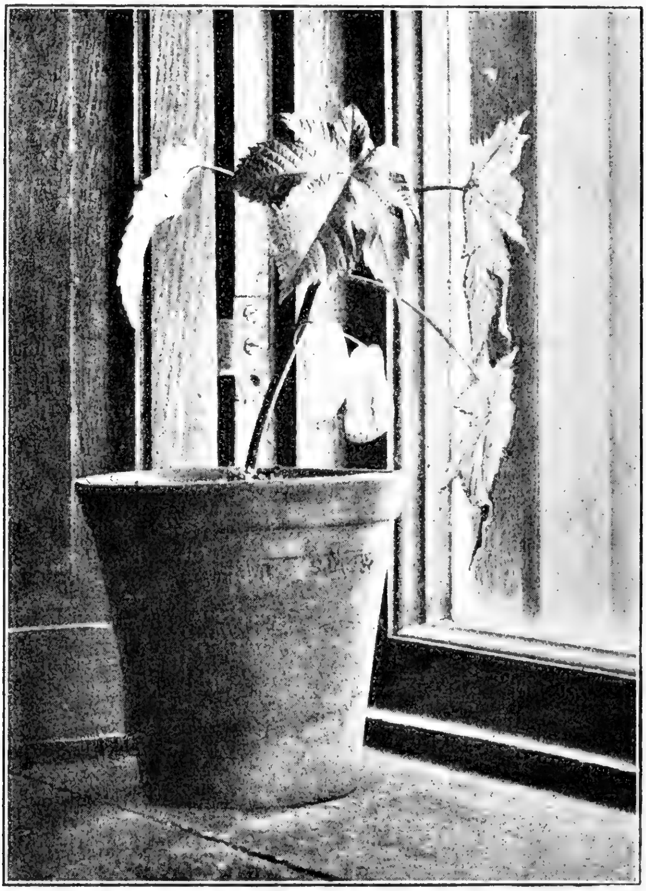


FIG. 29.—Leaves of young Castor-oil plant looking toward the light.

away from the light. Will they turn back? Try the experiment with other seedlings.

Fig. 29 shows a young castor-oil plant. All the leaves, including the cotyledons, have turned toward the window. The stalks (*petioles*) of the cotyledons have curved so as to bring the surface of the cotyledons into a favourable light position. The cotyledons of the bean have no petioles. On the stem of those which are turned away from the light, below the cotyledons, make a row of ink marks. Place in a lighted window. In a day or so the cotyledons will look toward the light. The row of marks will show that the stem has twisted to bring them into position. When that portion of the stem has stopped its growth, turn the plant halfway around. Will the cotyledons again turn toward the light?

Remove the tips from sunflower seedlings, cutting off some above and some below the cotyledons. Do the stems still curve toward the light?

Plant sunflower seeds and keep them covered so as to

FIG. 30.—The plant in this pot grew on the north side of a large rock. The portion beside the pot grew on the south side in the shade.

exclude all light. At the same time plant others and leave them exposed to light. When the cotyledons of the second lot are well expanded, compare with those which have been covered. The cotyledons are still closely pressed together. Cover those that were left exposed. After a day or two examine them again. Evidently light has an influence in spreading leaves apart; darkness closes them.

Notice *Oxalis* plants at night. Leaves and flowers are all closed. In the morning they open. On very bright days the leaves go to sleep, while the flowers remain open. On cold days they remain closed, so heat as well as light has something to do with the closing of leaves.

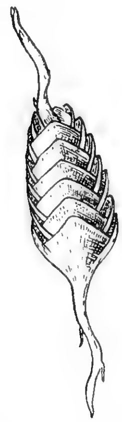


FIG. 31.—The boxed-up Karroo plant sent forth a shoot in search of light. Observe the difference in position and size of leaves.

Plants grown in sunlight have a sturdy appearance, and the leaves are well developed. Well-developed leaves would be of little use to a plant grown in darkness. It is best for the stem to push out as rapidly as possible in search of light. If a plant remains in darkness, the leaves remain small and undeveloped, while the internodes lengthen as fast as possible. The plant in Fig. 30 grew under the shelter of a large rock. The part in the pot grew on the sunny northern side, while the piece at the left grew in a more shaded place on the southern side. Fig. 31 is the picture of a very compact little plant when it is growing at home in the karroo near Beaufort West; but while boxed up for the post it started on a journey of its own in search of light.

While leaves grow more rapidly in light, the stem grows less rapidly.

CHAPTER IV

FURTHER GROWTH AND DURATION OF PLANTS

By the time the plant has germinated, that is, has unfolded the parts formed in the embryo, and has used up the stored food, the root, by means of the root-hairs, has become closely attached to the soil. New roots are sent out with their root-hairs, and the plant is able to get its own food material, partly from the soil through the roots and partly from the air by means of the leaves. While the embryo was unfolding the plant was not increasing in dry weight, but by the time the first new leaves are forming the plant is beginning to add to its weight; growth has really begun.

In none of the seeds studied were the cotyledons and plumule similar in appearance. In the bean, after the two plumule leaves, but one leaf unfolds at a time. There appear to be three, but they are all borne on one leaf-stalk. Notice the little cushion at the base of each part. Look for the cushion in the *Oxalis* leaf. When they are inflated with sap, the leaflets bend down to sleep. Look for them in clover. Are they in the same position? Do clover leaves lie down to go to sleep? Do bean leaves go to sleep?

One pupil kept her bean plant carefully watered. After awhile it bore branches. Where did they start? One day a white blossom was reported; others followed. They were short-lived, the pretty white part fell, and it was feared the plant would die. But in the centre of each flower a pod came. Seeds appeared in the pods, and in each seed a new bean life was formed. When the pods ripened, they split open, and the seeds fell out. Then care and watching no longer availed. The plant's lifework was done. It had borne fruit; then it

FIG. 32.—Bulbs—A, of a lily; B, of *Hæmanthus;* C, the same cut in two.

turned yellow, withered away, and died. This all happened in less than a year. A plant which completes its life history within a year is called an **Annual**. Some plants take two years to bear their fruit. The first year is spent in making food. This is stored away as fast as it is made, usually under ground. The second year a flowering shoot is sent up and the food is used to ripen the seed. These are **Biennials**. In cold countries, or where it is very hot and dry, work has to stop for part of the year; but in a mild climate the work of biennials may continue without interruption, and so the seeds ripen in less than two years. Many of them are found in vegetable gardens. Members of the carrot family are frequently biennials, though some plants of this family continue their growth under ground year after year, the part above ground dying down each year. This is also the habit of many *Pelargoniums* ("Geraniums"). If plants or their parts live more than two years they are called **Perennials**.

The underground part which stores food is sometimes a stem, sometimes a root. "April Fool" (*Hæmanthus*) stores food in a large bulb. A **bulb** is a short thick stem, surrounded by thick, fleshy leaves. Gladiolus Morea and their family, the Irideae, usually store their food in corms. A **corm** is a swollen stem bearing reduced leaves. The framework of these leaves remains attached from year to year, and gives corms of different plants distinct appearances. They are called **tunics**.

A white potato is a swollen stem. The "eyes" are buds. Under each bud is a scale which is a very reduced leaf. Each bud can grow out into a new plant. A potato is often called a **tuber**, but the definition of a corm fits it very well. A sweet potato gives off roots. The lower part at least is a root. The upper part has more the habit of a stem, as new shoots for planting are obtained from it.

Stems, more or less swollen, which creep under ground or are partly exposed, are called **rhizomes**. Plants with rhizomes can spread without being much exposed to the sun. Bulbs, corms, and rhizomes are abundant in South Africa and other dry, warm countries.

Asparagus, *Carrots*, many Pelargoniums, and others have fleshy roots for storehouses.

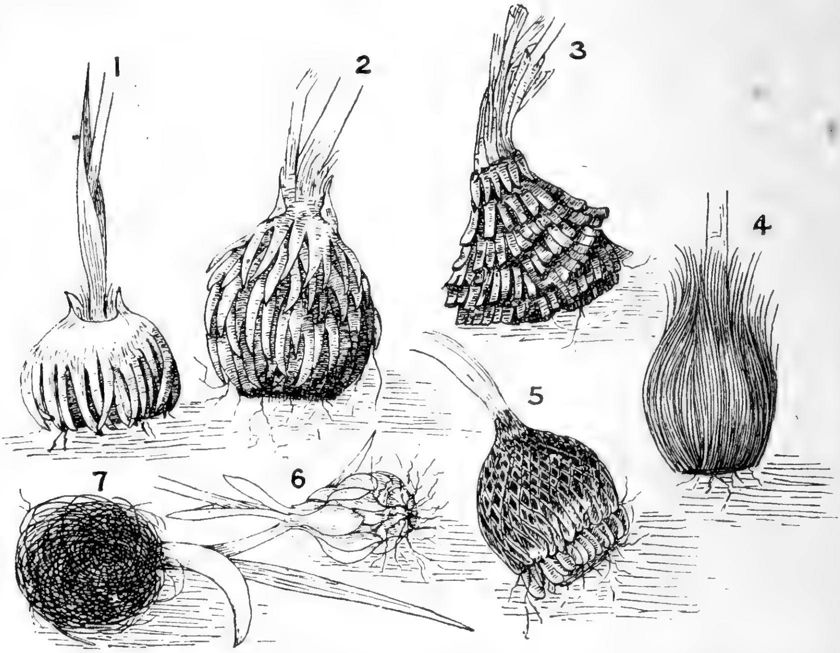


FIG. 33.—Corms with their "tunics." 1, *Antholyza revoluta*; 2, *Gladiolus alatus*; 3, *Lapeyrousia pappei*; 4, *Babiana*; 5, *Synnotia bicolor*; 6, *Romulea longifolia*; 7, *Hypoxis ovata*.

Just as stems are found under ground, roots often grow above ground. The Rubber Tree has its large root only partly

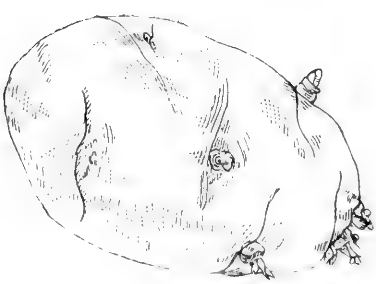


FIG. 34.—White potato.

FIG. 35.—The bracing roots of Indian corn.

buried. Roots borne above ground are not always for the purpose of storing food. Indian corn, which starts forming its roots on the stem while still within the seed, keeps up the habit. A ring of roots may be seen just above each leaf a long distance up the stem. They brace the plant as well as absorb nourishment. In the East, many orchids have long roots standing out into the air. They absorb moisture, as they grow on trees in moist situations. They are green, and act as green leaves do, of which we shall learn more later.

Roots borne in the air are called **aerial roots.** Plants which have aerial roots only are called **epiphytes**, because they attach themselves to other plants. The ivy and climbing cactus use their aerial roots for climbing. They have underground roots for absorption.

The way Trees grow.

The tree grows on, both above and below the surface of the soil, year after year. If such a plant grows to a height of twenty feet or more, and the lower branches remain undeveloped and fall off, so as to leave a central stem or **trunk** exposed, it is a **tree.** If it forks continuously from the base and has no strong central trunk, it is called a **shrub.**

The roots reach out over a large area or extend down to a great depth, so that trees having the two kinds of root systems may be planted close together. Should oaks and blue gums be planted side by side? Shade trees around a garden should have deep growing root systems, so that they will not remove the surface moisture required for the flowers or vegetables.

Plants in the germinator showed root-hairs near the tip. They died away further back where the side roots were forming. Of the great root system of trees, only the tips are absorbing food material. As they are always pushing forward in search of new food, the tips are protected by a short-lived cap of tissues, which is constantly being renewed as it is worn off. From the root-hairs the water with its dissolved minerals which the plant requires passes through very small cells at the root-tip, until it reaches the bundles of long slender tubes that pass from the roots through the stem to the very tips of the leaves. The tubes are not continuous through the length of the plant, but the water passes from one tube to another adjacent one. After this water has brought the minerals to the place they are required, part of it passes out through the leaves and stems into the air. This escape of water is called **transpiration**, or sometimes **perspiration**. Some of the water is used to make food for the plant.

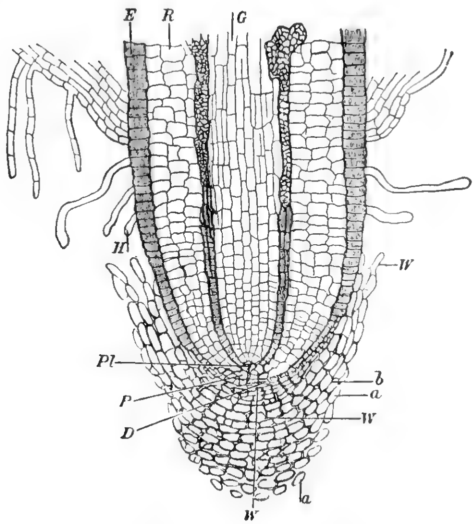


FIG. 36.—*G*, central cylinder, consisting of pith, vascular bundles, and pericycle; *R*, cortex; *E* piliferous layer; *W*, root-cap. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

The water, in its long journey, must not be dried up, and to guard against this, under the thin green dress of stems and branches an undergarment of cork is found. This garment is made of small cells also, but while the cells beneath have spaces between them to admit the air, cork cells fit closely together, and the walls are waterproof; so cork in trees serves the same purpose that it does in bottles. The cork cells are filled with air, and these air spaces, like the loft in a house, keep the tree cool in summer and warm in winter.

As the tree grows, the thin green over-dress gets too small; sap cannot get to it through the cork, so the cells of which it is made starve for lack of food; it cracks and peels off, and the tree henceforth is clothed in more fitting shades of grey or brown as become its years. Young cork cells stretch, but in time they lose their elasticity and become too small also. Just underneath lie special cells which keep it renewed, so that the tree is always properly clothed. Different trees fashion their cork after different patterns. In blue gums the renewing cells form long narrow plates, and the old tattered garment is shed in long thin strips. In the oak and pine the pieces are small and narrow but thick, while pieces of cork in the wild olive are thin, small, and rough. Cork does not fall off as fast as it cracks apart, but from a tree you can remove layer after layer that has been formed in successive years. This portion of the stem as far in as the cork is formed is known as the **outer bark.** So long as the renewing cells, or **cork meristem**, are not destroyed, cork may be removed without causing the death of the tree, and so from the Cork Oak, bottle cork is removed year after year.

In this bark a substance called **Tannin** preserves the wood from decay. Unfortunately for the tree, tannin is excellent for preserving leather also, and so the beautiful *Protea cynaroides* (Wagen boom), *Leucospermum conocarpon* (Kreuple boom) and *Rhus lucida* (Taai bosch) are destroyed for this substance which was intended for their protection.

In summer there are rifts in the bark to admit air and also to allow escape of water. These can be seen on young stems as small light-coloured raised openings. Being lens-shaped, they are called **lenticels.** In *Cassia* and the Cape Lilac they extend across the stem, and in *Erythrina* they are vertical. They become very conspicuous in poplars as the trunk grows, and give the peculiar marking to the bark. On quince bushes they become large knotty growths. Lenticel cells are also corky, but there are openings between them through which water and air may pass. When trees take their winter rest, a plate of cork seals them, so there is no waste of material. When there is no income there must be no expenditure. In spring, new spongy cells stretch and burst these little seals, and so the lenticels can serve another season. Cork extends down to cover the roots except the growing tip.

Many of the trees introduced to this country from the northern hemisphere are quite bare for a part of the year ; but they have come to shed their leaves in July and August at the time when they bear foliage in the north. Mingled with the northern trees all through South Africa are trees from Australia.

Do you know any? Do they shed their leaves so that they are quite bare at some time of the year? Can you tell how long leaves remain on any evergreen tree?

While roots are absorbing food material, leaves are taking in air and combining the air and water with the dissolved

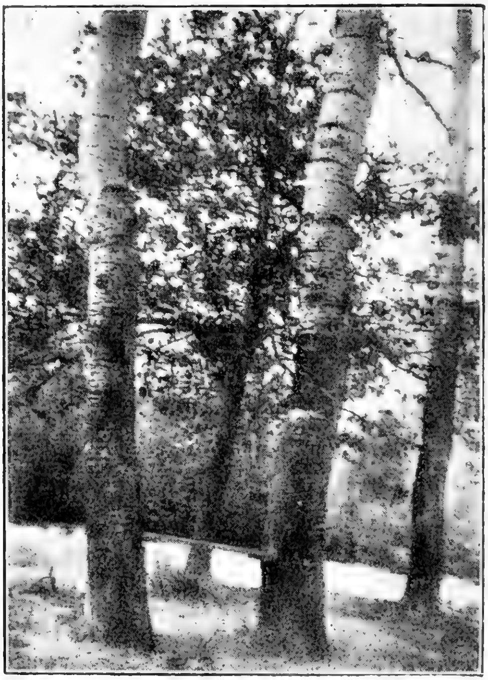


FIG. 37.—Lenticels on the bark of poplars.

earthy matter into food. Air, earth, and water seem at first rather unsustaining diet, but when we consider, we find that people, in common with other animals, since they depend altogether upon plants for food, are nourished by the same materials.

Leaf Fall.—When leaves have finished their work, the food that is left in them passes down into the tree, and is stored away in the roots until it is needed for the new growth the following season. A layer of cork is then formed in the leaf, where it joins the stem, which prevents the upward flow of sap passing back into the leaf, so it withers and falls off. The scar is healed by the cork. In oaks this cork is imperfectly formed, so many of the leaves rustle all winter in the storm

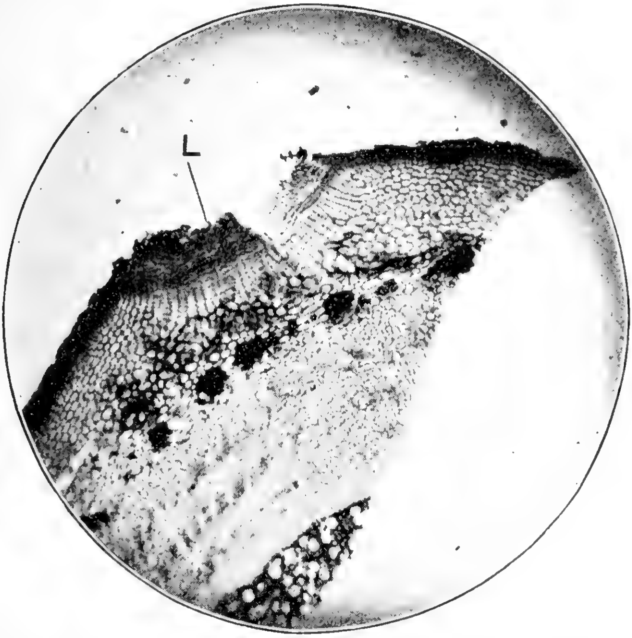


FIG. 38.—Apple stem. Section through (L) a lenticel (winter). (From Farmer's "Practical Introduction to the Study of Botany.")

until new buds formed in their axils (the angle made by the stem and the leaf) push them off.

To support and provide food for the branches added to the tree each year, the stem must increase in thickness. This it does by means of a ring of active cells just outside the woody portion of the stem. These cells, the **Cambium**, are most active in spring, when their walls are so delicate that they are easily broken,

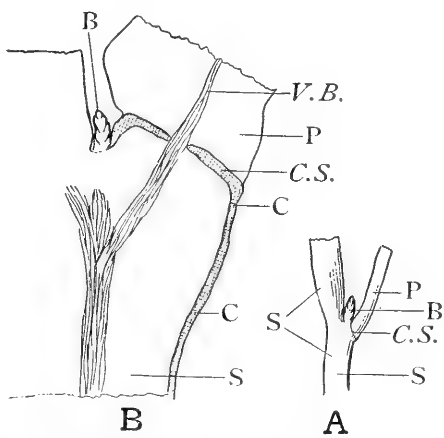


FIG. 39.—**A**. Longitudinal section through the stem and base of the petiole of a poplar. **B**. Part of the stem and petiole of **A** more highly magnified. S, stem; P, petiole; *V.B.* vascular bundle; C, cork tissue; *C.S.* "separation layer." (From Farmer's "Practical Introduction to the Study of Botany.")

and the bark may then be readily removed. All the growth outside of this ring of cells is bark or cortex. Every boy who makes willow whistles takes advantage of the active season of the cambium, for it is when the cells are young and tender that careful and judicious pounding with the handle of a jack-knife will bring the bark off entire. Later in the season, when the cambium is not so active (for the whistle-making season is limited, "as every schoolboy knows"), the cork gets to be a rather tight fit, growth is less active, consequently the cells of the wood are not so large. The large and small cells alternating make the **annual** rings in the wood by which the age of a tree may be determined. Rings are formed in the bark, but they are not so well marked as those in the wood.

CHAPTER V

GROWTH OF BUDS AND BRANCHES

PART of the food made by the leaves is taken to form the buds for next year's growth. In a dicotyledon a bud is formed in the axil of each leaf, so that if all grew there would be as many branches as there are leaves. Such is not the case; many buds are crowded out for want of light and air; others lie dormant low down on the branches as reserves, in case misfortune befall those higher up. The tender tips of branches offer tempting morsels to animals, and even after they are out of reach of grazing animals their dangers are not past. A swarm of locusts may pay an untimely visit, or a strong "south-easter" may scorch and kill leaf and branch in the spring.

Oaks and poplars retain the fashion that prevails in cold climates of wearing thick coverings to protect their little buds. The same fashion answers for some buds of this country for protection from the heat. Asparagus wraps up its summer buds with little papery coverings. These bud coverings are made of leaves or parts of leaves usually altered for the purpose.

Some buds contain both leaves and blossoms snugly tucked away together. Others contain only leaves or only blossoms. When the poplars border the streams with a delicate violet tinge, they are just shaking out their fringes of flowers to the breezes. They have been getting ready for the display for many months. Fig. 41 shows at *a* the flower-buds of a branch picked in December. They are well along towards next spring's flowering time. The furry coats on the scales will protect the little flowers from the hot suns of summer, and when winter rains come they will do excellently for storm cloaks until it is time for the long feathery tassels to burst forth. So long have they been storing food, that no wonder spring comes with a "burst." On the main branch are the scars of last year's leaves, *b*, and just above each one a scar tells where this year's flower-stalks

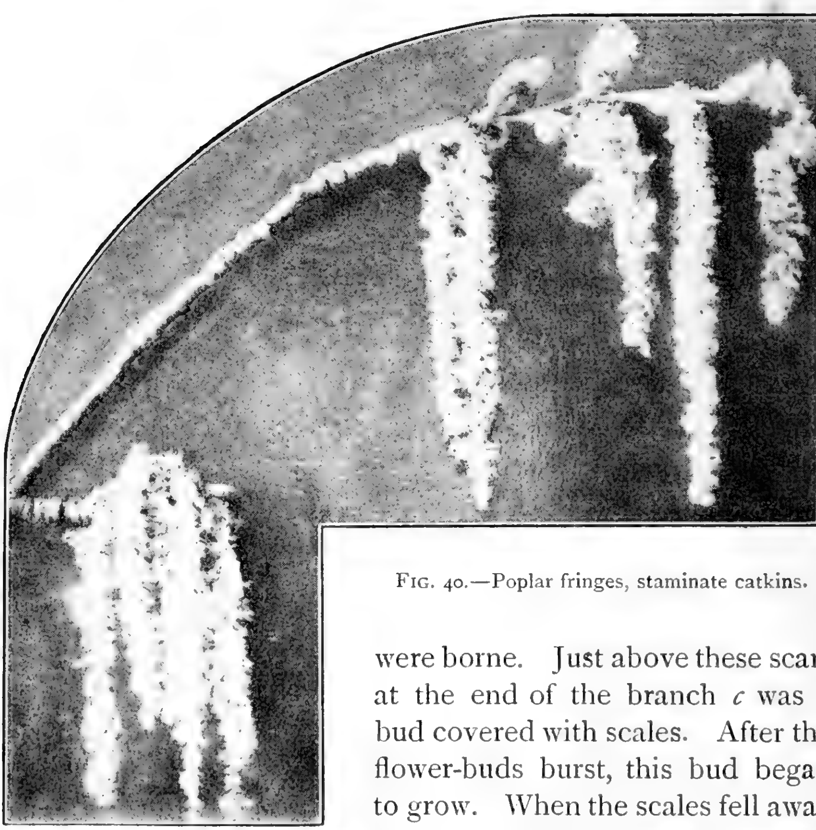


FIG. 40.—Poplar fringes, staminate catkins.

were borne. Just above these scars at the end of the branch *c* was a bud covered with scales. After the flower-buds burst, this bud began to grow. When the scales fell away they left narrow scars close together. By these scars we may tell how much growth has taken place in a season. The branch at the left has four flower-buds, and a bud at the end to continue the growth. The ring of scars at the base shows that a bud was there last year.

The oak branch in Fig. 42 began its growth this year at *a*. The leaves unfolded along the branch above about the same time that the catkins were hanging their pink-and-green tassels of flowers at *c*, *c*. The branch *a–b* rested in its growth until the acorns had "set" just below. After they were well formed, the resting bud unfolded, and the summer's growth commenced at *b*. The oak has two periods of growth during the season, so that in estimating the age of a branch a year's growth will include the distance between three bud-scars. Notice the

FIG. 41.—Twig showing leaf scars and buds of poplar.

terminal bud of a vigorously growing branch. Determine what part of the leaf protects the tip of the stem.

The terminal bud of a fig is covered by one pair of large stipules that are formed at the base of each leaf. They fall off quickly and leave their scar encircling the stem. Do any other trees have similar scales? What protects the bud in *Erythrina* (Boer bean tree)?

A bud is a shortened stem covered by leaves. Bamboos

FIG. 42.—Branch of an Oak.

have very long buds covered by enormous scale leaves. A cabbage is a large bud.

The life of a terminal bud determines the shape and character of a tree. In the blue gum and Norfolk pine the terminal bud continues its growth throughout the life of the tree. This gives to the tree a tall, erect habit. In Australia, where the blue gums are not cut for firewood, they become the tallest trees in the world.

If the terminal bud continues for a few seasons and then dies, the tree has a broader, bushier habit. Why does the weeping willow weep? If you examine the ends of the branches they will tell you. The branch grows for a season, and at the close the terminal bud dies. The lateral bud takes the nourishment and pushes the main bud to one side, which gives a drooping habit the reverse of the Norfolk pine.

FIG. 43.—Terminal bud of a Fig.

FIG. 44.—Galls on Cliffortia.

Galls.—The tips of *Cliffortia*, *Aspalathus*, and other shrubs often have peculiar terminal buds. We know they will not produce flowers. *Cliffortia* has two kinds of flowers, but they are not borne at the tips of branches. These swollen buds are **Galls.** In spring, when the buds were tender and full of sap, insects pierced them with a sharp lance they carry for that purpose, and placed an egg in the centre of each one. Shortly after, from each egg a small white grub was hatched, which passed all that stage of its life in solitary confinement. Its presence caused the bud to swell so that the few leaves usually formed were not sufficient to protect the mass of tender cells. A great number have to be formed, which give the bud the appearance of a small cone. Different combinations of insect and plant give galls of various forms. When they have reached full size (you can tell by last year's galls), you can split some through the centre and view the cause of all the disturbance.

Disguised Branches.—Some branches are so altered in appearance that it is not at first evident what they are. In the

FIG. 45.—Branch thorns of Kei Apple.

FIG. 46.—Branch thorns of Pomegranate.

Kei apple and Pomegranate it can be seen that the thorns are branches, because they rise from the axils of leaves. In the Pomegranate the end of a branch becomes a thorn. A leaf on a thorn also tells us that it is a branch. Some branches develop into tendrils. Collect as many tendril-bearing plants as you can find, and tell by their position whether they are branches or leaves or parts of leaves.

FIG. 47.—Leaf-like branches of *Asparagus*.

Similarly, by their position we can see that the "leaves" of asparagus are branches. This will be difficult to understand, especially in the broad "leaves" species, until we see that they grow from the axils of small scale leaves.[1]

[1] *Asparagus* with broad green branches (Phyllodes) is often miscalled *Smilax*, which has green leaves—not scale leaves.

The Law of Correlation of Growth.—This law has been observed by plants for ages. What does it mean? When a part of a plant is destroyed, the plant's first work is to replace that part. We see how beautifully the law is obeyed when flowers are picked; how many more come to replace them. When leaves are destroyed by locusts or caterpillars, dormant buds which might have remained for ever inactive are given light and air; the food that would have gone to the destroyed

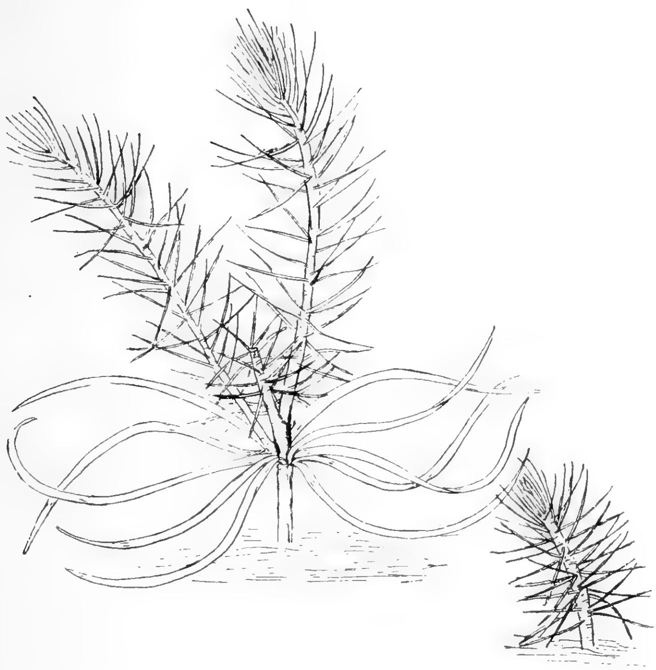


FIG. 48 — Pine seedling.

part is turned toward these buds, which grow and unfold new leaves. If shoots are destroyed, new shoots are produced; while if roots are destroyed, the first thing needed is new roots. It would be useless to unfold leaves if there were no roots to absorb nourishment. When trees are transplanted, some roots are necessarily injured at the tips. The roots are trimmed off, whereupon a vigorous growth of new roots takes their place.

Fig. 48 shows a young pine seedling which has had its tip cut off. To replace it two buds soon appeared. The tip, which was placed in the ground, began to form the lacking roots. This demand upon the plant retarded the growth of the stem, which made no evident growth, while the branches on the seedling increased nearly three inches. As a pine tree grows older it loses the power of renewing lost parts. If the tip meets with injury, a side branch will shoot upward rapidly to take its place, leaving only a vacant space to tell the tale, until the light and air cause the neighbouring branches to put forth extra energy to close in the space.

The Japanese have long been famous for their secret of producing dwarf trees. Oaks over a hundred years old grow comfortably in a small pot. Maybe if you bear this law in mind you may discover their secret—or a new process.

Cut back the roots and replant a thrifty acorn seedling. When new shoots have formed repeat the operation several times. Have another seedling growing to compare the growth.

Fig. 49.—Large and small leaves of *Carissa ferox*.

According to this law, if one part of a plant grows to a large size it does so at the expense of other parts. The leaves on horizontal branches of *Carissa ferox* show this. They are arranged in pairs. The leaves which are exposed to the light are large, while the alternate pairs at right angles to these are not so well placed to receive the light, and for this reason, or because the pair on either side have developed at their expense, they remain much smaller. Other examples of the same nature may be seen in the study of flowers.

CHAPTER VI

A STUDY OF LEAVES

How many can draw from memory leaf outlines of three different plants? From what plants were the leaves obtained for the drawings on this page? If you have never thought about leaves, you will be surprised to find how many different shapes there are, even on the same plant, and how differently they are arranged on different plants.

Most leaves are green, but not every plant has leaves. Mushrooms have none. Do all Mistletoes have leaves?

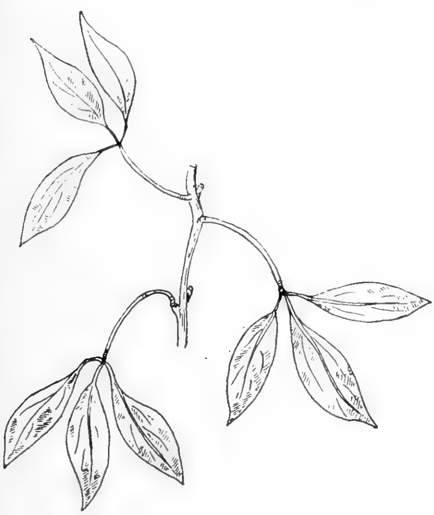


FIG. 50.—Trifoliate leaf.

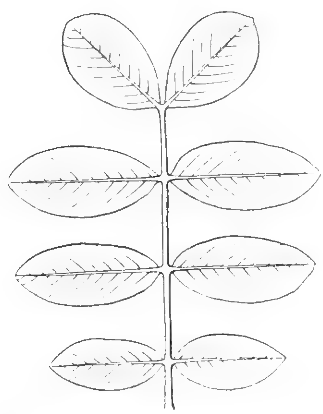


FIG. 51.—Paripinnate leaf. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

In studying leaves, we may consider their forms, their parts and positions on the stem, and see how they are all fitted to do their work to the best advantage.

What is a leaf? It is sometimes difficult to know just how much to call a leaf. In the bean we called what looked like three leaves a single leaf. How shall we tell that the third leaf in the bean was not three leaves? In studying branches, we found that they were borne in the axil of each leaf. If you examine a branch with leaves like those in Fig. 51, will you find buds at the base of each part or only where the main stalk joins the stem?

Another test will help us to decide. Leaves remain on a tree for a certain length of time and then fall. When a leaf like that in Fig. 51 falls, does the stalk that extends through the centre remain or fall off too? A leaf that has several distinct parts or leaflets is a **compound leaf.**

The Parts of a Leaf.—Fig. 52 is the leaf of Hibiscus. It has one large flat upper portion, the **blade,** a stalk or **petiole,** and at the base two small leaf-like bodies called **stipules.** If a leaf has no stipules it is said to be **exstipulate.** If the leaf-blade joins directly upon the stem and has no stalk, it is **sessile.** The needle-shaped leaves of pines and heaths have no expanded blades. Sometimes stipules are deciduous; that is, they fall off very quickly, as the fig and oak. We must examine young leaves to make sure whether they are stipulate or exstipulate.

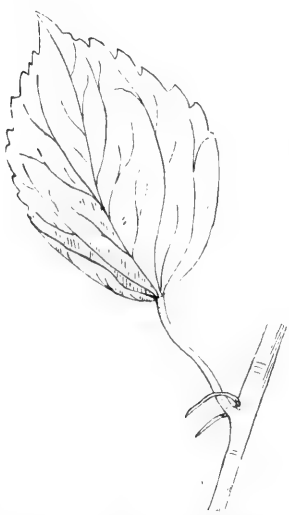


FIG. 52.—Simple leaf of Hibiscus with stipules.

The Veins of a Leaf.—Hold a thin leaf up to the light and notice how it is marked with delicate veins. These are made up of the long hollow tubes which carry the sap to its destination. They also serve as a framework to prevent the leaf from tearing. Do they serve like the framework of an umbrella to keep the leaf spread out? You can answer this by looking at pumpkin leaves which have withered in the heat on a sunny day.

Senecio has a thick leaf stored with food, which would be wasted if the leaf were torn in the wind. It has a firm vein running around the margin which prevents tearing. The thin broad leaves of a banana have no such border. The wind would bring such a strain on the trees that they would be blown down were it not that the leaves tear down between the veins. The younger leaves are rolled, so that the wind does not injure them. The date palm defends itself in the same way, only it is done earlier and the leaf has a more tidy

FIG. 53.—Firmly bound leaf of *Senecio*.

appearance. It looks like a compound leaf when it is quite unfolded. Examine young date leaves.

When leaves are branched, the branching depends upon the branching of the veins. In some leaves there is a strong central vein, from which other veins branch on either side as the pinnæ branch from the quill of a feather. Such venation is termed **pinnate.** Or several strong veins may start from the **base** or lower portion of the leaf, and the venation is said to be **palmate** (hand-like).

In dicotyledons the prominent veins join each other so as to form an irregular network. In monocotyledons they usually run more or less parallel. Simple leaves are sometimes cut. They are called lobed, parted, or divided, according to the depth of the incisions.

The leaflets of a compound leaf are attached by a little hinge or joint. *Lebeckia linearifolia* has but one leaflet. The hinge at the base tells that it is a compound leaf which has become reduced to a single leaflet. Other Lebeckias have

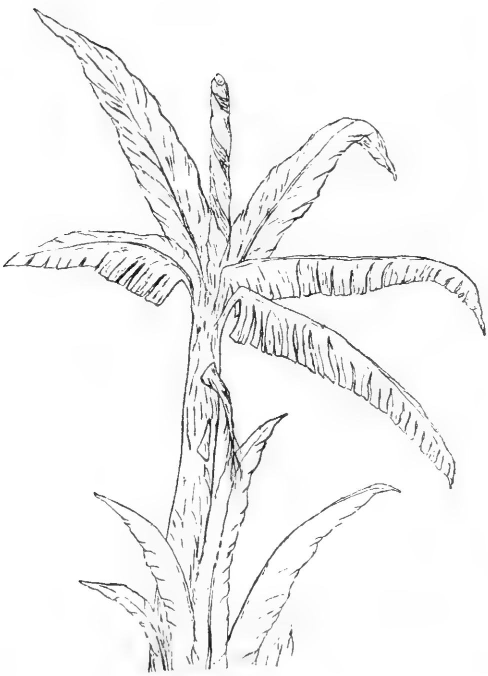


FIG. 54.—Banana leaves torn by the wind.

FIG. 55.—Compound leaf of Orange with one leaflet.

several leaflets. The same is true of the orange and lemon leaf. The trifoliate orange has three leaflets.

The Arrangement of Leaves on the Stem.—We have seen that leaves are not well developed when covered from the light. **Light is necessary for green leaves to do their work**, which is to make food for the plant. **Too much light prevents leaves from making food.** If we bear in mind these two facts, it will help to explain the meaning of the forms and arrangement of leaves.

Leaves breathe; they must have air. They also transpire; but the plant must not lose too much water. To be able to do all this, it is not surprising that we find such a variety of forms and arrangements.

The leaves of the Orchid in Fig. 56 have broad bases which encircle the stem. They are arranged in two rows, so that, calling the lowermost leaf No. 1, the third and fifth will be

FIG. 56.—Orchid stem with leaves arranged on opposite sides of the stem.

directly over it. The distance from one mid rib to another is one-half the distance around the stem.

Canna and Kei apple have broad thin leaves, the fourth is over the first, so that the second and third are exposed to the light. The distance from the midrib of one leaf to that of another is one-third the distance around the stem. What leaf will come over the fourth? You can tell by drawing a spiral and dividing it into three sections. Imagine the centre to be the tip of the stem. Beginning where one of the lines cuts the

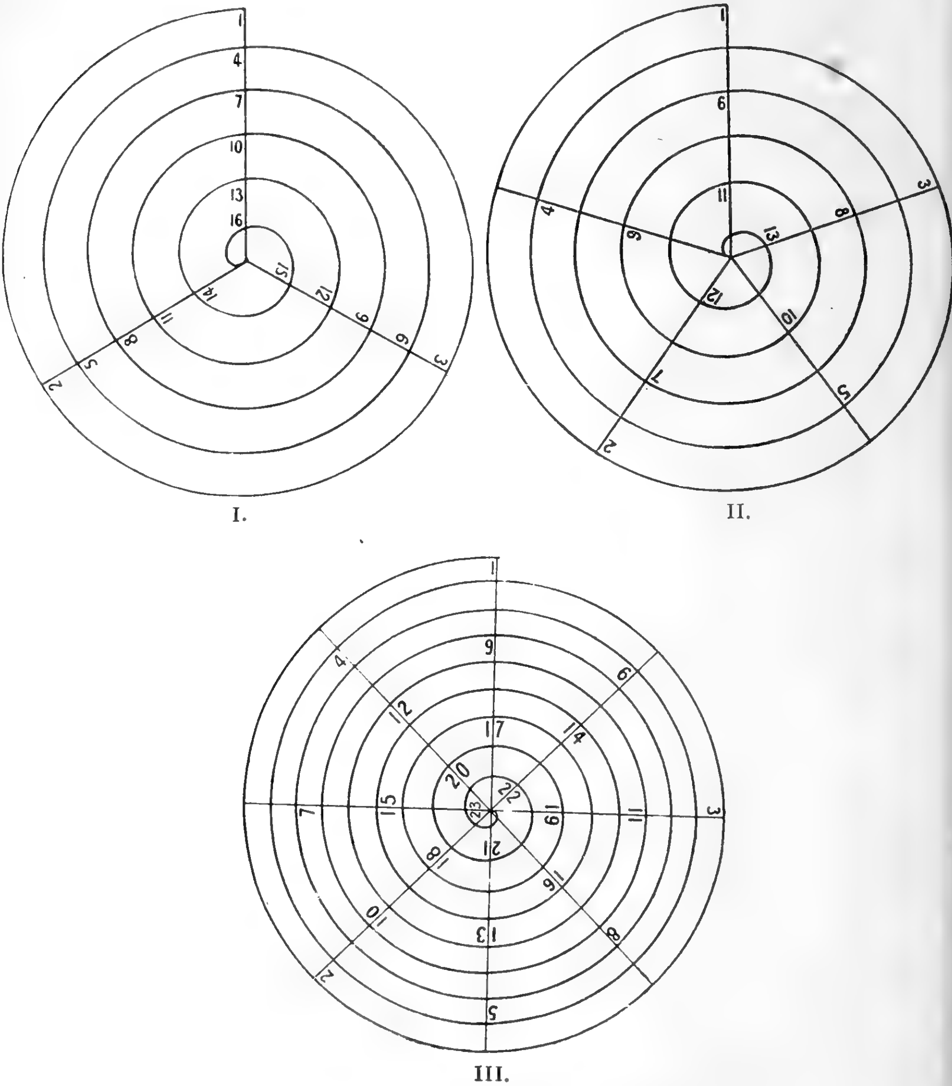


Fig. 57.—Spirals showing $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$. Phyllotaxy.

outer end of the spiral, place leaf number one. Two and three will fall on the other lines. The fourth will be in line with the first. By placing each succeeding leaf one-third of the way around the spiral, the seventh will fall on the line with the first and fourth.

Aloe ciliaris bears the sixth leaf over the first. The distance from leaf to leaf is two-fifths of the way around the spiral. What leaf will come over number three? The distance from one leaf to the one next younger is called the angle of divergence. Other Aloes have different angles of divergence. Besides the $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$ divergence, the fractions $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$ will represent the arrangement of leaves on Proteas and other plants with leaves attached by narrow leaf bases.

Besides the spiral arrangement, leaves are frequently placed opposite to one another. When the alternate pairs of leaves are at right angles to each other, as in *Carissa* and Sage, the leaves are said to **decussate.** Not all opposite leaves are decussate. The Crassulas have opposite leaves, but some have the pairs spirally arranged.

Making leaf spirals is excellent for very warm or rainy days. On pleasant days find as many plants as possible to illustrate these spirals.

Phyllotaxy is the word used meaning leaf arrangement. It is sometimes difficult to make out on branches placed horizontally, as the leaves borne on the lower side turn so as to face the light. Compare them with upright branches.

Instead of drawing spirals, long strips of paper, such as telegraph messages are received on, may be coiled and marked into divisions and then pulled out to represent the stem.

Dr. Kolbe has made an ingenious device for showing phyllotaxy, which he has kindly described and illustrated for us.

Dr. Kolbe's Phyllotaxy Apparatus.

"Take a strip of corrugated brown paper, about four inches wide and about three yards long. Roll it up closely, but not too tightly, and paste white paper round the cylinder so formed. From the top the coil will look like this—

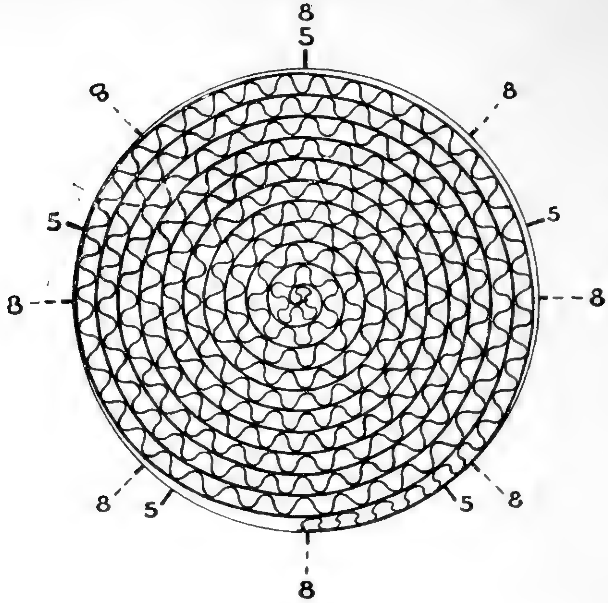


Fig. 58.—Phyllotaxy apparatus.

"On the outside of the white paper, divide the circumference into fifths, eighths, etc., as far as you want to show the fractions —fifths and eighths alone are enough for me. I mark the fifths with blue pencil, and the eighths with red. Side view—

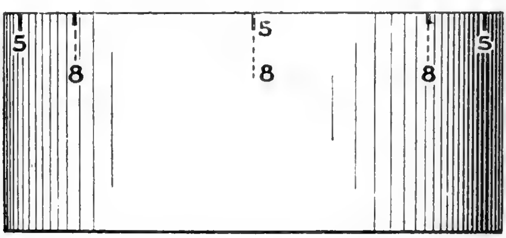


Fig. 59.

"Now cut leaves of various sizes and number them in order, the smallest being 1 for convenience sake, though, of course, it is the last in growth. Cut the leaf thus—

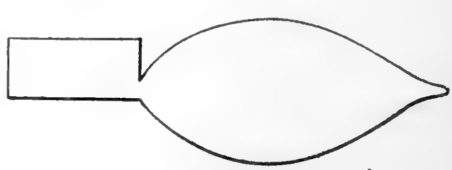


Fig. 60.

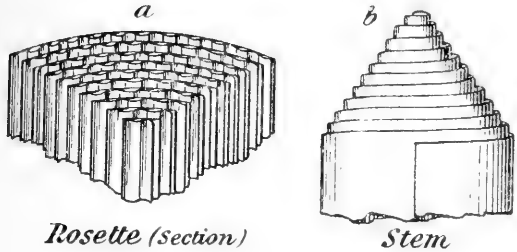


FIG. 61.

FIG. 62.—Branch of *Buplerum difforme*, showing variety in leaves.

"Roll up the parallelogram to form a petiole. These petioles will slip into the grooves of the corrugated paper, and when you let go they expand so as to fit fairly tight.

"Now put leaf I near the middle, pointing to one of the fifths; go round the spiral, and put the next leaf facing the second fifth from the first; and so on, till you have some

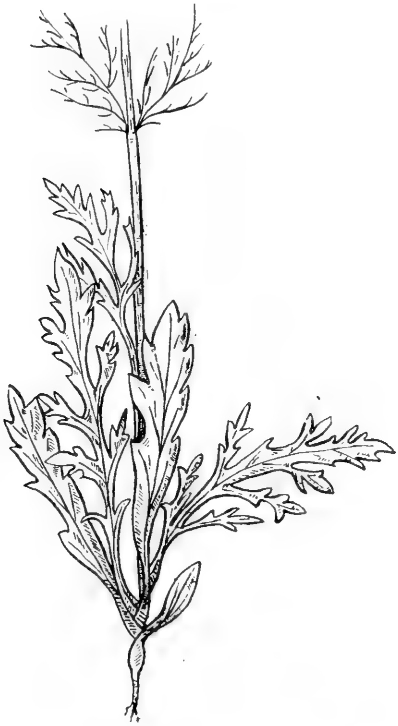


FIG. 63.—*Scabiosa.* The cut upper leaves allow the light to penetrate below.

FIG. 64.—Branch of Rhus, showing the simple leaf at the base.

twenty leaves in position. The phyllotaxy then becomes evident.

"If you have not twisted the spiral too tight, the central portion will be found to be moveable. Push it down to show a rosette of radical leaves; push it up to show a stem.

"The stem is very conical, even comical, but the rosette is almost an improvement on Nature.

"By taking coloured leaves for sepals and petals, wax-matches for stamens, etc., the same apparatus can be used for making solid diagrams of flowers."

Have you noticed by what other ways leaves manage to get

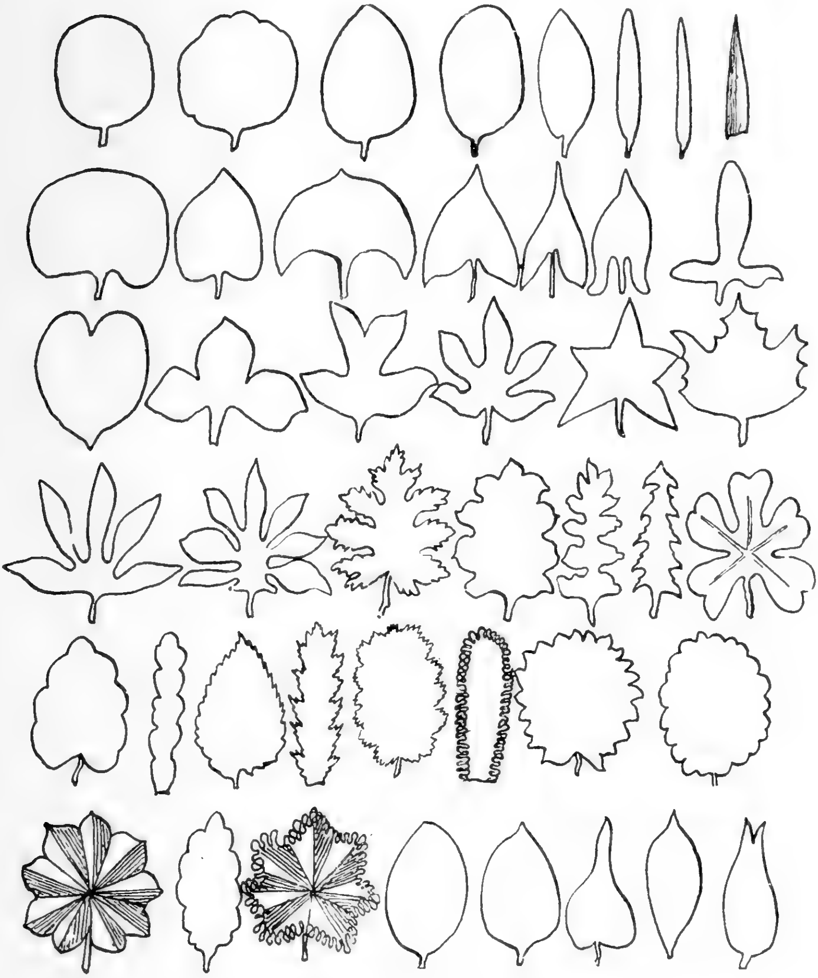


FIG. 65.—Diagram of forms and margins of leaves.

light? Some have much larger leaves below, so that the upper ones cover only a portion. It is more economical for the plant to extend the lower leaves on long petioles. The upper leaves let the light to the lower ones in some cases by being much cut or lobed. In this way the differences in the upper and lower leaves of *Buplerum difforme* and *Scabiosa* come to have a new meaning for us. Plants frequently lose all traces of their early leaves, but the first leaf on each branch of the *Rhus* shown in Fig. 64 serves to remind us of the plant's simple habits in early life.

Attempts have been made to name the different shapes of leaves. To name them all would be a difficult task, as no two leaves are just the same shape.

Aside from the general outline, leaves vary in their margins. They may be entire or serrate (saw toothed), dentate (toothed), crenate or scalloped, repand, undulate, and so on.

The diagrams of forms and margins of leaves mentioned by Linnæus are shown in Fig. 65. You can find other shapes.

CHAPTER VII

WATERWAYS IN PLANTS

How Roots take in Water.—In Chapter IV. we read of the water passing from the soil into the roots and thence to the leaves. It is now time to see how this is done.

Each root-hair is a small cell surrounded by a thin mass of a jelly-like but living substance called **protoplasm.** Each cell absorbs water, which makes it firm. This water holds salts dissolved in it, and is called **sap.** When a plant is supplied with water it passes through the walls of the root-hairs and on into other cells; for the whole plant is made up of millions of tiny cells. To see how this is done, let us try an experiment.

A Bottle Cell.—Take a small wide-necked bottle and fill with syrup made by dissolving a teaspoonful of sugar in half a cup of water. Tie over the mouth a piece of membrane.[1]

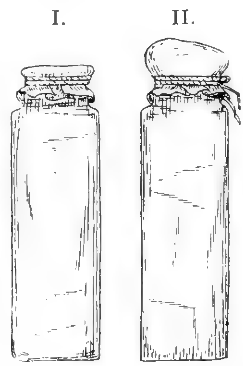


FIG. 66.—A bottle "cell." I. Bottle containing sugar solution; II. the bottle after remaining in the cup of fresh water.

Be careful that the solution quite fills the bottle before covering. Sink the bottle in a cup of fresh water and set aside until the next day. The membrane now bulges over the mouth. Water has been drawn into the "cell." Into the remainder of the syrup dissolve sugar until no more can be taken. Sink the cell into this thick syrup

[1] Obtain a bladder at the butcher's shop. Have the butcher remove the surplus meat and inflate it. When a piece is required, cut it the required size and soak it. It will become thick, but can be separated into layers. Botanical supply companies supply diffusion cells for the purpose, which are neater and more convenient, and should be obtained.

and set aside for another day. What has happened? The thick syrup has drawn the water out. The "cell sap" has passed in the direction of the stronger solution. Try the same experiment with salt instead of sugar.

Place the leaf stalk of a pumpkin in water which has had salt dissolved in it. Leave for a few hours. How does the stalk look? Now wash off the salt and place in fresh water. Notice a few hours later. How has the stalk altered?

Boil a piece of beet-root or a green bean pod for a few minutes in water. When removed they are quite limp. The water is coloured. When placed in fresh water they do not become firm again. Boiling has killed the living protoplasm. The dead membrane cannot hold the coloured sap. Living cells can retain the sap until a certain amount of pressure is set up within the cell. This keeps the plant firm. Then they give it up to cells with denser contents.

Protoplasm acts because it is alive. Roots not olny draw material from the soil, but they send out an acid to dissolve the hard rocks.

Germinate seeds in a flower-pot into which has been placed an inclined piece of marble having the smooth side up. Keep the roots watered until the pot is well filled with their growth. Remove the marble, and look on it for the etching made by the roots.

Fasten to a glass slide with a rubber band a piece of blue litmus paper, between the glass and a germinating seed. The glass and paper should be previously moistened well with steam or distilled water. Place within a covered dish. As the radicle lengthens, notice the faint change in colour on the paper. Acid colours blue litmus paper red. It may be the carbonic acid which is formed when roots breathe out carbonic acid gas, as we shall find out they do.

How the Water is lifted up.—Within the "bottle cell," pressure made the membrane bulge. Cut off growing bean stems below the cotyledons. Drops of water collect at the cut end and run down the stem. Pressure from below forces it up.

In order to see how long this continues, we may try another experiment. It will require a vigorous young plant such as a castor oil, pelargonium, or grape vine, a piece of glass tubing as large as the stem, also some string and a stake of wood.

Cut the stem an inch or two from the soil. Slip one end of the rubber tubing over the glass and the other over the cut stem which was left in the soil. Place a little water in the tube to prevent the stem from drying and tie the glass firmly to the stake. Be sure that the rubber makes a tight joint. It may be tied at each end. The water will rise in the tube. At the close of the day mark the height at which the water stands. Notice how much has passed during the night. Mark the height at each hour of the day. Are the marks the same distance apart? Does the water constantly rise?

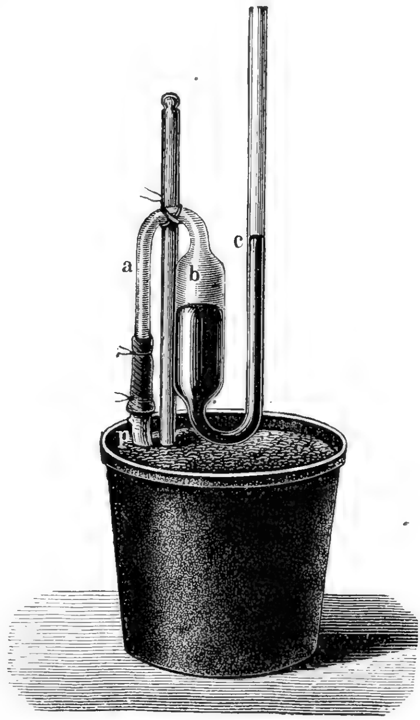


FIG. 67.—Apparatus for measuring the root-pressure. A manometer, *a*, *b*, *c*, is fixed into the upper part of the plant *p* growing in a pot, the top having been cut off. The difference in the height of the mercury in the two arms *b* and *c* indicates the intensity of the pressure by which the water sucked up by the roots is forced out at the cut section. (From Thomé and Bennett's "Structural and Physiological Botany.")

What becomes of the water? Place the upper part of the plant cut off in the last experiment in a slender jar of water. Pour a layer of oil over the top to prevent evaporation, or thrust the cut end through a stopper and seal with wax. Cover the whole with a bell-jar or a fruit-jar. See that the glass is quite dry before covering. In a short time the jar will be lined with a thin mist, which will collect in drops of water.

Water passes from the leaves and stem of a plant in the form of vapour. As the leaves give off vapour more water is drawn up to take its place. Thick sap in tiny cells of the leaf draws it up.

Soak strips of paper in cobalt chloride. Dry thoroughly, and notice how they change from red to blue as they dry. Dry the inside of the jar containing the plant. After remaining in the bell-jar for awhile the paper changes back to red. This also shows that vapour is passing from the leaves.

This pretty experiment should not be omitted. Cobalt chloride may be obtained from the chemist. Sixpennyworth will prepare sufficient paper to last some time. It will keep, and the same piece may be used repeatedly.

Place under the bell-jar fruits of *Erodium* or *Pelargonium* and watch them uncoil; remove, dry in the sun, and repeat the experiment.

Place a leafy shoot in a glass U-tube (a straight piece of glass may be heated and bent the required shape.) Connect the shoot to the tube with rubber tubing so that no air can enter. The tube should be filled from the other end with water. When the water has been nearly drawn out of one arm, pour in mercury. The mercury, which is very heavy, will be raised higher in the arm of the tube containing the plant than in the other, so the leaves can do some heavy lifting.

Does water pass from leaves in any form but vapour? If so, it must be in drops. Place a pot of germinating Indian corn or oats under a bell-jar overnight. The next morning notice the tip of each blade where there are small holes through which water can pass in drops.

In early morning a field of young corn is very beautiful when—

> "in each pettiest personal sphere of dew
> The summ'ed morn shines complete as in the blue
> Big dewdrop of all heaven."

They are not dewdrops, for they are there when no dew is formed on other plants. Other plants show the same nicely. See the drops on *Tropæoleum* (Nasturtium) plants where openings on the leaves are placed at the end of each strong vein.

Does vapour pass off in equal amount from both leaf surfaces? Place an apricot leaf between two sheets of cobalt chloride paper. The leaf should be dried from all surface water; then place between two plates of glass. On all place a light weight. In half an hour, or less, examine. The paper next the under side of the leaf will be red; that on the upper surface will be only slightly changed.

The greater amount of water passes off from the lower surface of the leaf. This is true of many leaves, but not of all. Is the result the same for the lower broad leaves and the upper narrow leaves of the blue gum? Where does the water escape from the water-lily leaf? From silver leaves? From "April Fool" leaves?

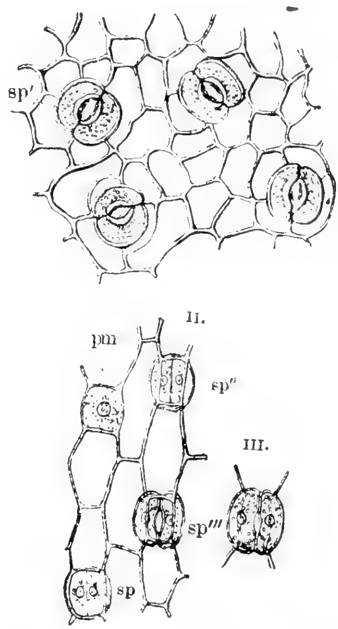


FIG. 68.—I. Horizontal section through the epidermis of the under side of the leaf of *Euonymus japonicus* looked at from below: *sp*, stomata. II. Course of development of the stoma of *Arthropodium cirrhatum*: *spm*, mother-cell ready for division; *sp′*, *sp″*, *sp‴*, successive stages of division. III. Mature stoma. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

Why do plants usually lose more water from the under side? How the leaf controls the escape of vapour can be seen with a microscope. A picture will help to make it clear for the present. Scattered over the under surface of the apricot leaf are very small holes called stomates (singular *stoma*) or stomata (mouths). Two crescent-shaped cells surround the opening. These lip cells open and close. During the day they are open, and evaporation keeps the leaves cool. If leaves were as hot as the stones around them they would die. In very dry weather the cells lose some of their water and close up so that less can escape. These stomata open into spaces within the leaf into which water passes from surrounding cells. On a summer day leaves lift up and lose tons of water. Leaves borne on the surface of water or close to the soil have their stomata on the upper surface.

The Water Path from Root to Leaves.—Water does not pass up to the leaves through all parts of the stem. If a begonia stem is placed in water coloured with red ink, in a few hours the ink will mark the path it has taken. Cut the stem across and the paths will show as small round dots. They show plainly in pumpkin stems as strong slender threads. These threads are bundles of still smaller tubes or vessels, and so the strands are known as "vascular bundles." Break off a

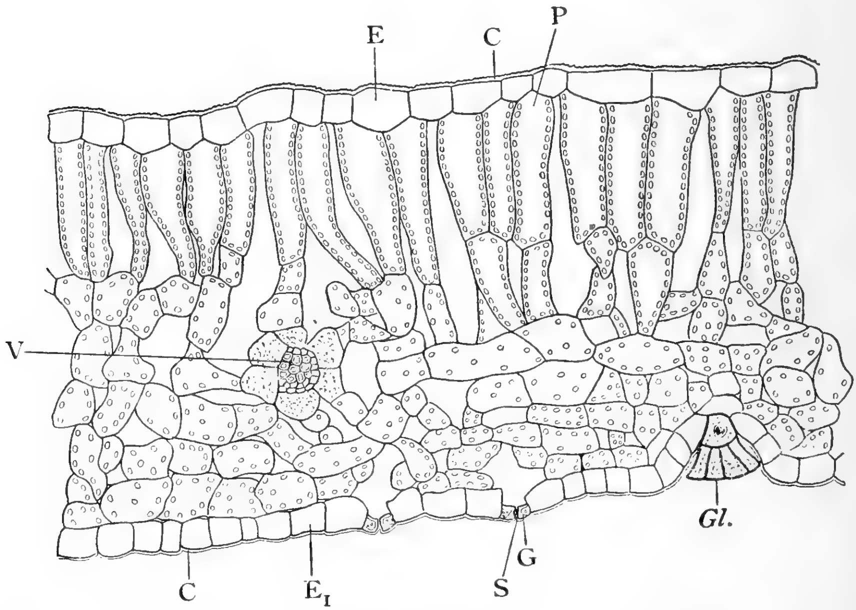


Fig. 69.—Leaf of Privet. E, epidermis of upper; E_1, of under surface; C, cuticle; P, palisade cells; V, vascular bundle enclosed in its sheath; S, stoma, G, guard cell; *Gl*, gland. (From Farmer's "Practical Introduction to the Study of Botany.")

violet leaf; the vascular bundles may be drawn out from the broken end. The petioles of plantain or wild sago, which grows along sluits, show the vascular bundles nicely. They may be traced to the veins of the leaves in which they end. They even pass to all parts of the flower. In the strawberry they may be easily seen passing into each "seed" of the fruit. All parts of the plant must be nourished.

From a woody stem bearing leaves (a willow is good for the purpose), remove a ring of bark down to the wood. Place the lower end in water over which a layer of oil has been poured; cover with a bell-jar. The water will be used up and the leaves will transpire water vapour.

Water is carried up to the leaves through the wood.

CHAPTER VIII

THE BREATHING OF PLANTS, OR RESPIRATION

WE cannot live without breathing night and day. Neither can plants. All parts of a plant breathe. If plants are supplied with too much moisture, so that the roots do not get enough air, the plant looks yellow and sickly and the leaves may fall. Plants living in moist places, like the arum or water-lily, have large air chambers running through the stem for supplying air to the roots. The hollow stems of pumpkins admit air to the parts underneath the large leaves.

To show that Air Passages are continuous throughout the Plant.—Provide a flask with a stopper containing two holes. Into one insert the stem of a leafy shoot, into the other a glass tube. They should fit so tightly that no air can enter the flask. By placing your mouth over the end of the tube withdraw the air. Bubbles of air will rush from the cut end of the plant as long as the air is withdrawn. The air enters the plant through the stomata.

A little over three-fourths of the air (seventy-seven parts) consists of nitrogen; about one-fifth is oxygen, and a very small part of carbon-dioxide. Carbon dioxide is a gas compounded of one part of carbon and two of oxygen, which hold on to each other very closely. CO_2 is the symbol or short form of writing this gas.

The proportion of nitrogen and oxygen in the air can be nicely shown by the following experiment: invert a glass jar with straight sides over a pan of water. Notice how high the water stands in the jar. Now lift the jar and place under it a piece of phosphorus fastened to a cork to keep it afloat. (Phosphorus should always be kept and cut under water.)

The phosphorus begins to burn, that is, it unites with the oxygen, forming dense white fumes. After a time the fumes disappear. Where have they gone? The water has absorbed them and formed phosphoric acid. What else has happened? The water has risen and fills about one-fifth of the jar. The acid occupies less space than the gas fumes, so the weight of the air outside the jar forces the water up to take the place of the oxygen. The nitrogen does not burn, but fills the remainder of the jar.

Water also absorbs CO_2 and forms carbonic acid; but there is such a small amount that you would not be able to see the water rise.

It is oxygen that we need for breathing. Nitrogen dilutes the oxygen enough for us and for land-plants to breathe. But fish and water-plants require the oxygen diluted still more with water. If oxygen were not diluted with nitrogen we should feel as uncomfortable "as a fish out of water."

When a match burns, the oxygen combines with the carbon of the wood and makes smoke or carbon dioxide (CO_2). So when we breathe, the oxygen that we inhale combines with the carbon substance of our bodies and forms carbon dioxide, which we exhale.

Similarly, when a plant breathes, the oxygen it inhales combines with the carbon substances of the plant, and the plant also exhales carbon dioxide. Plants and animals also exhale water.

How do we know that plants inhale oxygen and exhale carbon dioxide?

Respiration or Breathing in Germinating Seeds.—Soak a handful of peas in water for twenty-four hours. Remove from the water and put them in a glass jar. Cover tightly and set aside for twenty-four hours. Light a splinter, uncover the jar, and thrust the flame into the jar. It is extinguished. The oxygen which was in the jar has been used by the seeds. They have given off a gas which suffocates the flame. Place a short piece of lighted candle in the bottom of a tumbler. Pour the gas over them. It is heavy and puts out the flame. What is it?

To show that Carbonic Acid Gas or Carbon Dioxide

is given off when Plants breathe.—Make some baryta-water by dissolving barium carbonate in water and allow it to settle. Pour some of the clear water into a test-tube; breathe into it through a glass tube. The water becomes cloudy and a white film collects on the surface.[1] Place some baryta-water in a shallow dish. Uncover the jar of peas and pour the gas into the dish. We have seen it is heavier than air, and so can be poured. A white film appears on the surface. The peas have exhaled the same gas which you breathed into the jar, carbon dioxide.

Another pretty experiment shows that carbon dioxide is given off by plants while breathing. Place heads of flowers—daisies just opening are good ones—in a flask. Invert the flask in soda-limewater, which absorbs carbon dioxide. Pour some mercury into the soda-limewater. In a short time the water and then the mercury will be drawn up into the neck of the flask as the carbon dioxide is absorbed. If you do not see why, recall that when a gas is reduced into a liquid it occupies less space. The weight of the air outside the flask pressed on the mercury until it fills up the space occupied by the carbon dioxide, which is now absorbed into the soda-limewater. It will continue to rise until the gas inside the flask presses down on the mercury as much as the air outside is pressing it up.

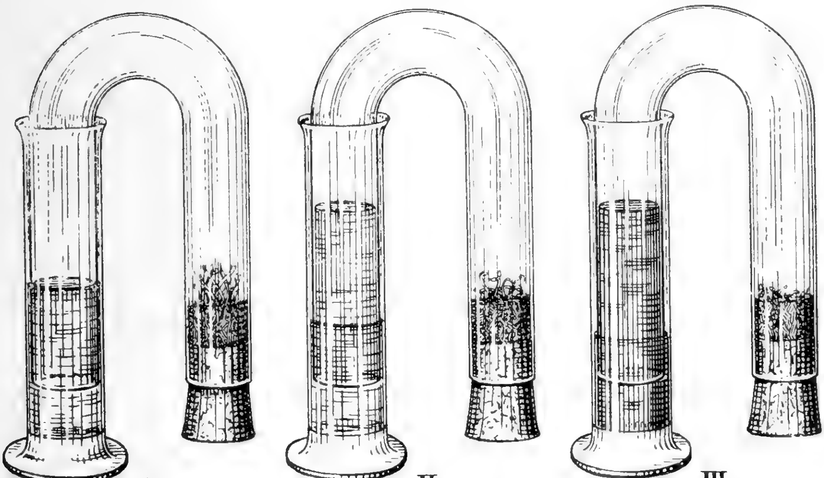
Place the flask in the dark and see if the mercury continues to rise. Mark the height at which the mercury stands at night, and again in the morning. A change in temperature affects the height. When the flask cools, the gas within occupies less space and the mercury rises.

Plants get energy to do work by breathing. Unless our rooms are supplied with plenty of fresh air we become dull and unable to work. Breathing decreases our weight but sets energy free to do work. Ask some one who plays football how much weight the team loses while playing a cup match. The stroke oar in a rowing match will lose six or seven pounds in twenty minutes or during a four-mile race. How hard you breathe when you are playing. Did you ever try to get warm

[1] Limewater may be used by dissolving calcium carbonate in water. The results are not quite so good. These liquids should be kept corked.

by breathing deeply? A plant loses weight and gives off heat in breathing; it also gets energy to do work.

Place some peas that have just started germinating in a U-tube. Cork tightly. Place the other end in a glass of



I II III

FIG. 70.—Peas germinating, deprived of oxygen.

pyrogallic acid and caustic potash (KOH). Since pyrogallic acid absorbs oxygen, the peas are deprived of the gas necessary for respiration. The peas make no further progress in germination. In Fig. 70 the first jar contains water, the second caustic potash, the third pyrogallic acid.

CHAPTER IX

THE FOOD-MAKING OF PLANTS

WHAT is the work of the plant? We have seen how the root has to go in search of food material which the protoplasm receives and passes on. In order to grow and sustain life, the plant must have food. Animals depend upon plants for food. Plants must not only manufacture their own food, but they entertain a gay society of bees and butterflies and their relatives, while the needs of the poor and humble guest must be supplied. Moreover, the plant must provide for its large family.

Not all the water which passes to the leaves is given off as vapour. Some of it is kept to make food for the plant. Food can be made only in daylight by green plants or those that contain chlorophyll. It is made faster than it is needed, and the surplus is stored during the day in the leaves as starch. During the night, when most rapid growth takes place, the surplus is used. Food is not used by the plant in the form of starch, but it is changed into sugar, and then combined with other materials brought up from the soil before it becomes part of the living plant. Starch is simply a convenient form for storing food until it is needed. It is formed not only for daily needs, but biennials and perennials store enough one year to give the plant a good start the next. It is usually stored under ground. Potatoes are almost entirely filled with starch which the leaves have made. Some plants store their food in the form of oil or sugar. To build up protoplasm, both animals and plants require food containing nitrogen.

We can tell where starch is found by staining with iodine.

A tincture of iodine may be obtained or the crystals dissolved in water. Scrape a small portion of potato and place it in a tube of water. Add a few drops of iodine. The liquid at once turns blue. Place some maizena or laundry starch in slightly warm water. Allow it to cool and add iodine. The same blue colour appears. The particles of starch are coloured blue by iodine.

Treat a castor-oil bean or a piece of onion in the same manner. No blue appears, because the food in these plants is not stored as starch.

Starch formed in Green Leaves.—In the afternoon of a bright day, place a few green leaves in a strong solution of chloral hydrate, which will dissolve out the green colour. Leave them overnight or until the green has dissolved. Boiling hastens the process. Place them in a porcelain or other dish with a white bottom, and pour over them a solution of iodine. The starch in the leaf will become a dark blue.

Perform the same experiment with variegated leaves of Coleus. Thin leaves should be used, as the colour is dissolved more readily.

In the afternoon cover a leaf with tinfoil. Leave it all next day. The following morning boil and blanch as before; stain with iodine; no blue colour appears. The starch has been used, and no more formed in darkness.

Corks may be fastened over a portion of a leaf; two pieces of cork on opposite sides matching above and below. When stained the part covered will remain white.

Much of the food stored in seeds is starch. Remove a mealie seedling from the soil. Cut the seed in two. Cut off a portion of the stem about half an inch long just above the seed. Cut this piece in two lengthwise. Place in a test-tube containing an inch or two of water. Gradually add iodine. Portions of the seed will show blue where some starch is still left. The stem does not stain blue. The food cannot pass to the growing parts as starch; it has been changed to sugar. The bundles through which the sap is passing up into the leaves are stained a yellowish brown. In the North American maple, the sap is so filled with sugar when it is passing up into the buds in spring, that it is drawn away through little troughs placed in holes bored into the trunk as far in as the new wood. On a bright day a drop falls about once a second. Drop by drop about twenty-five gallons of sap may flow from one tree in a season, until the buds begin to unfold, and this will boil down to about five pounds of sugar.

How can we tell when a plant is making starch? Place in a jar of water a plant which grows in water. The green silky thread-like plants in ponds are suitable. In spring, leaf-bearing plants may be obtained in some ponds which should be used when possible. Place the jar in the sun. In a few minutes bubbles will rise from the plant. Place the plants in water which has been boiled. No bubbles are given off. Boiling the water has driven off a gas which the plants need in making starch. Breathe through a glass tube into some boiled water, and place the plants in this water. Bubbles will soon begin to come off. The **carbon dioxide** that was breathed from the lungs is required by the plant to combine with water to make starch.

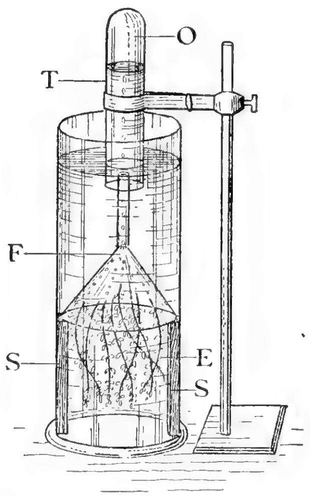


FIG. 71.—E, Elodea plants in water, with the cut ends of the stalks directed into the glass funnel, F; S, supports on which the funnel rests; T, test-tube; O, oxygen which has collected in the test-tube. (From Farmer's "Practical Introduction to the Study of Botany.")

What gas is given off when starch is made? Place a glass funnel over the plants in the jar, with the small end under water. Sink a test-tube into the water obliquely, so that all the air may escape and the tube fill with water. Without letting the open end come above water, place it over the small end of the funnel. As the gas rises it drives out the water. When the tube is full, light a long splinter, and blow out the flame, leaving the coal glowing. Quickly lift the tube from the water and thrust in the glowing splinter, which again bursts into flame. We know from the last chapter that oxygen is the gas necessary to light a fire.

To show that no Starch is made without Carbon Dioxide.—Cut under water two small shoots and place in small vials of water. Lower the vials into wide-necked jars and tie over the mouths of each some cloth net. Sprinkle over one net a thick layer of soda-lime; over the other a layer of sand. In a day or two the plant under the soda-lime withers and droops. A test for starch shows that none has been made. The covering of soda-lime absorbs the CO_2 and prevents any from entering. Carbon dioxide was admitted into the one covered simply with sand, and starch-making was unhindered.

When carbon dioxide is supplied to the leaves of a plant, it meets the water that has been drawn up from the roots. Water is made of two parts of hydrogen and one part of oxygen (H_2O). The water and carbon dioxide mingle and form carbonic acid (CH_2O_3). In the green of the leaf the carbon and hydrogen and oxygen, warmed by the light of the sun, become very active. They separate and come together until another compound, sugar, is formed. The symbol for sugar is $C_6H_{12}O_6$. To make one part of sugar requires six parts of carbon dioxide to supply sufficient carbon. But this provides twelve parts more oxygen than is required, which passes off in the way we have found.

After sugar is formed, one part of water is given off, leaving starch ($C_6H_{10}O_5$).

In making starch, plants give off the gas we require in breathing. In breathing, plants and animals exhale the gas which plants require for starch-making, carbon dioxide.

Plants get all their energy for doing work from the sun.

They require **chlorophyll** or green colouring matter for making starch.

CHAPTER X

DEPENDENT PLANTS

Some plants, like animals, cannot make their own food, but depend upon other plants for their food supply.

Parasites and Saprophytes.—A plant which depends upon another living plant is a **parasite**. Red rust is a parasitic plant which attacks corn-fields and gives the grain a sickly yellow look. It may have been living in the seed when it was sown, and only needed moisture which the grain supplied, to grow and send its colourless threads through the straw. When it fruits, short threads break through the surface of the straw or leaves of the grain, and on their tips small spores are borne. Spores formed in the early part of the season are red. Later, black spores are formed. The spores make red or black patches on the plant. When ripe they are blown by the wind on to other plants, where they grow and send small threads down into the grain again. Since they are taking the food, or some part of it, which the grain-plant is making, the heads of grain do not fill out properly. For this reason, farmer's try to get seed from countries where the rust has not injured the grain.

Dodder (*Cuscuta*) and *Cassytha* are parasites which have lost their leaves and most of their chlorophyll. At some season of the year, however, Cassytha stems are quite green. Try to loosen the hold of these plants from the plants around which they are twining and they betray their means of living. They send out root-like bodies which penetrate their host (as the plant is called which supplies another with food) and appropriate all the food they require.

Mistletoe and its relative *Loranthus* penetrate their host in a similar manner. They cannot obtain food from the soil of themselves, but there is chlorophyll in their stems and leaves so that they can manufacture the food for themselves from the material they obtain from their host and the carbon dioxide they can take in from the air. Some plants which come up from the ground are parasitic on the roots of other plants. The beautiful pink-and-white and crimson *Harveya*, the flaming *Hyobanche* and *Sarcophyte*, and curious *Hydnora* are root parasites. The leaves are reduced to mere scales, since they

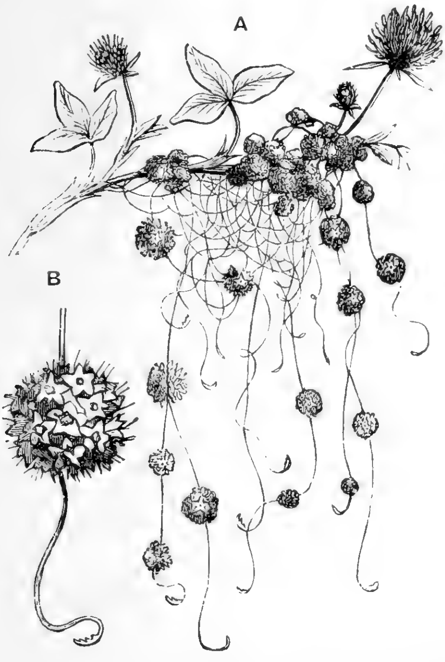


Fig. 72.—*Cuscuta Trifolii*: A, parasitic upon clover (reduced); B, a separate inflorescence (natural size). (From Thomé and Bennett's "Structural and Physiological Botany.")

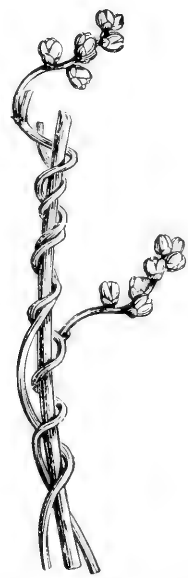


Fig. 73. — *Cassytha*, twining and parasitic flowering shoot. (From Henslow's "South African Flowering Plants.")

are no longer required to manufacture food, and they contain little or no chlorophyll.

A **saprophyte** is a plant which lives on dead or decaying matter. Mushrooms, the mould on bread and cheese, and bacteria are examples. Saprophytes are very useful members of plant society. Mushrooms change decaying vegetable matter into wholesome food. When insects or animals die, or leaves fall, there would be a great accumulation of useless matter were it not for the saprophytes, which seize upon this decaying matter and change it into the soil and gases, and so make it ready to be used by living plants again. So the large trees and beautiful flowering plants are quite as dependent upon saprophytes as the parasites and saprophytes are upon green plants.

In roots of legumes or the pea family very small bodies are found which cause small swellings on the

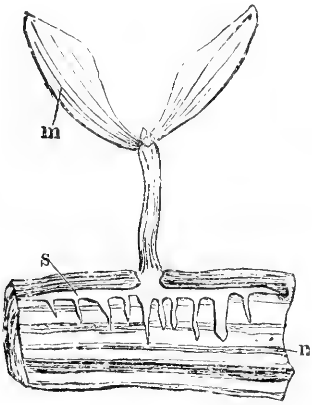
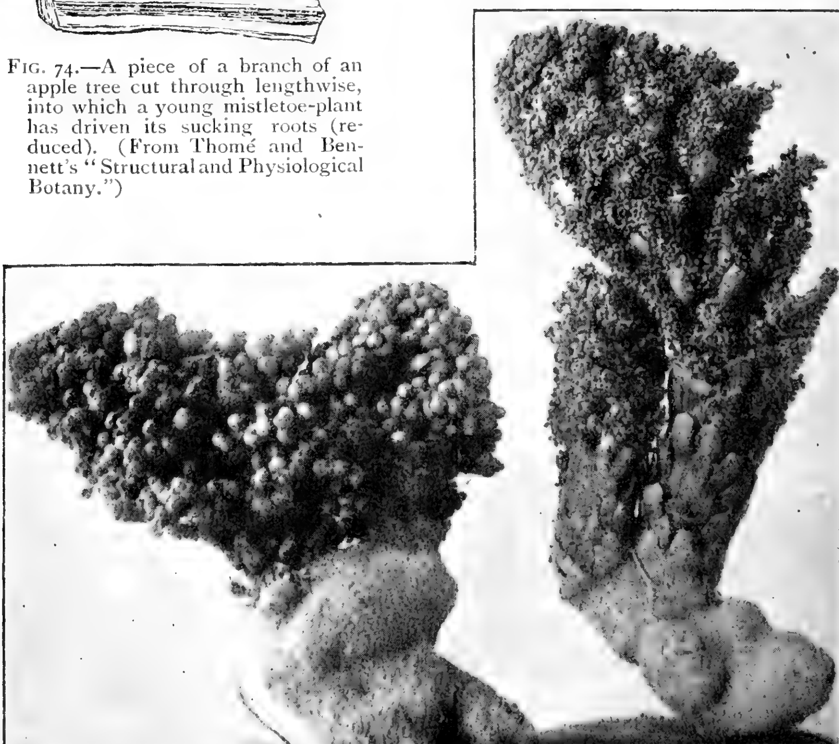


FIG. 74.—A piece of a branch of an apple tree cut through lengthwise, into which a young mistletoe-plant has driven its sucking roots (reduced). (From Thomé and Bennett's "Structural and Physiological Botany.")



I. II.

FIG. 75.—*Sarcophyte sanguinea spanni*, a parasite growing on the roots of Ehebergia and Acacia in the Eastern Province. I. Pistillate. II. Staminate flower.

roots. They are plants which obtain nourishment from their host, but they enable the host to use the free nitrogen which is abundant in the air. Nitrogen is a valuable and expensive food material, and can be obtained by most plants only from compounds in the soil. Legumes can not only obtain it for themselves, by the help of these little bodies, but they leave nitrogen compounds in the soil, to be used by other plants. Just think of all the plants in this country which have pods and belong to the pea family! How they are enriching the soil! Yellowwoods (*Podocarpus*) have little plants living in their roots which perform the same service.

Plants which live together in this way and are helpful to each other are called **Symbionts.** Plants are sometimes symbiotic with animals. There is a kind of Acacia with little holes in the base of the large hollow thorns. Within these thorns ants make their nests. Other insects eat and injure the leaves of the Acacia. The leaves manufacture a nectar which is poured out at the very tips of the leaflets. The ants sally forth in quest of the sweets, but on the way they make the first course of their feast off the marauding leaf-eating insects.

It has been suggested by the eminent German botanist, A. Kerner, that the leafy members of the Mistletoe family are symbionts with their hosts, making food in winter and giving it up to the host when the leaves have fallen, and it cannot make food for itself.

Insect-eating Plants.—The Sundew (*Drosera*) obtains its nitrogen from insects which the plant catches and digests by means of the sticky tentacles which are borne on their leaves and stems. *Roridula*, a small shrub belonging to the same family, has the same habit. Dr. Marloth has found that two animals live symbiotically with *Roridula*. The plant catches flies for a spider which is saved the trouble of making a web, while the spider acts as a scavenger, removing the remains of the flies from the leaves. Strangely enough, the spider can run where the flies would fear to tread if they but knew the doom awaiting them. Another still smaller insect lives within the flower and pays for its food by setting

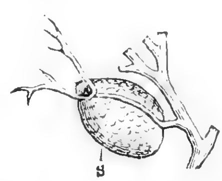


FIG. 76.—*s*, Bladder from a leaf of *Utricularia vulgaris* (× 4.) (From Thomé and Bennett's "Structural and Physiological Botany.")

off a little spring in the hinged stamen which flies up and scatters the pollen.

Utricularia, which grows along the edges of streams, is another insect-catching plant. The leaves are little hollow bladders which help to float the plant. Each leaf has a little trap-door opening into the bladder. Minute insects swimming by easily push the door in and enter. They never come out again, as pushing the door from the inside closes it.

CHAPTER XI

PLANT DEFENCES

SILVER leaves are favourite souvenirs for strangers who visit our shores. The stranger finds that the Silver Trees which wave their welcome from Table Mountain are but the harbingers of many surprises that await him in the plant world. The climate of South Africa is different from that of any other country, and so plants look and behave differently.

In many parts of this country plants have to do their work principally in winter, as the summers are too hot and dry. In the east and north winters are cool and dry, and plants have a warm summer with rains in which to do their work. In other parts it rains neither summer nor winter for months—even years; and to tide plants over these seasons of drought innumerable devices are found.

In cold countries of the northern hemisphere, winter is the sleeping-time of plants. When the leaves are cut off in the "fall" of the year, they lie in sodden heaps beneath the trees during the autumn rains and winter snows. In the spring these leaves hold moisture and give it up slowly to the roots. In this country very little decaying vegetation is left on the ground. The ants could partly explain the reason if you asked them. Have you ever watched them before a rain busily sawing off twigs and carrying them under ground? Even burnt matches are regarded valuable timber by them. The ants change the conditions for plants both above and below the soil surface.

Plants that work in winter must be suitably clothed for their work. Even when no rain falls, the Silver Trees on Table Mountain are frequently enfolded by the fringes of the "Table cloth." We have seen what a great amount of water, which is required to bring up the dissolved mineral matter, must pass off in the form of vapour. Vapour cannot pass off if the leaves are water soaked. Place a silver leaf in water and notice how

FIG. 77.—Vegetation in the Karroo where there are long droughts. The soil is alkaline.

the silvery sheen is brightened. The thick coat of hairs retains a layer of air which the rain cannot replace. It is because of this that vapour can pass off without interruption. A bamboo leaf under water glistens on the lower surface quite as brilliantly, but the upper surface comes out wet. The stomata are on the under side only of these leaves. It does not matter if the upper side is wet. On the lower side small rods of wax take the place of the hairs of the silver leaf.

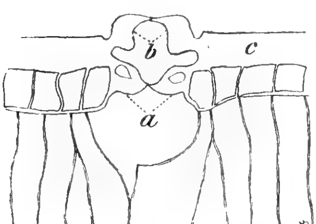


FIG. 78.—Section of sugar-bush leaf through a stoma: *a*, the guard-cell; *b*, projecting dome; *c*, thick cuticle.

The sugar-bush has another cunningly devised method of protecting its stomata. The cells bordering the stomata overarch, forming a little hut with an opening at the top, so small that the vapour can pass out but a drop of rain will not run in.

Phylica and the heaths usually have small needle-shaped leaves; their edges are rolled back so as to form partially enclosed channels on the under side where the stomata are placed. These channels are protected by a lining of hairs, making sometimes a close white mat. For similar purposes of

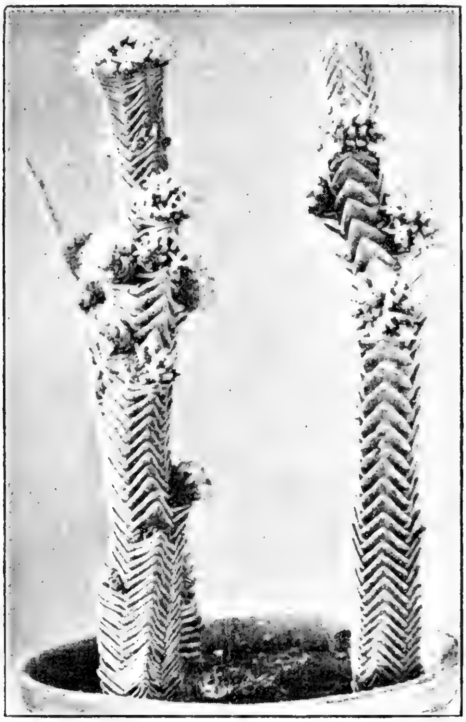


FIG. 79.—*Crassula pyramidalis.*

protection many plants have strongly ribbed stems; it is within these ribs that the stomata lie.

Our finest heaths are found in the Caledon and Riversdale districts. Compare the rainfall of these regions with that of neighbouring districts.

Fortunately for the plants, these waterproof garments are also useful summer styles. The hairs reflect the bright light from the plant, and keep a cool layer of air next the leaf, while preventing too rapid evaporation, although transpiration is necessary in hot weather to keep the plant cool, just as it makes us cooler to perspire in summer.

The thick waxy coverings on the leaves of Senecios, Crassulas, and Aloes, which shed rain, also prevent the escape of water in summer. Low-growing plants are often protected by incrustations of lime.

Besides especial coverings of leaves, many karroo plants

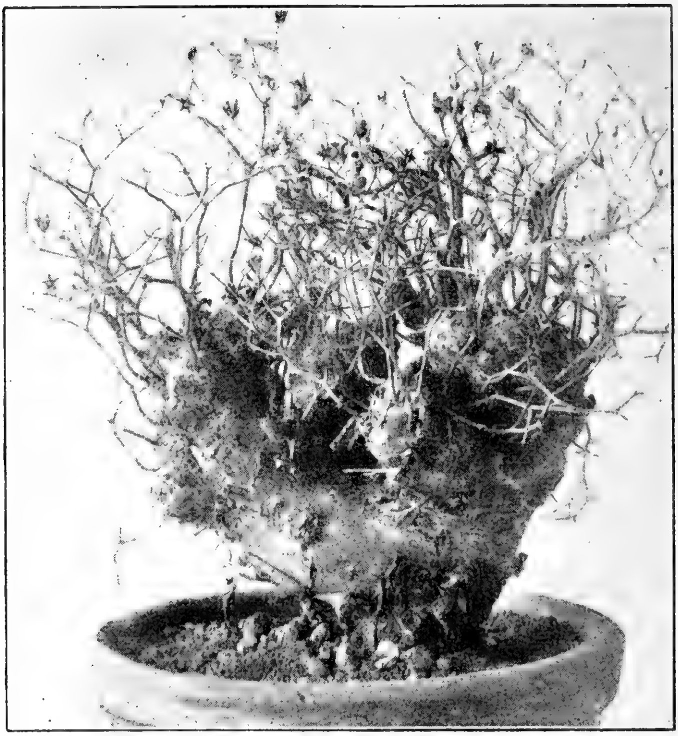


FIG. 80.—*Cotyledon reticulata*.

have their leaves packed as closely as possible. In Fig. 79 of *Crassula pyramidalis* the leaves shade one another, and no unnecessary growth is expended in stem and branches.

A plant's success in life is estimated by its ability to produce fruit so that its kind may be perpetuated. Judging by that standard, we cannot attribute failure to *Cotyledon reticulata* in Fig. 80, although the plant looks as though it had grown on the principle that the end justified the means. A large supply of food is stored in the ungainly trunk faster than the slender leafless twigs give it out. There is little waste, and so the plant does not come to want during the long droughts that occur where this plant loves to dwell. As an example of untidiness it is perfect.

Crassula semiorbicularis and the Mesembryanthemums

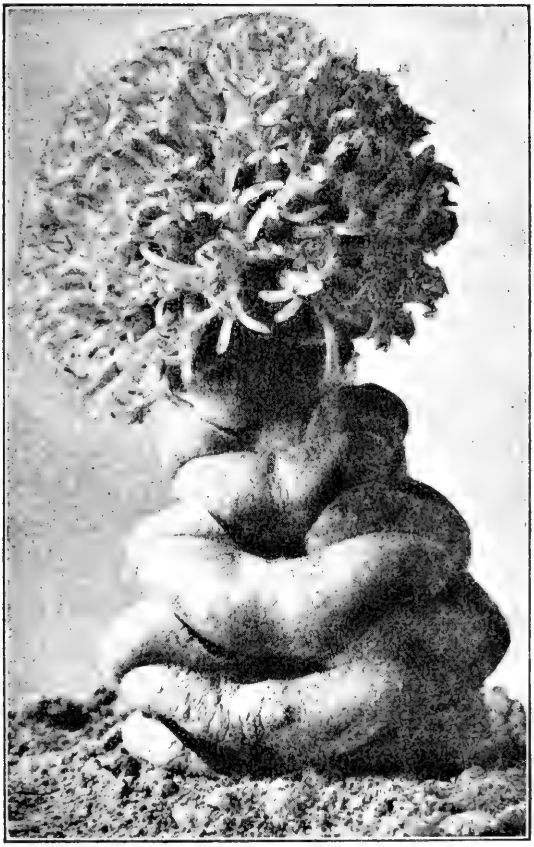


FIG. 81.—*Crassula semiorbicularis* with densely packed leaves.

shown in Figs. 82 and 83 testify that the heat is no excuse for untidiness. They can lay little claim to grace, unless on the ground that the most graceful is that which is best adapted to its use. They are painfully neat in their housekeeping arrangements, and instead of reducing their leaf surface after the fashion of their neighbours in the western part of the

Colony, their leaves are much in evidence. The plants of the Karroo have to defend themselves against the lack of rain by

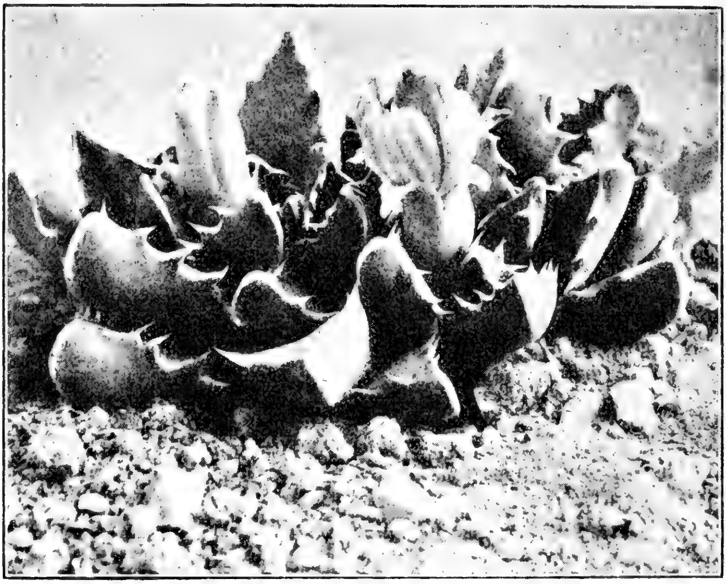


Fig. 82.—*Mesembryanthemum felinum.*

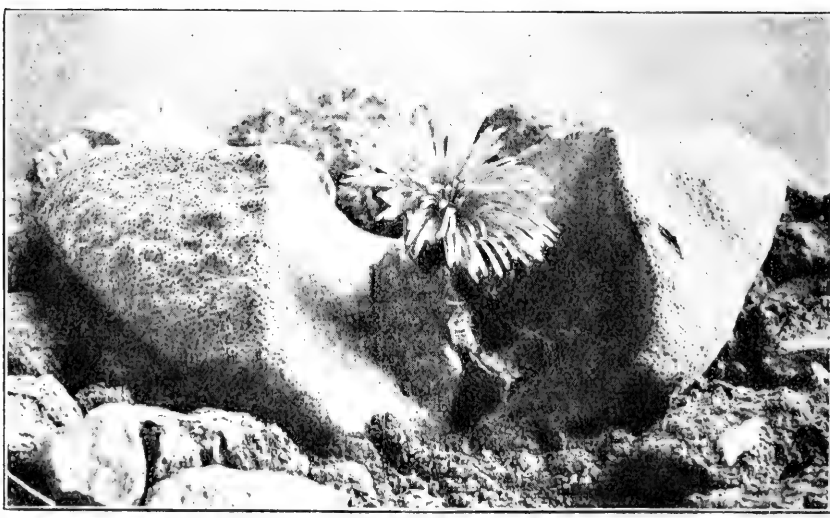


Fig. 83.—*Mesembryanthemum bolusii.* A native of the dryest part of the Karroo coming from the neighbourhood of Prince Albert. The water-storing leaves enable the plant to live through long droughts. (Photograph by A. J. Fuller, Esq., Cape Town.)

storing water in their swollen roots or stems and leaves. The leaves have thick cuticles, which are often incrusted with lime or covered with wax. In the leaf depressions rain and dew may be caught and retained, and the delicately tinted blossoms that crown the labour of these plants declare that Nature need seek no further devices for her Karroo garden. A drink of water from a well driven in the Karroo shows the salty or alkaline condition of the soil, and the fleshy leaves of the Karroo plants remind us of the plants along the salt marshes and sand dunes by the sea. It was once thought that roots absorbed all the water required by flowering plants. The water caught by the leaves of these plants suggests that they also absorb moisture. Notice how the pitcher-like leaves of *Satyrium* and the cups formed by the stipules and leaf bases of *Hydrophyllax* catch water. It is possible that these water gatherers are for preventing ants from reaching the flowers to rob them of their honey intended for some more serviceable insect.

FIG. 83A.—*Hydrophyllax*. The leaves and stipules form a cup which catches and holds rain.

A swarm of locusts leaves little green in its path, and in times of drought animals are not fastidious in their tastes for herbage; unless the juices are bitter or poisonous, plants have to battle in other ways against their living enemies. As a guard against destruction from browsing animals, plants are protected by spines or a felt of hair. *Hermas gigantea*, the "Tontelbloom," has the lower leaves well protected by a dense hairy covering on both sides; as they get older, and their leaves become firmer, they are less in need of protection, and the hair is easily brushed off.

Instead of exposing the precious store of water above ground, it is stored by underground reservoirs of bulbs, corms, or root tubers which abound in the Karroo. These have often to give up their stores to thirsty natives and travellers.

Some plants have large bulbs near the surface, or, as in *Boweia*, above ground, while others send a long neck deep down into the earth; at the end, patient digging reveals a small

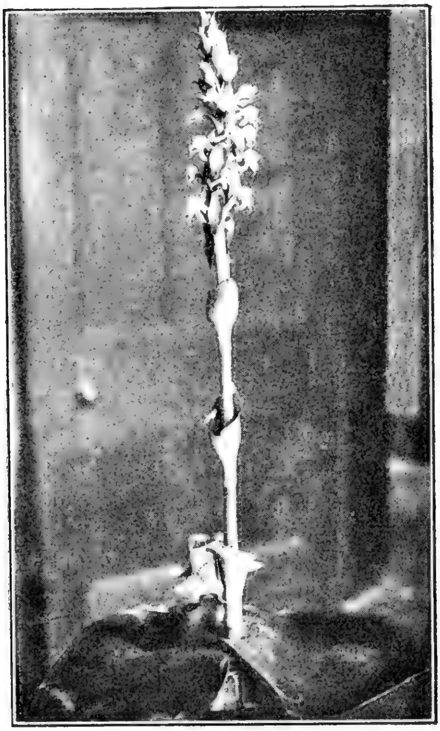


Fig. 84.—*Satyrum candidum*.

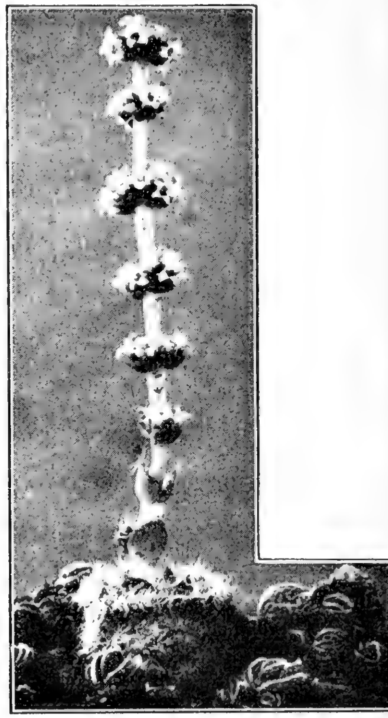


Fig. 85.—*Crassula barbata*, with spine-protected leaves and bracts.

bulb or corm. There is not the need of storing such an abundant supply if the neck can go down in search of water.

For this reason much of the gardener's labour is in vain which is spent in carefully hoeing up the soil around his onions. Compare the size of onions which have had the earth heaped around them with those which have been cultivated, leaving their bulbs partially exposed.

Plants growing in dry places frequently bear their leaves all in one plane, so that one leaf covers the leaf beneath it. Some bulbous plants have their edges, instead of the flat surfaces, turned toward the stem, their bases, partly sheathing the bulbs, lead the water down to the place where it is needed. Such leaves are called **ensiform.**

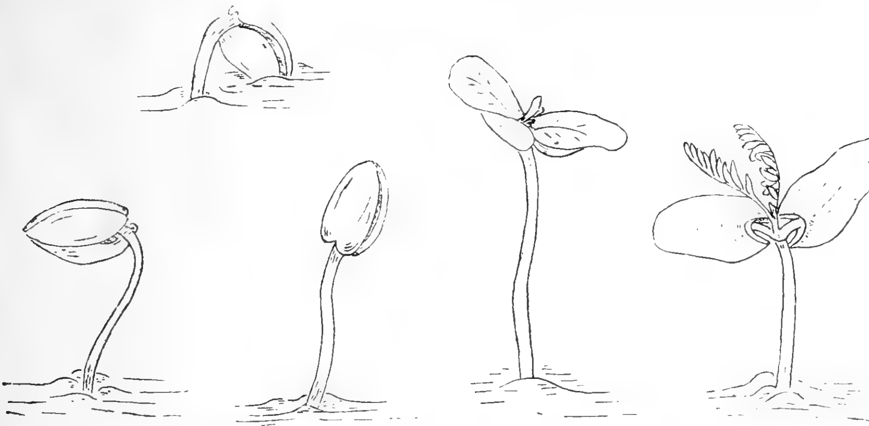


FIG. 86.—Seedlings of Black Wattles (*Acacia melanoxylon*).

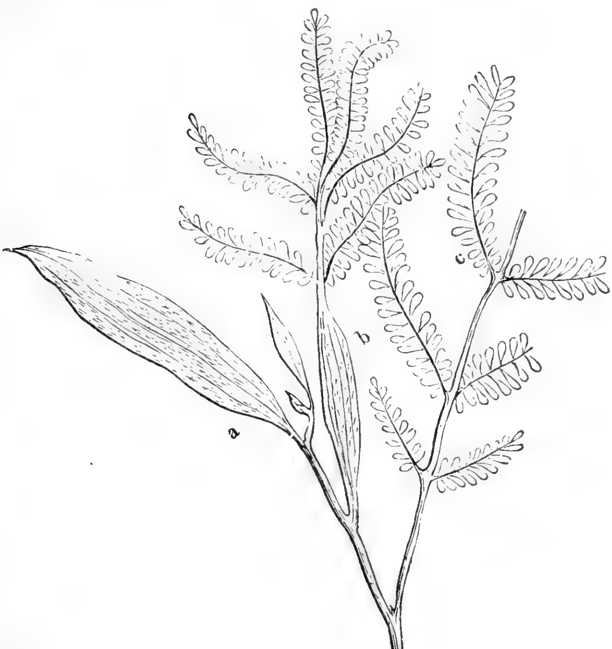


FIG. 87.—Branch of *Acacia melanoxylon*, showing phyllodes (*a*, *b*). (From Thomé and Bennett's "Structural and Physiological Botany.")

Every one has noticed the two kinds of leaves borne on the *Eucalyptus* (blue gum). The upper leaves are placed with edges toward the noonday sun. The broad surfaces of the lower leaves receive less light. At sunset, when the light is not so strong, the upper leaves receive it on their broad surfaces, and so are prevented from cooling too rapidly. It is

Fig. 88.—The Black Wattle trees lose all trace of the compound leaves they had as seedlings.

the position of the upper leaves which gives such a delicate tracery against the sky.

Sow Mimosa seeds, those of the Karroothorn and Blackwood, or the Port Jackson "Willow." Watch the seeds of both come up "with a loop," bringing their cotyledons with them. On the first leaves note the little bristle-like stipules. Can you see them on both kinds of seedlings? Are the next leaves the same in each. Watch the seedlings until you find how the Port Jacksons get their long narrow leaves and the Mimosas get their thorns.

When petioles flatten and take the place of the usually expanded portion of the leaves, they are called **phyllodes** (having the form of leaves). The Mimosa and the Port Jackson look very unlike as trees. But their early history shows that they are really closely related. Their flowers and fruit show the relationship also, so their book name is the

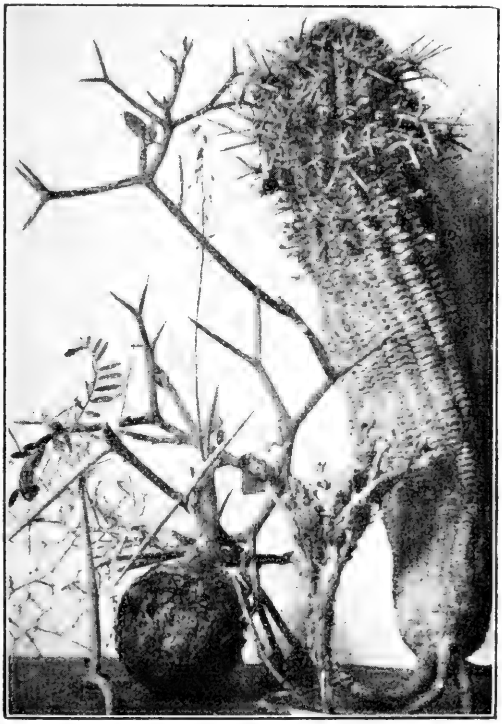


FIG. 89.—A nosegay from the Karroo.

same, *Acacia*. The thorn tree of the Karroo is *Acacia horrida;* its Australian cousin is *Acacia melanoxylon* (black wood).

Notice the bushes and trees about your district. Are their edges or their flat surfaces turned toward the sun? The slender green branches of the beef-wood tree (*Casuarina*) take the place of leaves. This tree also comes from the "land of shadowless forests."

At noon we spread rugs over the Karroo thorns when we sit under them for shade. Place the tin of little Karroo trees in bright sunlight. How do they protect themselves?

All the plants have their lessons to teach. The blue-grey of the western foliage, the stretches of Karroo, the restful green of the Kei, the Katberg, and the Vaal,

> "The aching Oudtshoorn ranges
> Lit by the last of the sun—
> Opal and ashes-of-roses,
> Cinnamon, umber and dun,"

all have their beauty, their lesson, and their mystery.

We had been picnicking in Bain's Kloof. Full justice had been done to the last brewing of coffee. Proteas, heath, orchids, and ixias filled our waggon. The spirit of the mountains behind us breathed mysterious silences. Below were vine-clad hills with bordering orange groves sloping down to the half mist-wreathed village. Around lay the untilled veld, beyond which the Malmesbury grain district swept on over rolling hills out of sight. Table Mountain lay in the distance, and at the right the surf-beaten Blueberg range.

"Look! where can another such view be seen?" exclaimed one who loved the West, to a student standing near. At length, with a far-away look, came the reply, "Wait till you have seen Beaufort West." That was—

> "His Sea in no showing the same—
> His Sea and the same 'neath each showing."

CHAPTER XII

NEW PLANTS WITHOUT SEED

FLOWERING plants usually reproduce by seeds, but they may reproduce by other methods.

FIG. 90.—Lily growing in ostrich egg.

Oxalis has a vigorous underground stem system, upon which bulbs in great number are formed. Within these bulbs, on the tips of slender coiled stems, other bulbs are formed, which send up new plants year after year. Creeping underground stems are called **rhizomes.**

The lily growing in the ostrich egg (Fig. 90) had blossoms, but the seeds did not set; possibly for lack of food which passed on to form little plants on the tip of each flowering stalk. The little plants send out roots in search of food. If they had been left in the mountain they would have been more successful in their search. The little plants are given a good start in the world, for the wiry stems throw out each plant a

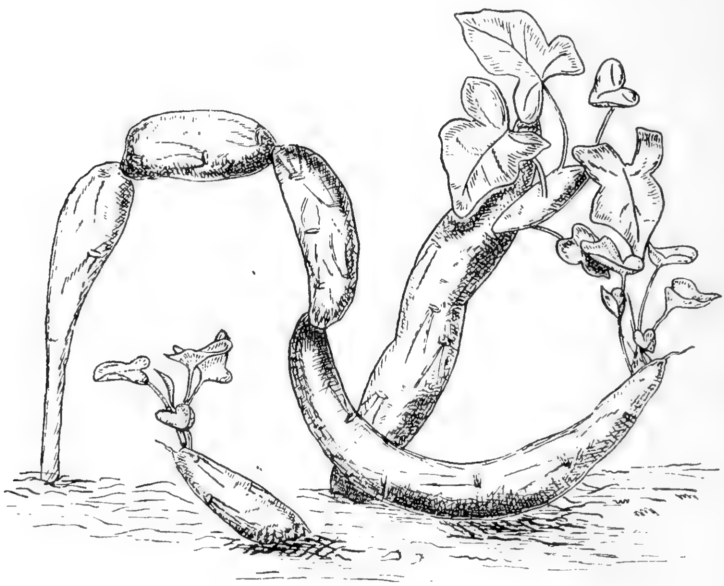


FIG. 91.—*Kleinia articulata.*

long distance from the parent, and in a few years they will travel a long distance up or down the mountain.

A great many of the Cape plants reproduce by bulbs. They may lie dormant in the ground for years. After the vegetation has been burned off these bulbs have a chance, and then send up flowering stalks which turn the blackened veld into a garden.

New plants are obtained by **cuttings** from old ones. Sometimes the stock is cut back so as to obtain a supply of shoots for this purpose. It is in this way that potatoes are propagated. *Kleinia articulata*, which grows about Uitenhage, propagates naturally by cuttings. The fleshy stems are jointed or constricted at intervals. A strong wind breaks the plant at these joints, and new shoots start from the axils of the leaves.

Grafting and Budding.—When plants are grown from seeds they often differ from the parent plant, owing to the fact that the ovules have been cross fertilized, *i.e.* pollen has been brought from another variety or species. Grafting is then resorted to to insure retaining the desirable fruit. By this method, new and delicate varieties may be introduced into the country by grafting on to hardy plants, as in grafting varieties of grape on to the American vines.

Grafting has another advantage, as trees grown from seed take several years to bear fruit. Buds of the first or second order, that is, those borne on trees one or two years old, do not develop fruit-buds, but leaf-spurs. By using grafting scions of a higher order, fruit will be borne much sooner.

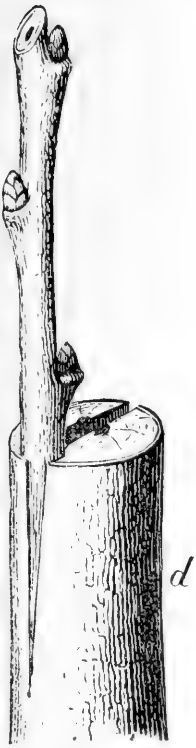
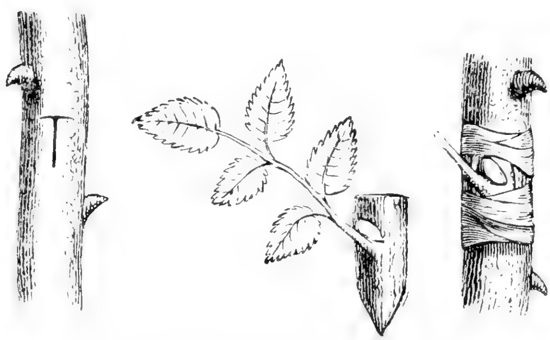


Fig. 92.—Grafting; *d*, the stock to which the graft is attached.



The various elements in the process of budding.

(From Thomé and Bennett's "Structural and Physiological Botany.")

To graft in a simple form, select two branches of the same species; cut from each a portion of the bark and a little wood, which will be bordered by a ring of cambium. Bring the two cut surfaces together and bind them firmly. When the two have united, one may be cut from the parent stock. Sometimes it is desirable to graft a small scion on to a larger stock. The stock is cut off, the scion is pointed at the lower end and thrust in between the wood and the bark. The stock is prevented from drying by a covering of clay or grafting wax. Drying would kill the cambium.

Budding is a form of grafting. A single bud with a portion of wood is inserted into a **T**-shaped opening of the stock. This method is used with especial success with oranges, apricots, and roses. An apple will graft on to a quince, but a quince does not take well to a pear. A pear will not grow well on an apple. Professor Bailey tells us that tomato-plants will grow on potato stocks, the combination forming potatoes under ground and tomatoes above. When tomato plants are the stocks, what will happen? If you own a rose bush, it will be interesting to see how many kinds of roses you can bud on to one stock. Try it.

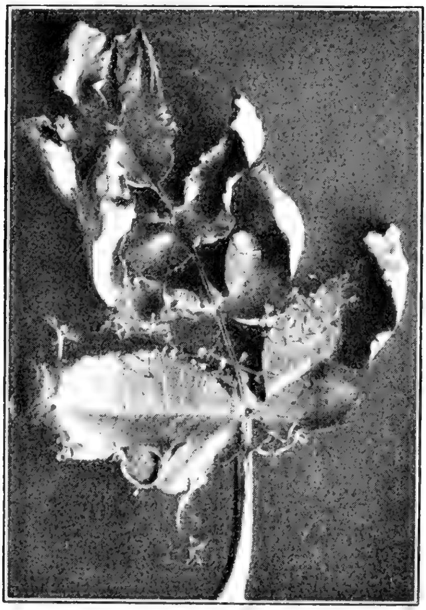


FIG. 93.—Leaf of *Bryophyllum*. Little plants are borne all along the edges of the fleshy leaf. They send out roots, fall off, and start new plants.

Budding and grafting should be done when the sap is active in the spring.

Pineapples and bananas have lost the power of forming seeds. The leafy stem above the pineapple fruit readily sends out roots when placed in the soil, and a new plant is grown. How are banana plants propagated?

The mother fern, *Bryophyllum*, and begonias are propagated by means of buds formed on the leaves. The stem or axis of the bud lengthens, and the leaves unfold; roots are sent out from the lower portions of the stems, and the little plants fall off, forming new plants.

Mosses and mushrooms do not form seeds, but are reproduced by tiny bodies called spores. The fern spores are borne in spore cases usually on the under side of the leaves.

CHAPTER XIII

CLIMBING PLANTS AND PLANT MIGRATIONS

It is interesting to notice along waysides and waterways how different varieties of plants dwell in congenial plant societies. Many a delicate plant owes its start in life to the protecting branches of some overhanging shrub or forest tree which it afterwards uses to "rise in the world."

Fig. 94.—*Microloma* gets up in the world by twining on stems of other plants.

We could not make a satisfactory classification of climbing plants, because almost any family of plants might have climbing members if their surroundings made climbing necessary. In fact, a plant which may have quite an erect habit out in the open will become tall and slender and in need of support if growing among bushes.

Stem Twiners.—*Microloma* and *Cyphia* show a common method of climbing by twining. The stems twine from left to right, or away from the sun. Growing on the open veld as they do, their support is seldom long enough for their entire length, but the stems often twine several together in a strand firm enough to bear their weight of pretty blossoms up into the sunlight. You may watch them in the school-room, if you place them in water, and see how at different hours of the day the stems point in different directions. The tips of the stems make wide sweeps, but as they extend in length the coil tightens around the support. One keen-eyed student says she can tell from what hillside *Microloma* has been gathered by the plant it entwines. On one hillside she seeks it on *Restiaceæ;* in another locality it twines about the rigid branches of *Montinia acris;* while elsewhere it mingles its scarlet waxy flowers with the hoary heads of *Eriocephalus*.

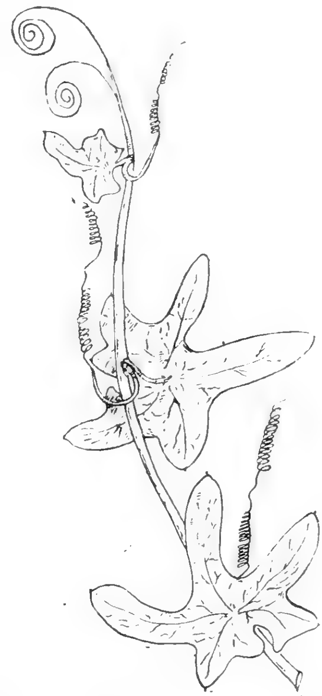


Fig. 95.—The first leaf of the branch in the pumpkin family changes into a tendril.

Tendril Climbers.—The pea family, *Grenadilla* and other plants, climb by tendrils. The pumpkin, cucumber, and calabas seldom make use of their tendrils. Their heavy fruits would be a great strain on the plants; but several native relatives, Luffa and Lagenaria, with their lighter fibrous fruits, are climbers, and *Gerrardanthus megarhiza* of Natal climbs to the tops of highest trees.

The tendrils of the pea are formed from the upper leaflets of a compound leaf. This use of the leaf throws the responsibility of making food upon the stipules or upon the broad-winged stem. In the grape vine the main stem turns aside to form the tendril for climbing and bearing the fruit, while the tendrils of *Clematis* are formed from the petioles. What is the tendril of the Grenadilla?

The beautiful scarlet and orange blossoms of *Gloriosa* are borne up against their glossy background of trees by the coiled tips of their leaves. *Littonia* and *Flagellaria* have a similar habit. They can grow erect for some time without a support, and so no tendrils are borne on the tips of the lower leaves.

Hook Climbers. — Some plants like *Asparagus* and Dog Roses lean against others for support. The recurved thorns or prickles which ward off animals serve to fix and support the plant. The ivy climbs by means of roots (haustoria) which grow out along the stem.

FIG. 96.—The petioles of Clematis act as tendrils.

Plants in dry open places, on the other hand, are less congenial. Their chief concern is to appropriate as much soil as possible to the exclusion of others of their own or of different kinds. Some species of *Brunsvigia* and *Hæmanthus* spread their flat leaves closely upon the ground, preventing others from gaining a foothold, and smothering any weaker plant which may have taken root in the soil which their leaves can cover. So the plants appropriate water and food material from a wide area.

Foreign Immigration.—Have you ever thought how much or how little South Africa owes to other countries for its flora? Dr. Bolus, in his "Sketch of South African Flora," mentions as one of its peculiarities "its power to resist the aggression of foreign invaders." The bulbous plants offer a most determined resistance to other plants. Even South African plants seldom spread when removed from their restricted locality. A Mimosa (*Acacia horrida*) was planted in Wellington as a thank-offering for a difficult journey suc-

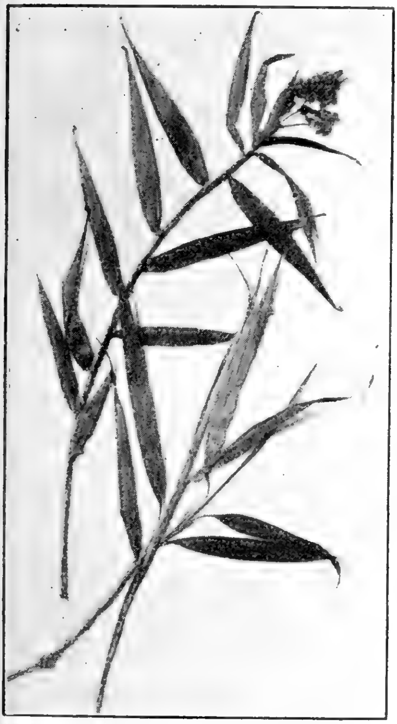


FIG. 97.—The leaf tips of *Flagellaria* serve as a means of support.

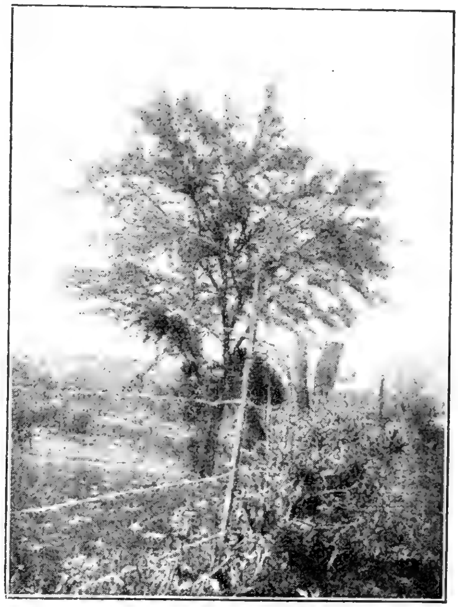


FIG. 98.—A Mimosa tree in Wellington. Out of its natural habitat it thrives, but does not spread as does its relative the "Port Jackson" from Australia. (Photograph by Mrs. Aiken.)

cessfully completed before the railway extended to Worcester, more than thirty years ago. Beautifully green in winter, in summer it is a fragrant mass of golden flowers. Fruit and seeds are produced in abundance, but still it stands the only Mimosa tree in the vicinity. However, it is much the same with plants as with people who come to our shores. If they bring something to the country which it needs, if they adapt themselves to the conditions as they are, and make the most of them, they are apt to thrive and find hospitable soil.

The country needs shade, fuel, and building timber. Have you ever thought how different Johannesburgh would look without the Australian blue gums? How we should miss the oaks which make French Hoek and Stellenbosch so delightfully shady, and how different the suburbs of Cape Town would look without the European pines!

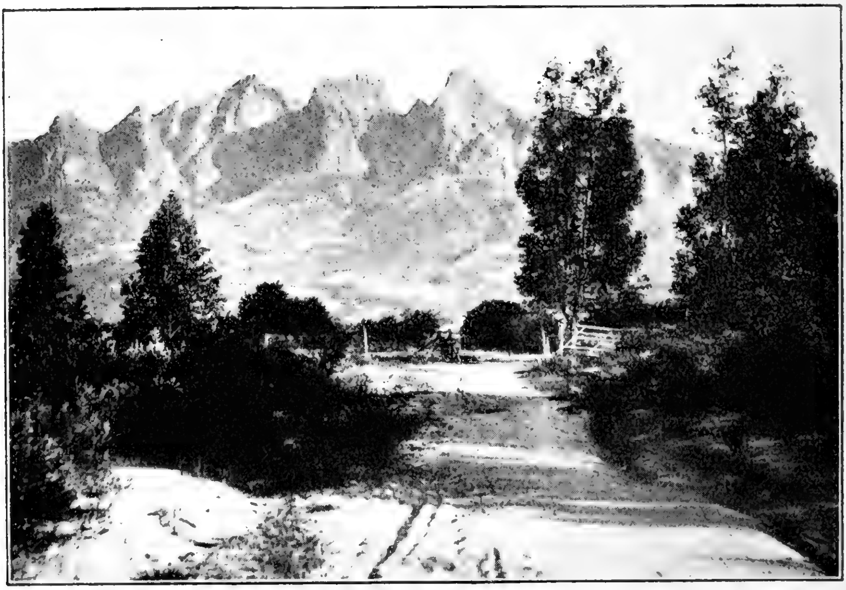


FIG. 99.—Mount Hawakwa, near Wellington. The Australian Eucalyptus softens the treeless landscapes of the Colony. (Photograph by L. Grant.)

The fever districts need draining. What tree could better do this than the blue gums? Their thirsty roots make enormous demands on the water supply, while their vertically placed leaves and slender erect habit allow the sun to penetrate to the soil. The pines or "firs" and the blue gums which belong to the myrtle family remind us of the prophecy in Isaiah lv. 11–13: "So shall my word be that goeth forth out of my mouth; it shall not return unto me void, but shall accomplish that which I please. . . . Instead of the thorn shall come up the fir tree, and instead of the brier shall come up the myrtle tree:

and it shall be to the Lord for a name, for an everlasting sign that shall not be cut off."

Along the coast the sands are ever shifting and piling up new dunes. The native plants do their share in staying the sands; the succulent creeping *Mesembryanthemum* (*T'gau-kum* and *Paarde Vigen*), and *Myrica*, with its spreading trunk half hidden in the sand, all help to render the sands more stable. The "Port Jackson Willow," from Australia, is admirably adapted to aid in this work. Besides spreading by

FIG. 100.—*Myrica cordifolia* (photograph by Dr. Marloth).

the countless seeds which it produces, the plant spreads by tough suckers, that run underground in all directions, forming a firm foundation upon which their humus or decaying leaves mingle with the verdureless sand. Moreover, these plants belong to the great group of leguminous plants, the nitrogen gatherers. Their innumerable roots are claiming quantities of the precious nitrogen of the air, and are giving wealth to the soil as fast as it is being removed from the Kimberley and Johannesburgh mines.

Plants introduced into America have spread until they have become pests. The same plants brought to this country for their beauty of flower may grow, but seldom become noxious. South Africa, with its wealth of beautiful flowers, can well dispense with introduced flowers, except the roses and violets, which are lacking in this country—and how they do thrive!

CHAPTER XIV

FLOWERS AND THEIR PARTS

To understand the parts of a flower, it is better to take those of the veld. Roses, carnations, chrysanthemums, and dahlias of our gardens delight us with their glorious masses of colour, but by long cultivation they have lost some of the characters which Nature originally gave them. Chrysanthemums (the gold flowers), it is said, have been in cultivation for over two thousand years. Enthusiastic cultivators have so put their hearts into showing what a range of colour and size is possible in these old garden favourites, that the flowers themselves have yielded up their own golden hearts to the cause. The centres have grown out into flattened petals, which gradually reveal all the colours they have caught from the sun.

"The lovely wild flowers are the flowers which God has made." We repeat Jean Ingelow's thought when we come upon heaths, *Nerine*, and orchids in some hidden inaccessible place. But garden flowers have their beauty too—beauty obtained by care and skill of those who love them. The wild flowers were so made that they can change most wonderfully under cultivation, and lend added cheer and colour and interest to the lives of those far from heath-covered hills or Disa-bordered streams.

If you examine the flower of *Crassula*, you will find on the outside a circle or **whorl** of green leaves—the **calyx**; each leaf is a **sepal**. The calyx is the cover of the flower. In *Dianthus* (Carnation), *Datura*, and *Hibiscus* the sepals have grown together, forming a cup. When sepals have grown together, the calyx is said to be **gamosepalous.**

NOTE.—This chapter will contain many new names. We must have them when we study flowers. Do not try to learn them all at once, but find as many flowers as you can and make out each part named in this chapter. You will have the names in mind before you know it.

Within the calyx, the second row of flower leaves is the **corolla,** or little crown. It is usually the showy part of the flower. Sometimes the calyx is brightly coloured, and may at first be mistaken for the corolla. Calyx and corolla taken together make the **perianth.**

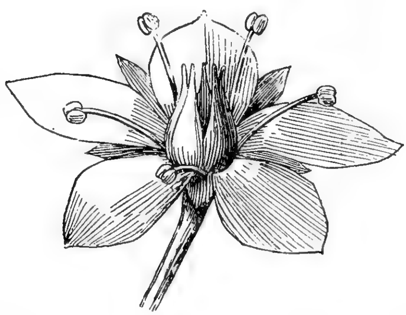


FIG. 101.—*Crassula centauroides,* Thumb. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

The third whorl bears little resemblance to leaves. It consists of as many slender threads as there are petals; each thread ends in a yellow knob. They are the **stamens.** The thread of the stamen is the **filament** (*filamen* thread), and the knob the **anther.** The anther is really the powder-box, and each box contains very valuable powder, called **pollen.** In the centre of the flower are several boat-shaped bodies, tapering to a point. They are the **pistils** or **carpels.** The lower part of the pistil is the **ovary** or egg-box. It contains small rounded bodies, the **ovules,** which are destined to form seeds.

You can find these parts in **Hibiscus.** The stamens, however, are joined by their filaments into a tube. Above the stamens are five crimson velvety cushions, the **stigmas.** Carefully split down the stamen tube, and see how these five cushions are borne at the top of a long slender stalk, the **style.** By following the style down its entire length, we come to the ovary. A cut across the ovary shows as many parts or **carpels** as there are stigmas. Within the cavities or **locules** are the ovules. Remember that the ovules are not at first seeds, any more than a new-laid fowl's egg is a chicken.

When carpels are separate as they are in Crassula, they are said to be **apocarpous.** When they are joined as in *Hibiscus*, they are **syncarpous.** The parts of a pistil are—**ovary, style,** and **stigma.**

Crassula, *Hibiscus*, *Ornithogalum* ("Chinkering chees"),

FIG. 102.—Flower of Thorn-apple (*Datura Stramonium*) (natural size), showing gamosepalous calyx. (From Thomé and Bennett's "Structural and Physiological Botany.")

FIG. 103.—*Hibiscus æthiopicus*, L. (From Edmonds and Marloth's "Elementary Botany in South Africa.")

FIG. 104.—Pistil of Lily, with ovary. style, and stigma, (From Thomé and Bennett's "Structural and Physiological Botany.")

and other flowers have four whorls. Their flowers are **complete.**

Clematis (Traveller's Joy), *Protea*, and others have but one whorl of floral leaves. Although it may be showy, the one whorl is usually called the calyx. If any one or more whorls of the flower are wanting, the flower is **incomplete.**

After a few weeks the *Clematis* loses its sepals, and only the seed-forming portion remains. A flower exists for the sake of forming seed. The ovules within the ovary cannot become seeds without the pollen from the stamens; so the stamens and pistils are called the **essential organs.**

If the anthers are removed from any flower before they shed their pollen, and the flower is then covered or removed from any similar flower, the ovaries will wither away and form no seed. If, after the stamens were removed, pollen were brought from a similar flower and placed at the right time on the stigma, the pistil would continue growing, and seeds would be formed as though there had been no disturbance, even though the petals and sepals were removed. A **perfect** flower has both stamens and pistils. In the flowers which bear the seed in the Silver Tree, Indian corn, or *Montinia* stamens are wanting, while those that have stamens produce no seed. Flowers in which either set of essential organs is wanting are **imperfect.** If the pistils are wanting, the flowers are **staminate.** If the stamens are absent, the flowers are **pistillate** or **fertile.** A perfect flower is sometimes called **bisexual** or **hermaphrodite.** The willows and arums have neither calyx nor corolla. A flower may be reduced to a single stamen or a single pistil, as in some Euphorbias.

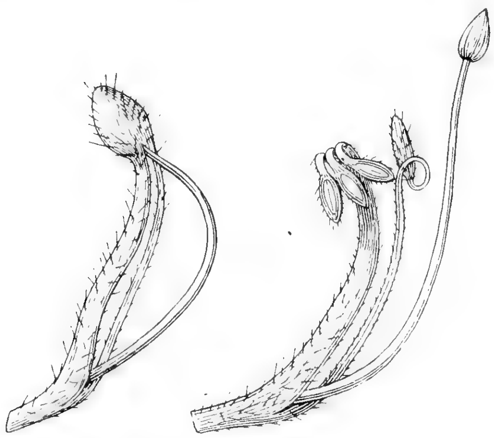


FIG. 105.—*Leucospermum ellipticum.* *L. e.* has no corolla. The flower is incomplete. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

A complete flower has—

(1) Calyx, made up of sepals.

(2) Corolla, ,, ,, petals.

(3) Stamens, made up of filaments and anther.
(4) Pistil, ,, ,, ovary, style, and stigma.

A perfect flower has—

(1) Stamens.
(2) Pistil.

Practise making out the four whorls of flowers. Find other flowers which are pistillate or staminate.

Do not try to remember any of these names until you have seen the parts themselves.

Different kinds of Pistils.—The long style of *Hibiscus* is necessary to bring the stigma out beyond the stamens. In some *Ornithogalums* and in *Albuca* the stigma sits directly on the ovary. The style is not in all cases necessary to the pistil. It depends upon the shape of the flower.

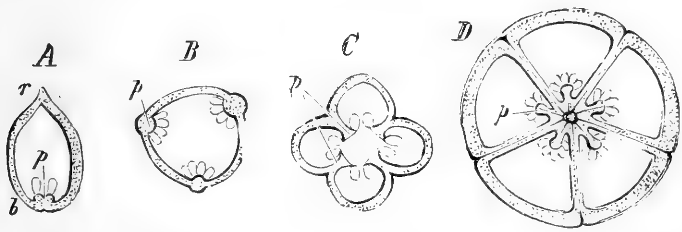


FIG. 106.—Diagrammatic sections of ovaries: *p*, the placenta, to which the seeds are attached. A, apocarpous; B, C, D, syncarpous. (From Edmonds and Marloth's "Elementary Botany.")

If a flower has two or more carpels, they generally grow together. A syncarpous ovary may be one-, two-, three-, four-, or many-celled (or uni-, bi-, tri-, quadri-, or plurilocular).

As the ovaries are variously formed, the ovules are placed in different positions. In the bean they are placed on the upper edge of the ovary; in orchids, violets, and *Drosera* the ovary is made up of three or five carpels which just meet at the edges. The joinings make three thick ridges the length

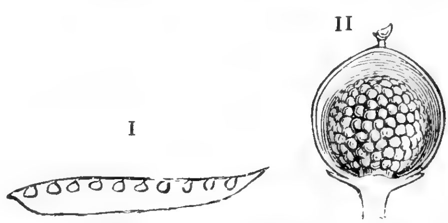
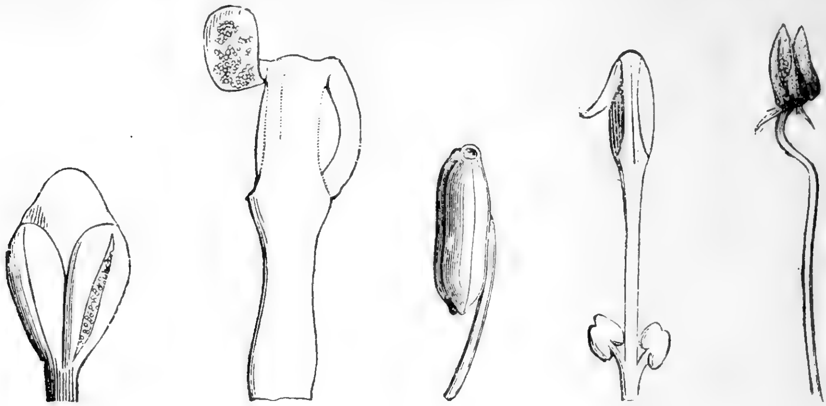


FIG. 107.—I. Marginal placentation. II. Unilocular ovary, with free central placenta. (From Edmonds' "Elementary Botany.")

of the ovary. The part upon which the seeds are placed is called a **placenta.** In *Ornithogalum* and *Gladiolus* the



I. II. III. IV. V.

FIG. 108.—I. Stamen of *Pinus sylvestris* with longitudinal dehiscence (magnified). II. Stamen of barberry, the anther opening by recurved valves (magnified). III. Stamen of *Rhododendron*, each anther lobe opening by a pore. IV. Stamen of bay, *Laurus nobilis*, with two glands at the base of the filament, the anther opening by recurved valves. V. Stamen of *Erica*, the anther opening by pores and bearing two appendages at its base (magnified). (From Thomé and Bennett's "Structural and Physiological Botany.")

three carpels curve in until they meet at the centre of the ovary. In carnations, "Poor Man's Weather-glass" (*Anagallis*), and *Portulacaria* (Spekboom) the ovules are borne on a column, the end of the flower-stalk or **receptacle**; they are free from the wall of the ovary.

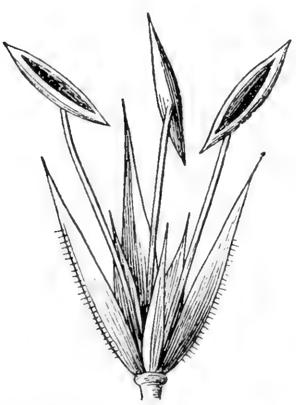


FIG 109.—One-celled swinging anthers of *Restio*. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

These three kinds of arrangement or **placentation** are **marginal,** which includes the **parietal,** and **axile,** and **free central placentation.**

Different kinds of Stamens.—Most stamens have long filaments, but in some flowers the filaments are very short, and in *Protea* they have disappeared. Like the style and the petiole of a leaf, they are present only to place the essential part of the organ in a favourable position.

Anthers are differently attached to the filaments. In *Gladiolus*, *Lobelia*, and the heaths the filament is joined to the base of the anthers (basifixed). In Jasmine the filaments extend between the anthers. In grasses and in *Bulbi-*

FIG. 110.—Stamens of *Cyanella capensis*.

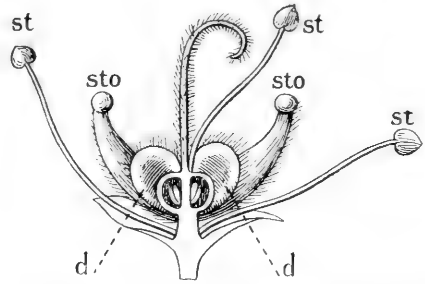


FIG. 111.—Section through flower of *Barosma crenulata* after the removal of the petals (magnified): *st*, fertile stamens; *sto*, barren stamens (staminodes); *d*, lobes of disc. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

nella the filaments are so joined to the centre of the anther at the back that they easily swing.

Most anthers have two cavities or locules. *Restio* and *Hibiscus* stamens have but one.

Anthers open in different ways to let the pollen escape. The anthers of *Watsonia*, *Antholyza*, and *Protea* open the entire length. *Cyanella* and the heaths open by little pores at the tips. Do you know of any other that open in this way? *Cassytha* and *Oreodaphne* (Stinkwood) open by little lids upon which the pollen adheres.

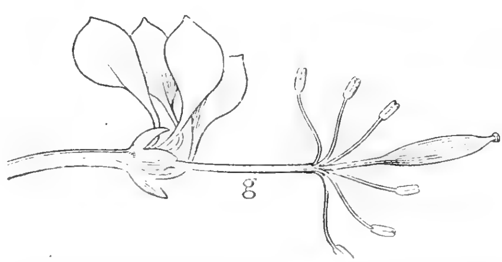


FIG. 112.—*Gynandropsis pentaphylla*. Flower with large gynophore, *g*. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

The portion of the filament between the two anther lobes is called the **connective**.

In *Adenandra*, *Barosma*, and in some species of *Albuca*, what appears to be every other stamen bears no anther. They have been changed for some special reason. In *Adenandra* they bear honey glands at the tip. Bodies which are in the position of stamens, but which do not form pollen, are called **staminodia.**

FIG. 113.—*Peach.* Vertical section of flower. (From Henslow's "South African Flowering Plants.")

The Insertion of the Flower.—The end of the flower-stalk, the receptacle or thalamus, is usually a shortened cone, so that the four whorls of the flower are borne closely together. Sometimes the part between any two whorls may be lengthened.

FIG. 114.—*Mesembryanthemum.* Vertical section of flower. (From Henslow's "South African Flowering Plants.")

In the *Capparis* family, which is found chiefly in the East, the thalamus is lengthened between the petals and stamens, and again beyond the stamens, so that they are separated from the pistil. The thalamus may be swollen into a disc, as in

Tecoma and *Plumbago*. Where there are many ovaries, as in the strawberry, it is much enlarged.

In some flowers the receptacle grows up in a tube around the ovary and bears the perianth and stamens on the rim of the tube. If the tube is free from the ovary, the stamens and petals are **perigynous.**[1]

If the tube is joined to the ovary as it is in the Hottentot fig (*Mesembryanthemum*), the stamens and petals are **epigynous.** These two conditions come late in plant life. In earlier flower forms the three outer whorls are situated below the ovary. The stamens and petals are hypogynous. The ovary is superior and the calyx inferior. All these forms are found in different members of the rose family. Which kind is found in the pumpkin?

The Duration of the Parts of the Flower.—The corolla usually has the briefest life, and in some flowers it lives but a day. If the perianth remains until the fruit is ripe, it is **persistent.** The strawberry has a persistent calyx. If it falls off after the pollen has reached the stigma, it is **deciduous**, as in members of the lily family. If the calyx falls off before the corolla opens, it is **caducous.** What do farmers mean by grapes "shedding their caps"? When is this done?

Different Forms of Calyx and Corolla.—In describing the calyx and corolla it is necessary to have names for the different shapes. They get their names from something more familiar to us. Kalkoentjes and patrijsjes are good names for some flowers if one understands Dutch. Some flowers have Zulu names. Wheel-shaped answers for a flower the shape of the one in Fig. 115. It is also called **rotate**, from the latin word for wheel, *rota*.

Fig. 115.—Rotate flower of *Solanum*. (From Thomé and Bennett's "Structural and Physiological Botany.")

[1] Perigynous means around the ovary. **Gynœcium** is the term applied to all the ovaries of the flower. The corresponding term for the stamens is **Andrœcium.**

Polypetalous, corresponding to **polysepalous**, is applied to petals when they are distinct from each other. In *Roella* and *Tecoma* the corolla is made from a single piece; they are **gamopetalous**. The lower part of the corolla is the **tube**, and the upper spreading part the **limb**. The upper boundary of the tube is the **throat.**

Flowers, especially gamopetalous corollas, often have very curious shapes. We liken them to butterflies, spiders, bells, trumpets, lips, kalkoentjes, patrijsjes, kappies; but since Latin names have been longest in books, we still use them. The most important thing is to know the flowers and to find out, if possible, how they came by their different forms. When the parts of the corolla and calyx are all the same shape, the flowers are **regular.**

FIG. 116.—*Disperis capensis* (Mother cappies or Hottentot bonnets).

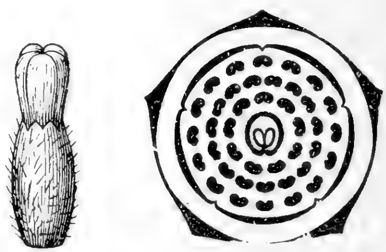


FIG. 117.—Valvate æstivation of *Acacia horrida*. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

When they are two-lipped, like Lobelia, or butterfly-shaped, like the pea, they are **irregular**. Bright-coloured flowers are often irregular.

Flowers built on the plan of three often have sepals and petals of similar shape and colour. By this time you have observed that certain flowers have three sepals, three petals, and that the stamens and carpels are also three or some multiple of three, while others are built on the plan of five. Four is less commonly the number found.

Æstivation.—Like the leaf buds, flower buds have their parts neatly folded. The stamens are curved inward to bring the anthers as near the centre as possible, and sepals and petals are carefully wrapped around them. Sometimes petals and

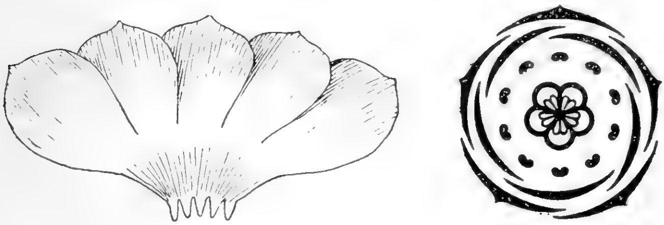


FIG. 118.—Convolute æstivation of *Oxalis* (the sepals are imbricate). (From Edmonds and Marloth's "Elementary Botany for South Africa.")

sepals are **valvate,** that is, they just meet by their edges. If they overlap, the æstivation is **imbricate.** In *Hibiscus* and

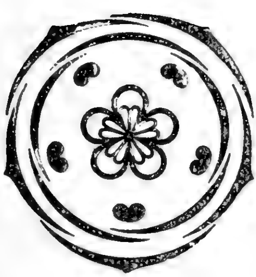


FIG. 119.—Imbricate æstivation of both sepals and petals. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

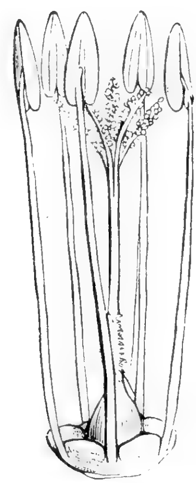


FIG. 120.—*Plumbago.* Stamens, honey glands, and pistil. (From Henslow's "South African Flowering Plants.")

Oxalis the petals so overlap that one edge of each is without and one within another. They are twisted or **convolute.** In *Crassula* and *Adenandra* one is quite within the others and one overlaps by both its edges. Which æstivation is more common?

Honey glands are the parts of flowers which secrete nectar for insects. In the buttercup (*Ranunculus*) and *Grewia* a gland is placed at the base of each petal. *Geranium* has a gland at the base of each long stamen.

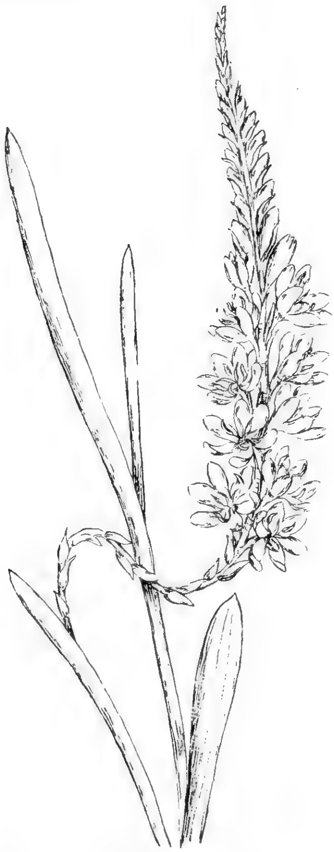


FIG. 121.—*Micranthus fistulosus.* A scape bearing a spike of flowers.

FIG. 122.—Raceme of *Cyanella capensis.*

These flowers are regular and the glands are evenly distributed around the flower. In irregular flowers, where insects alight in one particular place, the gland is situated where the insects can most easily help themselves. *Pelargonium* (commonly called Geranium) holds its honey in the long spurred sepal at the back of the flower. The spur is joined to the stalk. It can be located by cutting the stalk just below the flower.

The calyx tube catches honey. If the calyx tube is attached to the ovary, the gland is borne at the top of the ovary, as in the Carrot family and *Mesembryanthemum*.

Arrangement of Flowers on the Stalk.—Anthotaxy[1] is a term applied to the arrangement of flowers as phyllotaxy applies to leaf arrangement. Some of our large flowers, as *Hypoxis stellata* (Peacock's Eyes) are borne singly on the end of the flower stalk. Others, as *Malvastrum* and *Hermania*, are borne singly in the axils of the leaves; the stem can then continue to lengthen. If the peduncle of flower stalk arises from the ground and bears hardly any or no leaves it is termed a **scape.** Fig. 121 shows a scape bearing a cluster of flowers. The ovary of each flower is **sessile,** or borne close upon the stem. The anthotaxy is a **spike.**

FIG. 123.—Corymbose raceme of *Ornithogalum thyrsoides*.

A **raceme** has the flowers attached to the main stalk or axis by a short stalk. If the lower stalks are lengthened and the upper ones shortened, the raceme is a **corymb.** If the stalks themselves are branched, the inflorescence is a **panicle.** This is common in the grasses, the grape, and the olive.

The spike and raceme have a lengthened axis. A **capitulum** or flower head has a shortened axis and sessile flowers, as in the Everlasting family and *Protea;* for here

[1] Anthotaxy is a recent word for the more familiar term Inflorescence.

what looks like a single flower is really a cluster of many flowers. If the flowers are borne on pedicels which spring from the same height on the axis, we have an **umbel**. The Carrot family takes its name from the umbel or umbrella-like arrangement of the flowers. Widely different families have this floral arrangement—as the Pelargoniums and Erodiums

Fig. 124.—Simple umbel of Nerine.

of the family *Geraniaceæ*, many of the Amaryllideæ or Belladonna family, *Microloma* and *Asclepias*.

In these four types of flower arrangement, the spike, raceme, capitulum, and umbel, the younger flowers continue to open toward the top or centre, which in the umbel corresponds to the top.

When a telescope is closed or shortened, the smaller or upper end becomes the centre.

In *Dianthus* and other members of the Carnation family, in *Crassula* and *Datura*, the central or terminal bud opens first, and later buds come from side branches below. This type of flower cluster is known as a **cyme**, and the flower arrangement is definite or determined; that is, the first flower determines that the stem shall extend no farther. It has a definite length. It happens that flowers do not, as a rule, follow strictly one or the other arrangement, but the definite and indefinite are often mixed. The flower cluster of the

FIG. 125.—Compound umbel of Bubon. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

olive is a raceme, but the separate branches have the flowers arranged in cymose clusters. In *Leonotis* each separate flower cluster is definite, but the younger clusters are at the top. The terminal umbels of Wild Carrot, which are the first to open, are indefinite. Younger umbels tip the branches which come from the axils of lower leaves, the youngest being lowermost on the stem.

Examine different flower clusters and make diagrams of the anthotaxies. We have found that Nature does not do things without reason. Be sure there is a good reason for the different arrangements of flowers. We may find out some of these reasons in the next chapters.

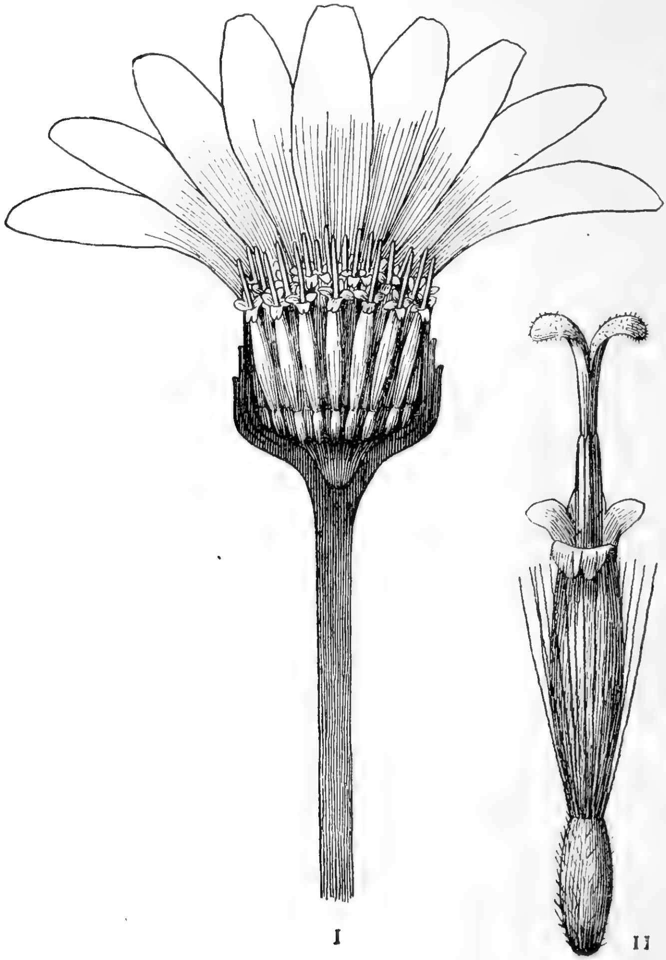


FIG. 126.—*Gerbera asplenifolia.* I. Section through head. II. Disc floret. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

FLOWER ARRANGEMENTS.

General Method.	*Kinds of Clusters.*
Indefinite	SPIKE :—**Catkin** : deciduous, pistillate and staminate flowers ; oak.
	Spadix : fleshy spike ; Arum.
	Cone : parts hard and woody ; fir, *Leucodendron*.

General Method.	*Kinds of Clusters.*
Indefinite	RACEME:—**Corymb**: more or less flat-topped; *Ornithogalum*. **Panicle**: branched stalks; Grasses. **Umbel**: simple. *Hydrocotyl*, *Microloma*, compound. *Daucus*, *Bubon*. **Capitulum** or head: *Compositæ*, *Protea*.
Definite	CYME:—2-sided: *Spergula*, *Crassula*; 1-sided: *Lobostemon*, Heliotrope.
Mixed	OLIVE:—*Leonotis*.

Bracts.—In examining flower arrangements, the flowers are usually found protected by one or more leaf-like bodies, green or coloured, which may have been mistaken for the calyx. In *Gladiolus*, *Antholyza*, and their relatives this mistake is often made, but you will find that in these flowers the sepals are like petals, and are borne at the top of the ovary.

FIG. 127.—Flower and fruit of the Olive, showing a definite or cymose panicle (see p. 113).

Leaves in whose axils flower-buds instead of leaf-buds arise, are termed **bracts**. They are generally smaller than leaves, but sometimes much larger and more showy than the flowers, as in *Protea*, *Poinsettia*, and *Hæmanthus*. When several bracts surround a head of flowers, as in *Protea*, the Barberton Daisy, and others of their tribe, they form an **involucre**.

When a bract is large and sheaths the flower, as in Arum,

it is called a **spathe.** Bracts which enclose the flowers of grasses and sedges are called **pales** and **glumes.**

In *Satyrium* the bracts be-

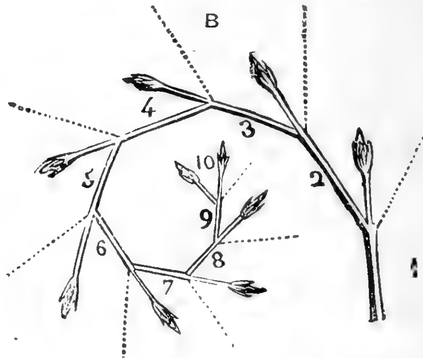


FIG. 128.—A, Cymose inflorescence of *Myosotis;* B, diagrammatic representation of the order of development of the flowers in the scorpioid cyme. (From Thomé and Bennett's "Structural and Physiological Botany.")

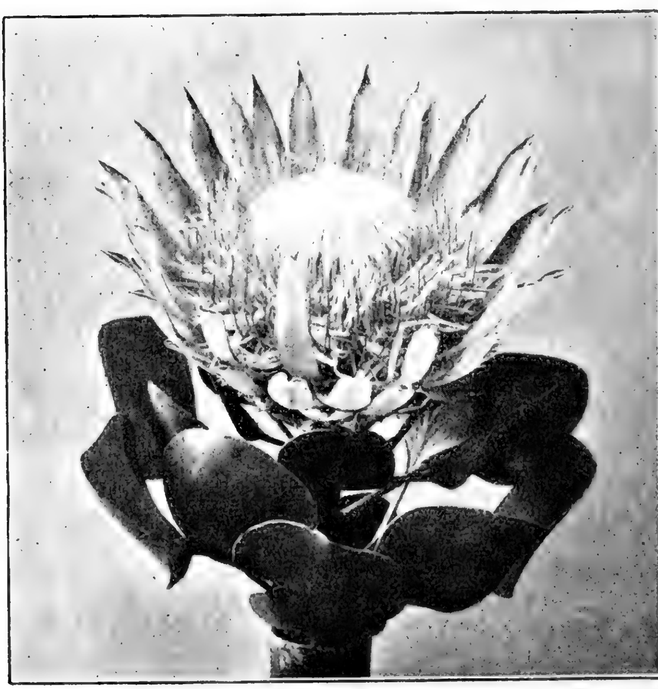


FIG. 129.—*Capitulum*, or head of *Protea*, surrounded by bracts forming an involucre.

come more and more like the foliage leaves further down on the stem. Bracts are modified leaves. Are all flowers subtended by bracts?

Relation of Flower Parts.—Just as bracts merge into leaves, so the sepals may become quite leaf-like, and there are green roses and dahlias in which the petals have taken on the appearance of leaves. Usually stamens and pistils look very unlike leaves, but here the garden flowers come in as teachers.

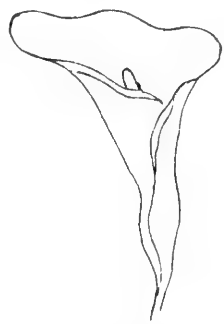


FIG. 130.—Spathe of *Richardia Africana* surrounding spadix.

A canna flower is interesting. Above the ovary are three small sepals; then three narrow-pointed petals. The showy part comes next, and on one of them an anther locule is formed; the other locule is replaced by a petal-like part. It must be a stamen. It is the only one which bears an anther, but from the position of the others we call them sterile stamens, or **staminodia**.

Water-lilies and garden flowers which double show all gradations of stamens that have become transformed into petals.

The pistil at the very centre of the flower has been so protected and has its one special work to perform, the bearing

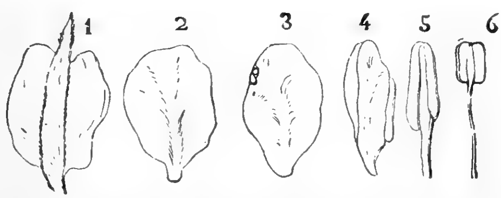


FIG. 131.—Stages of transition between the petals and stamens of *Rosa centifolia*. (From Thomé and Bennett's "Structural and Physiological Botany.")

of seeds, that it is seldom altered so as to make evident its kinship to the leaves. The carpels of *Sterculia* appear like five leaves with petioles. Before they are ripe they spread open, and the seeds ripen along their edges. In the "Christmas rose," leaves and leaflets take the place of ovaries and ovules. The centre of the flower is a mass of crumpled leaves.

In Fig. 132 the centre of the rose has lengthened and become a leafy branch. So the garden flowers show us that the essential part of the flower and the leaves have been derived

Fig. 132.—The centre of the rose has grown out into a leafy branch.

from similar sources. As plants come to be propagated by other means than seeds, the seeds and seed vessels turn their energies toward the work of foliage leaves to supply more food to the plant.

CHAPTER XV

POLLINATION AND FERTILIZATION

THROUGHOUT the Colony a bush two or three feet high with smooth linear leaves grows on dry hillsides. The whole plant

I. II.

FIG. 133.—*Montinia acris*. I. Branch tipped by an ovary. II. Branch bearing staminate flowers.

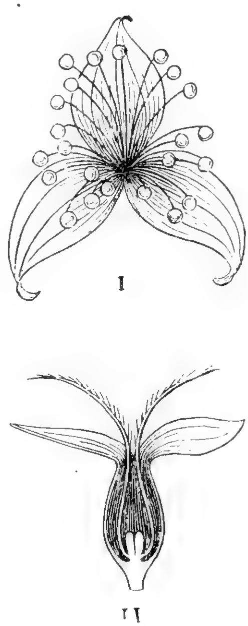


FIG. 134.—*Cliffortia rusci-folia*, L., with one staminate flower. II. Section through female flower. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

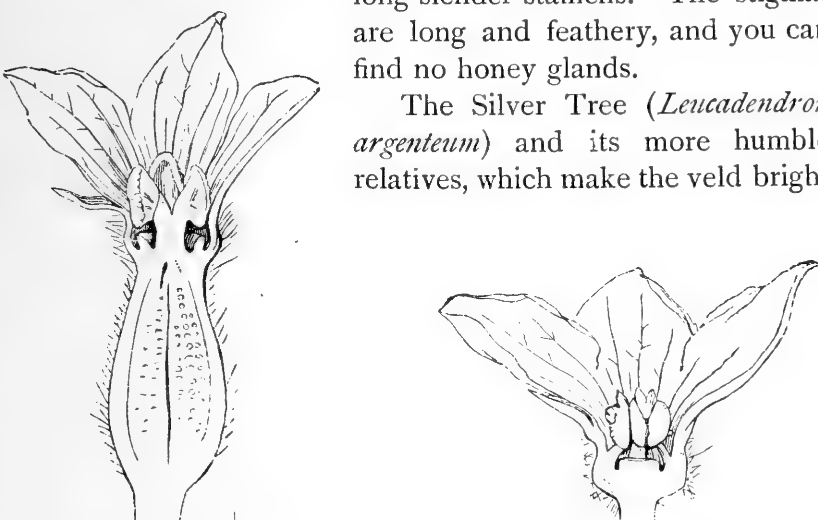
has a sharp taste, from which it gets its last name. The flowers of this bush, *Montinia acris*, are not so very pretty, but the dry rattle of last year's pods bids us examine the flowers of this season. We find a small white flower with four petals terminating a branch. The calyx is small, even in the bud hardly covering the flower. The large ovary below is sur-

FIG. 135.—Melon. Flowering branch, with male and female flower. (From Henslow's "South African Flowering Plants.")

mounted by a four-angled honey gland and two short stigmas. Opposite the sepals are four small bodies that look like the unfulfilled promise of stamens. What is the flower to do without pollen?

A little further on we come to another similar bush, but the flowers are borne in cymose corymbs. Below the flower is no sign of an ovary, but between the petals are four perfect stamens. Here is indeed a division of labour! You will seldom find one bush without coming to another close by.

Cliffortia is another common bush often with sharp-pointed leaves. It has two kinds of flowers. Look for the staminate flowers in the direction of the prevailing winds. You may have to go far afield before finding them. They have long slender stamens. The stigmas are long and feathery, and you can find no honey glands.



I II

FIG. 136.—Melon. I. Pistillate. II. Staminate flower. (From Henslow's "South African Flowering Plants.")

The Silver Tree (*Leucadendron argenteum*) and its more humble relatives, which make the veld bright in spring with their pale yellow leaves and bracts, have also their flowers of two kinds on separate trees or shrubs. Sometimes the different species grow so sociably that it is difficult to decide which pistillate and staminate flowers grow together, as is true of the *Restiaceæ*.

The Pumpkin family has large yellow flowers. Some of them open for a day and their glory is departed. They contain stamens. Hidden sometimes beneath the foliage are flowers, with large ovaries below, which were wanting in the other flowers; these give promise of becoming pumpkins, or Kafir water-melons or calabases, according to the plant.

FIG. 137.—*Zea mais* is monœcious, *i.e.* the staminate and pistillate flowers are on the same plant. The staminate flowers form the tassel at the top, the pistillate form the "ears."

Are the two kinds of flowers on the same or on different plants? Do they open again after closing? What time of day do they open?

Zea mais, or Indian corn, is shown in Fig. 137. At the top of the stalk the tassel is composed of staminate flowers. Two flowers are in each cluster protected by two glumes each. When ripe, the long slender filaments hang out and dangle their anthers in the wind. Where large fields of Indian corn are growing the air is heavy with pollen which they shed. Look as hard as you may, you will find no pistil in these flowers. Pistils produce the seed, and we do not look for seed in the tassels. Down below, if all goes well, seeds will ripen in the "ears." Notice the long silks at the top of the ears. Turn back the large bracts (husks), and trace some of the silks to the kernel of grain. Each grain is an ovary containing a single seed, and partly enclosed by two bracts.

The silk is the long style, the upper portion of which is stigmatic.

Examine Kaffir corn. Where are stamens and grains borne?

The white spathe of *Richardia* ("Arum") surrounds a central column, on the lower part of which ovaries are borne. The upper portion is not ripe until a few days after the stigmas are. It consists of stamens closely crowded, which will in time discharge quantities of white pollen. The spathe or bract

FIG. 138.—Spadix of *Richardia Africana* with one half of spathe. The pistillate flowers are below, the staminate flowers above. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

surrounds a spadix of flowers, the pistillate at the bottom and staminate at the top.

These are only a few examples of imperfect or **diclinous** flowers. Why should stamens and pistils be separated in different flowers? Often on different plants?

We are beginning to feel sufficiently acquainted with flowers to ask for confidences not revealed to chance acquaintances. If we find a new acquaintance on the veld, let us know all we can about it before it is pressed. Some of them have not wholly revealed themselves until they are past pressing.

The pleasure in knowing a flower's structure and plan is increased when we learn the meaning of the endless variety of forms and markings from patient watching or from reading what others found. Long after flowers had been studied and their parts described the use of pollen remained a mystery. At last, in 1682, an English botanist, Nehemiah Grew, discovered that before seeds were produced pollen must be transferred to the stigma. No one believed him, nor did he know just why it was so. Fifty years later Linnæus, the Swedish botanist, said it was true, and then people began to think it must be so. It is hard to believe what we do not understand. Even the great Linnæus had not found out all, and it was thought that pollen was necessary for the ovules of the same flower; since, in the *Roella* family, for instance, the pollen from the anthers is all caught upon the bristles along the style of the same flower. But even here the pollen has been brushed off before the clapper-like stigmas have split open at the end and exposed the part which receives the pollen if it is to be of service to that flower. One man declared even that when a pollen grain had been caught on a bristle it drew back and pulled the pollen grain into the style. It does not, but when we have wrong ideas they make us think a great many things are true that are not. He thought he saw what he was so sure must happen.

Another fifty years went by. People were carefully and patiently watching, and the truth is bound to be known when people are eager to know it. A German botanist, Sprengel, found that in most flowers the pollen cannot reach the stigma of its own flower, even if it is caught on the style, unless it reaches the tip or sensitive part of the stigma. What he saw puzzled him and others, until Darwin, seventy years later, showed that nearly all flowers are so constructed that they receive pollen from another flower, and so ovules are usually cross fertilized.

When pollen has been transferred from the stamens to a pistil, the pistil has been **pollinated.** But that is not all, for to enable the ovule to become a seed, or to form an embryo within it, the pollen grain has to send out a little tube which carries a most marvellous little body called a **nucleus.** Within the ovule there is another similar nucleus with which the first must meet and unite. When this has been effected the ovule has been **fertilized.** You do not understand how it is done? Neither does any one else yet, but it can all be seen and drawn by using a microscope, which you all may do some day.

It takes some time after pollination for fertilization to take place. It may be completed within a few hours. In the Arum it takes several days for the pollen tube to reach the ovule nucleus with its own, though the distance is so short. In pines the tube grows about half the length one year; then it rests over winter and makes the rest of the journey the following year, so that it takes a pine cone two years to ripen.

There are thousands of devices used by flowers to prevent pollen from coming in contact with the stigmas of the same flower, to attract insects, and to ensure the pollen's delivery to its proper destination—another flower of the same species.

In early spring, Nature carpets the veld with *Oxalis.* Large centre-pieces of brightest yellow are bordered with pink and buff and white. The brighter the sun, the brighter will be the carpet. Upon first sight the flowers appear to have fifteen stamens. A second look will show five greener than the others, tipped with round cushions that look as though they were stuck full of pins. The cushions are stigmas. In some flowers they stand higher than the stamens, in others shorter. Examine a handful until you find some stigmas standing between the two lengths of stamens.

The *Oxalis* has a meaning when we know that bees which visit it have long tongues, which are neatly rolled up when not in use. When a flower is visited, the tongue is uncoiled and thrust down the flower after honey. If the bee has just visited a flower with long and short stamens, there will be tell-tale marks on

FIG. 139.—Diagram of bee's tongue after visiting *Oxalis* with long and short stamens.

its tongue, as shown in Fig. 139. When it visits another flower with long stigmas the pollen will be brushed off on the upper part of the tongue, and short stigmas of a flower will brush it off below.

In *Gazania* and *Cryptostemma* the stamens are joined by their anthers (**syngenesious**), making a collar around the stigma. Watch the flowers of the disc in the centre. The outer flowers of the disc open before the inner ones on successive days. On a bright morning the long club-shaped stigmas push up through the collar, well covered with pollen. On the

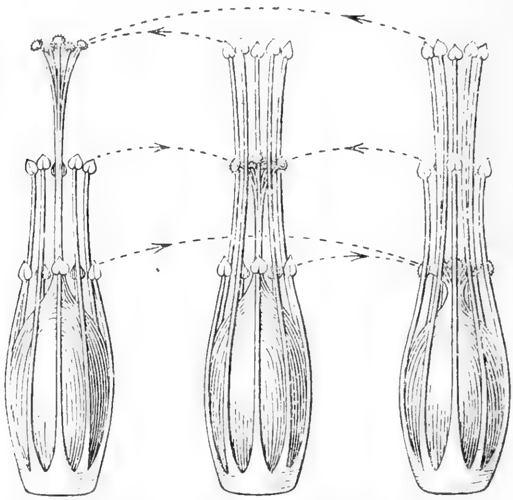


FIG. 140.—Trimorphic flowers of *Oxalis cernua*. The arrows indicate the legitimate combinations. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

following day the elastic style has shortened, the five teeth made by points of the stamens brush off the pollen and leave it in little rings in each flower. These stigmas now open at the top to receive pollen, while closed stigmas of an inner whorl brush out rings of pollen from their flowers. When they in turn are ready to receive they split down the centre and spread apart. The fruits formed in these flowers give evidence that the insects have unconsciously brushed off the pollen from the stamens and delivered it to the stigmas.

Senecios, on the other hand, spread apart the stigmas in the disc flowers. They have a little brush just at the tip. They can curl back far enough to help themselves from neighbouring flowers, and even from the pollen that has adhered to their own stigmas if no insect pays them a visit.

Take any of the Indigoferas. They are usually creeping plants with blue or purplish flowers, belonging to the pea family.

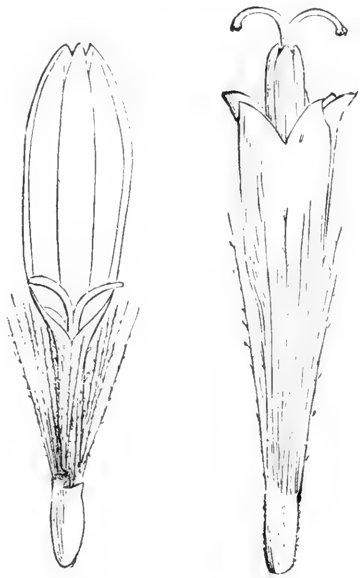


FIG. 141.—The disc flowers of Senecio have stigmas that can coil back and help themselves to pollen. The ray flowers (I.) have no stamens. (From Thomé and Bennett's "Structural and Physiological Botany.")

Botanists state in a matter-of-fact way that the keel, or two boat-shaped petals in front, is provided with a spur or prominence at each side near the base. The bees have never had their attention called to this, and are unaware that these prominences are hidden springs, and that this keel contains concealed and loaded weapons. The unsuspecting bee poises on the two side petals invitingly offering a resting-place, when, presto! the springs are set off, the side petals spread apart; the keel drops, releasing the stamens charged with powder, and up they fly. The range is just right, and the bee is well dusted for the next flower which has its pistil ready to receive it.

Every one who lives in the Eastern Province knows what is meant by "lighting matches." The "matches" of *Loranthus oleæfolius* are borne in umbels of three to five flowers, bright red at base, and orange in the upper portion with green tips. The plant, which is parasitic on Acacia trees, pays for its support by brilliantly illuminating the tree at Christmas time with its flowers. When ready for lighting, the tips which hold the ends of the stamens become black. When this sensitive point is struck by birds, back fly the petals, and the pollen is thrown some distance as the stamens are freed from confinement. In Natal another species (*L. natalitius*), which the children know as "lighted candles," has waxy white flowers tipped with

FIG. 142.—*Loranthus oleæfolius*. The sensitive tips of the corolla fly back and scatter the pollen as the stamens are released.

yellow. The sugar bird sets free the arched style of *Protea*, which scatters the pollen before the stigma is ripe.

When other flowers are closed for the season, the blue sage (*Salvia*) may be depended upon to offer refreshments to visiting bees. Down by the four-parted ovary there is a little yellow gland where honey is made. At the entrance of the flower a "rocking chair" is invitingly placed, made of the two swinging stamens. One pollen chamber of each stamen has been sacrificed to make the "seat" of the chair. As soon as the bee touches this, the upper locules bend down and dust the bee's back with pollen just along its hairy belt. The bee then passes on to other sage blossoms. In some of these, stigmas which are ready to be pollinated arch down far enough to be dusted with the precious load.

Holes cut in the tubes of flowers are evidence that a robbery has been committed. The flower has been broken into and

FIG. 143.—*Salvia.* I. Corolla, the hood removed. II. Ditto with bee. (From Henslow's "South African Flowering Plants.")

pilfered of its honey without the insect performing any assistance in conveying pollen. You can watch bumble-bees bite holes in flowers which have tubes too long and narrow for the bee to enter. Darwin tells us that honey-bees, which usually pay down for each meal, are not above using the holes made by bumble-bees the previous day.

Once a beautiful red lily grew in a conservatory beside a white one. Bees seldom find their way into a greenhouse, and so the plants seldom set seed. But the gardener carefully removed the pollen from the red lily and placed it on the stigma of the white one. In due time seeds were formed. When they were planted and a flower came they were white beautifully marked with red.

Try the same experiment in your garden, but be careful, before the buds are open and until after the seeds "set," to keep the flowers covered with gauze to keep out insects, or else they will come and manage affairs their own way.

NOTE.—To know what orchids mean by masquerading as they do, Darwin's book on "The Fertilization of Orchids" should be read. The beautifully illustrated books of Dr. Bolus on South African orchids will help you to understand the flowers.

Orchids have gone to such an expense in making their perianth attractive to insects, and in filling their long cornucopias with honey, that they make up arrears by economizing in pollen.

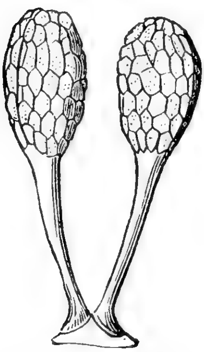


FIG. 144.—Pollinia of an Orchid, with their pedicels united by the rostellum. (From Thomé and Bennett's "Structural and Physiological Botany.")

However nicely flowers are adapted for scattering their pollen as dust, some of it is sure to be wasted. The pollen of the orchid is bound up in neat parcels (**Pollinia**), each provided with a gummed label attached to an elastic cord, or the two parcels may be attached to one label. At meal times butterflies or moths collect these parcels, which become firmly gummed on to some part of their bodies, and as they go from flower to flower they deliver directly to the stigmas some of the quickening grains. You can see how it is done by applying a pencil point to the two white labels at the entrance of a *Satyrium* or a *Disa* flower.

The moth or butterfly sometimes gets so many of these parcels on to various parts of its body as to seriously inconvenience it. Sometimes their tongues become so covered that they starve to death. Professor Gray illustrates a moth flying with a pollen mass on each eye. Fortunately each eye is made up of hundreds of smaller ones, so the moth has enough left to guide him to another flower.

Microloma, *Secamone* (Bavian's touw), *Asclepias* (the milk bush), which is so plentiful on the Karroo, and all their family have their pollen in masses also. One of this family cultivated in gardens is known as the Fly-catcher. Toward evening all kinds of moths are caught by their feet between the edges of two stamens just where two parcels are joined together by a black gland. Most of the prisoners have a short sentence, as will be found by looking for them the next morning. One beautiful moth imprisoned overnight was seen to escape next day, but it carried a pollinium with it, as it escaped with a jerk, from the little slot where the gland is situated.

Flowers are not at home to all visitors. The sticky juice covering the upper portion of the stems of heaths and of other flowers prevents ants from scaling the heights to rob the honey within the flower. Flowers are often closed when unwelcome guests are flying about. The opening and closing of flowers at certain times of the day led Linnæus to arrange a floral clock, but the movements of flowers, like those of leaves, are regulated by varying conditions of temperature and sunshine, so it would not do to depend upon such a timepiece for getting to school on time.

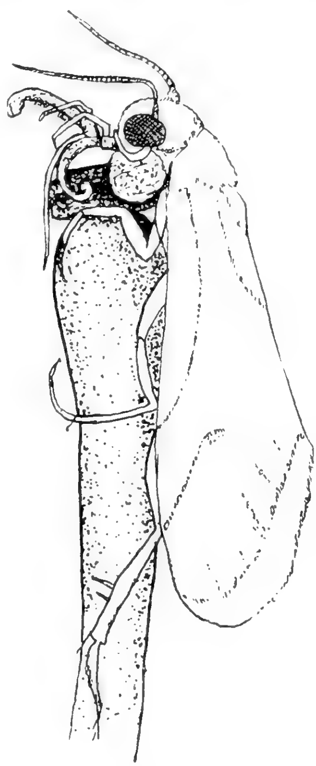


FIG. 145. — The Pronuba moth gathering pollen from the stamen of Yucca to carry to the stigma. (From the "Popular Science Monthly.")

When moths and beetles are flying about our lamps, have you ever wondered what they are about so late at night? It will be worth while to visit flowers with a lantern to find out.

The story of the Yucca and its moth has been often told since it was found out in 1890,[1] but it is so interesting that it will bear repeating. The Yucca, which bears its majestic panicles in many of our gardens from November till January, has come from Mexico. The flowers are scentless during the

[1] C. V. Riley, Missouri Experiment Station Report, 1891.

day, but give forth their fragrance, as do so many of our flowers, only to attract night visitors. Have you ever seen the seeds after flowering? For seven years the flowers of one plant have been watched, and seven times they have withered and fallen off, for Nature retains no useless burdens. The moth which can aid in quickening the seeds has been left behind in Mexico. There in the daytime it rests, hidden in the half-closed flowers, matching them so nearly in colour with the front wings that it is difficult to detect. Like other night flowers, they are white, so that they can be seen from a distance. At night the flowers expand like large six-pointed stars, and the mother moth begins her rounds. First she goes from one stamen to another, until she has obtained a ball of pollen nearly as large as her head, which is held by her front legs against her body. She is not intent on nectar, nor does she gather pollen as bees do for making bee-bread. Why, then, does she carry her precious load? She now lays her eggs in a pistil. They pass from her body through a long tube furnished with a saw. With this she pierces the ovary and deftly places an egg just beside a tiny ovule. When the eggs hatch out, the little larvæ have the growing seeds for food. Now we know that the ovules will not develop into seeds unless they receive the power from the pollen. It looks as though the moth knew this long before we did, for when she lays an egg up she runs with her ball of pollen, thrusts it into the cleft stigma, and works her head up and down vigorously to ensure that some pollen has been driven home; then she runs back, lays another egg, and repeats the operation.

One year a Yucca in a neighbouring garden surprised us by bearing fruit. The fruits did not show the spots which result from the injury when the eggs are placed, and no larvæ were found among the seeds. Had our own large grey moths performed the service? This year a few bees were seen among the other Yucca flowers, but hopes for fruit were in vain, for the bare withered stalks a few weeks later told that once more the flowers exiled from home had wasted their sweetness.

The scarlet bells of *Antholyza revoluta* are often found in fields of corn. Their long curved tubes are narrowed at the base and suddenly enlarge about the middle, where honey is made which fills the lower part of the tube. The stamen attached to the front sepal is arched backward and brought into line with the two at the back, which by a twist of the filaments turn the anthers so that they all discharge their pollen toward the centre of the flower. In the younger flowers at the top of the stalk the stamens ready to discharge their pollen

FIG. 146.—*Antholyza revoluta.*

hang forward below the style, whose three branches are closed like the pages of a book. In the older flowers below, the anthers which have discharged their pollen are drawn back by the drying of their filaments. The lobes of the stigma are unfolded and hang down below the stamens. An insect in search of honey sips and flies away, unconscious of the dust on its back, or that this dust is brushed off on to the stigmas of other flowers. When a stigma is well dusted the perianth withers and closes to prevent the pollen from getting brushed off. This is a sign that the honey season is over, and no more insects need apply.

Antholyza has no noticeable markings on the brilliant coloured perianth, as irregular flowers usually have, to advertise their sweets. The upper petals are transparent, and the light shining through brings into prominence the veining which may indicate the way to refreshments. A transparency is of little value unless a light shines through it. Flowers that open in a shaded room have a much lighter colour. The pigment that gives the flowers their brilliancy is often concentrated in bright patches on the three lower parts of the perianth, where irregular flowers of this order are usually marked.

Why are the flowers all turned in the same direction on the stem? If they turn toward the light the transparency would lose its effect. Do you find them turned toward the light or away from it? At which end of the flower-stalk does the visiting insect begin when in quest of honey? Do different insects have the same habit? Maybe you can already answer some of the questions. If you cannot, it will pay you to watch with us.

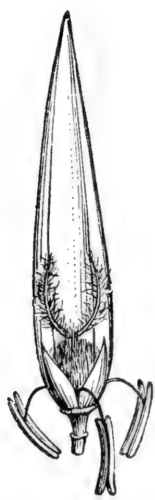


FIG. 147.—The swinging anthers of grasses scatter their pollen in the wind, which the feathery stigma catches. (From Thomé and Bennett's "Structural and Physiological Botany.")

Although so many flowers are designed to attract insects, some flowers are self-fertilized. The violet has inconspicuous flowers late in the season. They never open, and so have to be self-fertilized. Some species of *Oxalis* and *Stapelia* also have closed flowers after the others have withered. In early times such extravagance as brilliant colour, honey, and choice perfume were not indulged in by plants when the wind was the only method of transporting pollen. An abundance of pollen had to be provided in those days, as the wind is a wasteful messenger. The conifers doubtless shed their pollen to the breeze before the hum of flies and bees had been heard.

Grasses have kept the old-time habit. Their long filaments hang out the swinging anthers to the breeze and the feathery stigmas catch the pollen as it passes. Willows, poplars, and oaks have a very ancient history. Their flowers are not showy. Do you find bees visiting them? Does a bee pass from the catkins of an oak to the acorns, or is it simply in quest of pollen? From what flowers is honey made in your district? Do butterflies have their favourite colours? Do you know any regular flowers with guiding lines on their petals? Recall *Montinia* and *Cliffortia*. Are they pollinated by the same agency?

Since so much has been learned about flowers and their insect guests, it has been asked whether flowers were designed to attract insects or whether insects, by visiting flowers, have given them their markings where they have come in contact with them, and made them irregular by always lighting on the same spot. We can tell what was in the past only by thinking about what we see now. At least, we feel sure, from fossil plants and insects, that there were no showy flowers until bees and butterflies had been created to gather honey.

Dr. Kolbe was one morning the uninvited guest at a sugar-bird's breakfast. We will "let him tell in his own words" his thoughts on that occasion.

The Gladiolus and the Sugar-bird.

Some time ago I was reading "The Making of Flowers," by the Rev. Prof. G. Henslow ("Romance of Science Series," S.P.C.K.), in which he explains the forms and markings of flowers as a result of plant responsiveness to the mechanical stimulus of insects in search of honey. The theory was particularly attractive to me: it seemed to explain so much. Thus thinking, I noted one day how a lot of *Gladioli* in a garden had deep markings *at the back*, just where the perianth lobes begin to separate, but where they still overlap one another. No insect, I said, would be such a fool as to go prodding at the back when so wide a front door was provided. I had plenty of time to theorize. It was holiday time in a region where our next-door neighbours were over the hill two miles away. So I sat on the stoep and lazily condemned Prof. Henslow's theory. A single fact, I severely reminded my reluctant fancy, was enough to upset any hypothesis. While I sat, mentally active but bodily motionless, there flashed quite close to me one of those animated streaks of God's brightest colours that we call sugar-birds—as brilliant as America's intensest humming-bird, only more of it. I was delighted, for my nearness of sight prevents much acquaintance with wild birds. This little thing evidently took me to be part of the stoep furniture, and by absolute stillness I encouraged the delusion. From his coign of vantage he made a brief survey of the garden, with a determination of breakfast written on every feather of him. But breakfast on what? In the West, Nature supplies them abundantly with Proteas, but of this order I think there is only a little *Leucospermum* growing in the Transkei. What was it to be? Honeysuckle, or *Tecoma capensis?* *Habemus utrumque* as Horace said of certain human nectars. Birdie did not leave me long in doubt. Down he swooped on the spikes of *Gladiolus*—there were some twenty of them—and he sampled every open flower on every spike. And he attacked them at the back, clinging to the column of the spike and working his way downwards from side to side so as to miss nothing. His curved beak entered the flower just where the lobes part and scraped down the tube till it found the honey. Now, if you look at the inside of the *Gladiolus*, you will find that the purple mark goes all the way down the path of the beak; and in some of the flowers this purple path is not visible from without, but only the spot at the lobe-parting. How about the theory now? Shall we say the flower spontaneously advertises in front for insects and at the back for birds? Or did it just blush at being so tickled?

Nay, more, why are all the blooms on only one side of that spike? Don't tell me they want to face the light. In my garden they face to all points of the compass. Can it be that, just as the weight of insects enlarges the lip of *Labiatæ* and *Acanthaceæ*, so the push of the sugar-bird has driven all the flowers to one side and left the gay robber a clear vertical perch?

My little friend took a considerable time over his breakfast. You can't conscientiously rob a hundred flowers of all their honey on both sides just in a couple of minutes. But I was so grateful to him for enlarging my knowledge and for bringing his loveliness so near to my eyes, that by no movement did I spoil his meal with any nervous tremor. If he had known how I wanted to stretch my limbs in the middle of it, he would have been grateful too.

CHAPTER XVI

FRUITS

IF a flower has been fertilized, changes will take place in the ovule and other parts of the plant, and fruit will be formed. Sometimes, after wind and insects have done their share in pollination, a prolonged rain will wash off the pollen before fertilization has taken place. In that case the flowers are of no more use. They are quickly cut off by a layer of cork, and fall to the ground. If a hard storm comes when apricots are flowering, "it will be a poor year for fruit," the farmers say. But, as compensation, a few flowers which were protected will form fine large fruit. The storm may be fortunate, as it gives the trees a rest. It is exhaustive work to form fruit. Food must be made for the embryo which begins to grow, and the seed-coats must be strengthened. Sometimes a third coat, called an **arillus**, is formed after fertilization. When the ovule is ripe it is called a **seed**.

In the second place, the ovary undergoes changes, which aid the seed-coats in protecting the embryos, but their chief use is to scatter the seed. We speak of the ripened ovary as the **fruit**. The ripening ovules derive their nourishment from the mother plant through their attachment to the ovary.

Some fruits are dry and hard; others are juicy. A dry fruit is frequently miscalled a seed. On the other hand, any part of the plant that is good to eat is apt to be called a fruit, even to a potato! Have you ever seen the fruit of potato?

A. FRUITS FORMED FROM A SINGLE FLOWER.—*Osteospermum* forms a circle of seed-like fruits. Each one contains a hard white shining seed. The fruit is borne below the flower and is indehiscent; that is, it does not open to let out the seed. The fruit of the **Composite** family, to which *Osteosperm* belongs, all have their fruit formed in this way, although, instead of being smooth and shining, it may be woolly or differently marked.

A dry one-seeded inferior fruit is called a **Cypsella.**

Protea and *Clematis* have also dry indehiscent fruits. The styles of the ovaries remain on the ripe fruit, and the enclosed seed is attached at one place, the **placenta.** *A Protea* flower has but one ovary, but Clematis has a cluster or an **etærio** of fruits. In these flowers the ovary is borne above the perianth.

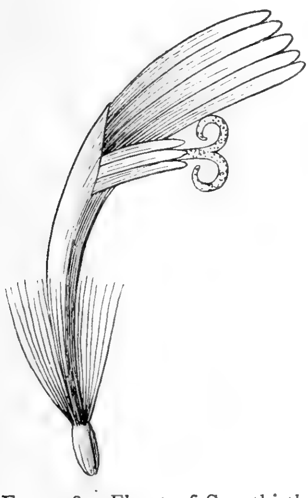


FIG. 148.—Floret of Sow-thistle. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

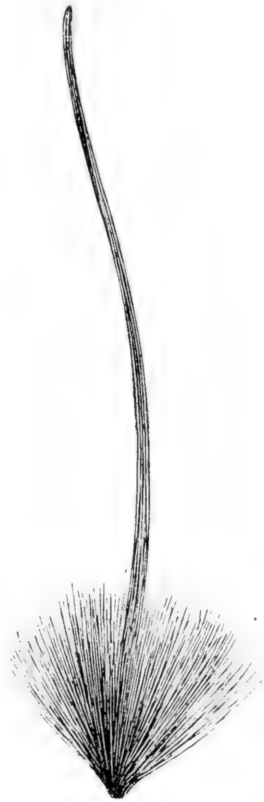


FIG. 149.—Tailed achene of *Protea mellifera.* (From Edmonds and Marloth's "Elementary Botany for South Africa.")

A dry superior one-seeded fruit is an **achene.**

In the strawberry the receptacle which bears the achenes is convex and fleshy; in the rose it is hollow, and conceals the hairy ovaries.

Tripteris, Triaspis, and *Portulacaria* (*Spekboom*) have winged fruits.

A winged fruit is a **samara.**

In the fruit of the grasses the ovary wall and the seed-coat become attached to each other. On the grain of Indian corn a little point on one side indicates the place where the style, the silk, was borne.

A dry one-seeded fruit in which the ovary wall and seed-coat are attached is called a **caryopsis.**

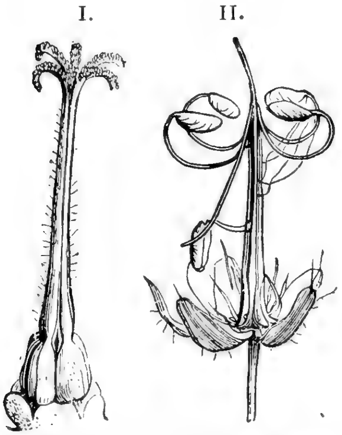


Fig. 150.—Quinquepartite schizocarp of *Geranium Robertianum.* I. The immature pistil. II. The mature fruit. (From Thomé and Bennett's "Structural and Physiological Botany.")

A dry fruit which splits into several portions each containing a seed is a **schizocarp.** Some of the *Malvaceæ* have this fruit. It is found in the fruit of the Geranium family, the *Euphorbias*, the *Umbelliferæ*, *Labiatæ*, and others.

If a fruit contains many seeds it must open or dehisce to let the seeds escape, or there would be trouble when the seeds began growing. Such fruits are called **pods** or **capsules.** The bean, Port Jackson, and *Erythrina* has a pod which has only one

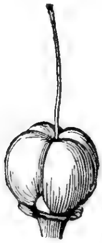


Fig. 151.—A schizocarp consisting of four nucules.

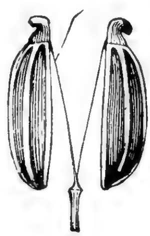


Fig. 152.—Fruit of the Fennel: *a*, carpophore.

Fig. 153.—Multiparlite schizocarp of Malva.

(From Thomé and Bennett's "Structural and Physiological Botany.")

carpel, and which splits along both edges. It is called a **legume.**

Asclepias (wild cotton plant) and *Crassula* have similarly formed fruits which split on one side only. Such a fruit is a **follicle.**

The siliqua and silicula are found in the Cruciferæ or mustard family. They are made of two carpels joined by their edges where the seeds are borne. A partition, or **replum**, grows up from below and divides the fruit into two chambers. When ripe the two carpels split apart from the bottom upward,

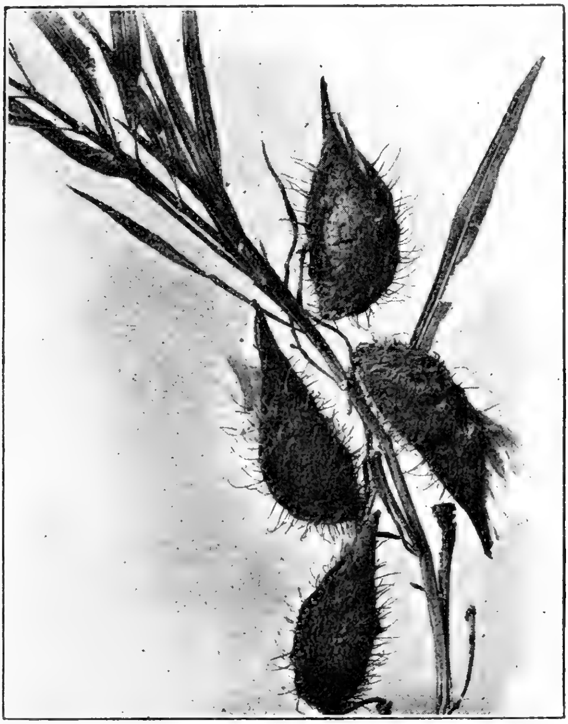
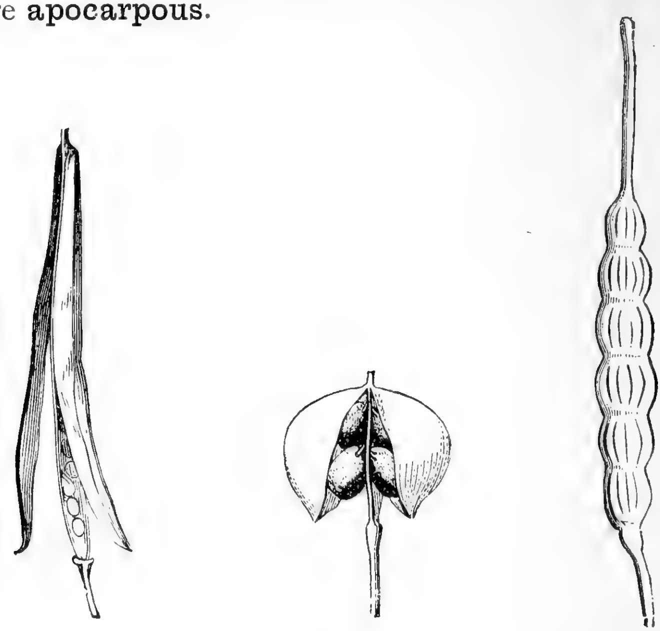


FIG. 154.—Follicles of *Asclepias*.

leaving their edges with the seeds surrounding the replum. If the fruit is several times longer than broad it is a **siliqua**; if it is about as long as broad it is a **silicula**. In some of the Heliophilas the siliquas are prettily constricted so that they look like a string of beads. If the fruit splits across at each narrow place, as it does in some fruits of this family and in *Hedysarum* of the bean family, it is called a **lomentum**.

Some fruits have more than one chamber when made of several carpels that have grown together. They are then said to be **syncarpous**. If carpels are separate from each other they are **apocarpous**.



I. II. III.

FIG. 155.—I. Wallflower (*Cheiranthus Cheiri*). Siliqua. II. Silicula of *Cochlearia* open and showing the seeds attached to the replum. III. Lomentum of *Raphanus*. (From Thomé and Bennett's "Structural and Physiological Botany.")

Dehiscence takes place in various ways. The ovaries of Albuca hang downward in flower where the stigmas are pro-

I. II. III.

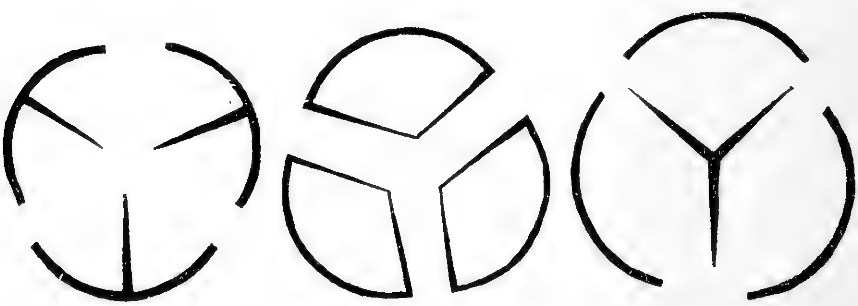


FIG. 156.—I. Diagram of a loculicidal capsule. II. Diagram of a septicidal capsule. III. Diagram of a septifragal capsule. (From Thomé and Bennett's "Structural and Physiological Botany.")

tected from rain. When the fruit ripens it straightens up and splits from the top down the centre of each carpel (**loculicidal**

dehiscence). When the wind blows through these slits the thin flat seeds blow out at the top. If the fruit did not stand erect the seeds would be in danger of falling in a heap beneath the plant. When the split occurs between the carpels the dehiscence is **septicidal.**

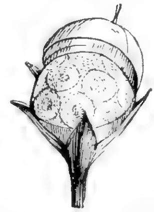


FIG. 157.—Capsule or pyxis of *Anagallis*, with circumscissile dehiscence. (From Thomé and Bennett's "Structural and Physiological Botany.")

The "Poor Man's Weather-glass" (*Anagallis*) and *Hypoxis* split around the centre of the ovary so that the upper half falls off. In *Wahlenbergia* a small triangular lid lifts up at the top of each carpel. *Mesembryanthemum* has a curious fruit. The capsule is below the flower, and has from five to twenty carpels. The seeds are borne near the base of the carpels on long cords or funicles. The flowers open in the sunshine. Do the fruits? Place some ripe fruits in a glass of water. In a few minutes the roofs of the chambers

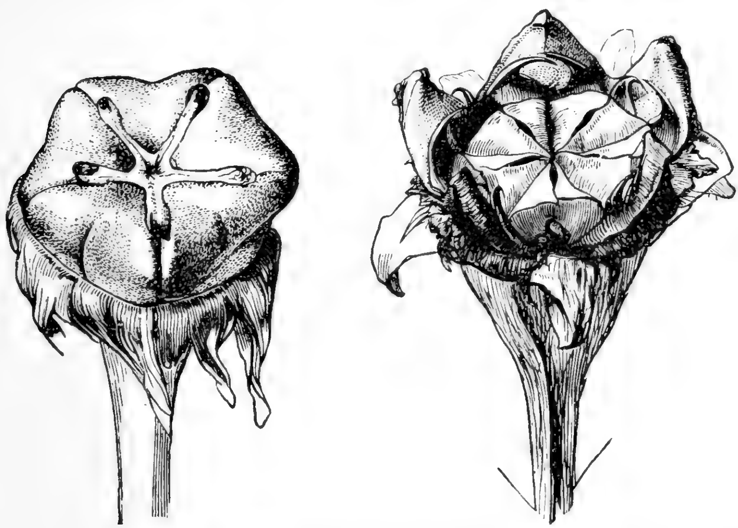


FIG. 158.—The fruit of *Mesembryanthemum* dehisce by triangular valves. (From Henslow's "South African Flowering Plants.")

will lift up and expose the seeds. Remove the fruits and watch them close as they dry. Try the same experiment with the fruits of *Wahlenbergia*. Do the fruits act in the same way? *Mesembryanthemum* thrives in the sun and the sand;

but the seeds are kept within the closed fruit until the rain comes, when they are released to germinate.

The apricot, grape, date, and water-melon are fleshy or

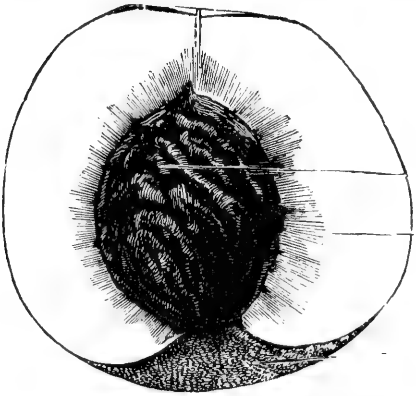


FIG. 159.—Longitudinal section through the unilocular drupe of the Peach. (From Thomé and Bennett's "Structural and Physiological Botany.")

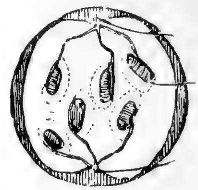


FIG. 160. — Transverse section through a Gooseberry; the firmer outer layer of the pericarp encloses the succulent flesh; the seeds lie embedded in the latter, and are attached by long funiculi to two opposite parietal placentæ. (From Thomé and Bennett's "Structural and Physiological Botany.")

succulent fruits. Since succulent fruits are formed in different ways, different names are given them. In these fruits the three parts of which the wall of the ovary is made is more easily distinguished than in dry ones. In the apricot the outer wall, or **epicap**, is the downy skin. The juicy middle layer is the **mesocarp**, and the inner layer, or **endocarp**, is the hard stone or pit which contains the seed. Such a fruit is a **drupe.** An almond is formed in the same way. Since the inner wall of the ovary is so hard, there is no need for the seed-coat to harden. Make out the parts of a date. A date is not a drupe.

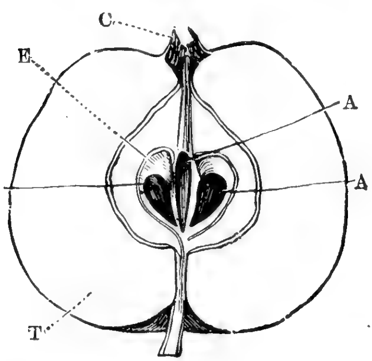


FIG. 161.—Longitudinal section through an Apple: C, dry persistent calyx limb; E, loculi with cartilaginous pericarp; T, mesocarp. (From Thomé and Bennett's "Structural and Physiological Botany.")

A berry is a fruit with a firm outer covering; the rest of the fruit is juicy. Did you ever look at a young orange? The inner walls of the fruit are covered with tiny hairs. These grow and fill the cavities as the fruit ripens. They make the juicy part of the fruit.

Botanists confess that they do not know how an apple is made. A young apple shows five carpels surrounded by a green cup. This cup grows and ripens with the ovaries. A rose hip has a fruit built on a similar plan, only there are more carpels. The cup may be the lower part of the calyx or the hollow receptacle; or the receptacle may line the calyx. What other fruits are like the apple? It is called a **pome**.

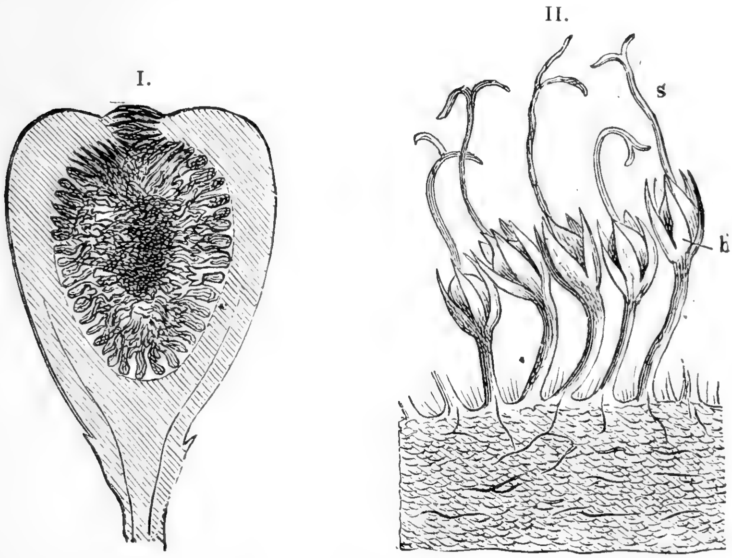


FIG. 162.—I. Longitudinal section through the hypanthodium of a fig, exposing the flowers in its interior; II. a piece greatly magnified, with five female flowers; *s*, pistil; *b*, perianth. (From Thomé and Bennett's "Structural and Physiological Botany.")

By our definition of a berry, a tomato, a kalabas, a grape, and an orange are berries, but a strawberry, a blackberry, and a mulberry are not. This seems like a study of plants "through a looking-glass."

The pomegranate has a two-storied fruit. If you cut across the fruit very low down you will find three chambers with seeds borne at the centre; higher up a cross section will show five or more chambers where the seeds are borne in the outer edge. When the fruit ripens the bright red calyx takes part in its formation.

B. Fruits formed from a Collection of Flowers.—All fruits thus far described have grown from the centre of a single flower. In the fig the hollowed receptacle bears within its cavity a great number of flowers. In some figs the flowers bear only ovaries; in others the staminate flowers are borne. It is the work of one very small insect to convey the pollen from one kind of fig to the stigmas in the other. The Agricultural Department is introducing the figs with staminate flowers (Caprifigs) into the country (1905). The little wasp is to be brought from California to carry on its special industry in South Africa. Figs will ripen without the wasp and the Caprifig, but they are not such fine fruit.

In the mulberry several female flowers grow in a head. The blackberry looks something like this fruit, but if the two fruits grow in your district you can see that the blackberry is formed from a single flower, and that the mulberry is a head of imperfect flowers.

The pineapple is a head of perfect flowers crowded together in a spike. The flowers, with their bracts and the central axis, become juicy. By cultivation the pineapple has lost its seeds.

CHAPTER XVII

THE SEED'S TRAVELLING OUTFIT

SEEDS are not only well supplied with food before beginning their independent life, but every care is taken to arm and equip them in such a way that they may travel far afield, if necessary, to find congenial soil. If they were to drop down under the plant and remain there they would have a hard struggle for existence in soil already exhausted.

The *Asclepias* and *Stapelia* family provides its seeds with a long tuft of silky hairs. The seeds are packed away in the ovary with a marvellous economy of space. When ready for their

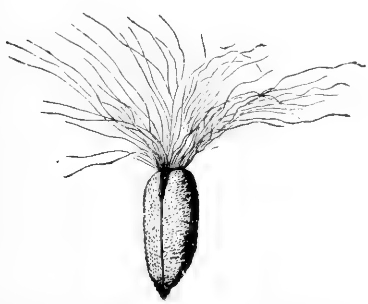


FIG. 163.—Ripe seed of *Epilobium*, with coronet of hairs (magnified). (From Thomé and Bennett's "Structural and Physiological Botany.")

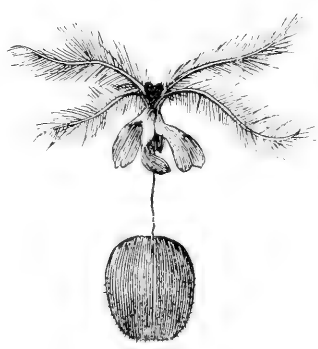


FIG. 164. — *Leucadendron argenteum.* Nut with persistent style and calyx, the latter split at its base and prevented from slipping off by the knobby stigma. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

journey the ripe pods split open, the tufts of hairs push out the seeds, and they go sailing, sometimes miles away.

Epilobium of the Evening Primrose family has seeds similarly provided.

The seeds of the South African Proteaceæ do not escape from the ovaries, which are variously fitted for aerial navigation. *Protea* ovaries have at the base long tufts of silky hairs which are caught by the wind. The seeds of the Silver Tree appropriate the whole perianth for a sail, which is prettily fringed along the edges. As the fruit enlarges the lower part of the perianth is split open and run up on the style for a mast, where the little knob of a stigma keeps it from slipping

FIG. 165.—*Urospermum*. The fruits travel in dry weather.

off. It must be that many a craft is wrecked, for, besides the trees on Table Mountain and Devil's Peak, few have found anchor. Some have found a haven beneath the shelter of Paarl Rock, and a few have grown on the mountains about Wellington.

Some species of *Leucodendron* have winged fruits. The Australian *Hackea* and *Grevillea* of this order have dehiscent fruits. The fruit of *Hackea* is hard and woody, and contains two seeds with broad membranous wings. The face of the seed which fits into the woody cavity is rough. The seeds are so weighted that they fall rough side down. Hold them under water and the rough side glistens with air that is held in the crevices. The projections help secure a foothold and carry air for the young plant's needs.

Many of the Compositæ fruits are scattered by a tuft of hairs. This is the calyx, and is known as **pappus**. (See Fig. 165.)

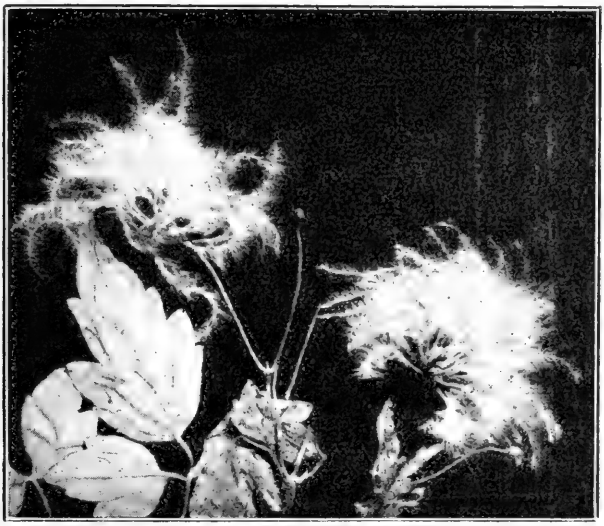


FIG. 166.—*Clematis* fruits with their feathery styles ready for a journey.

Clematis, or Traveller's Joy, seeks fresh fields by means of the long hairy styles, which bear the ovaries away. The fruits of *Pelargonium* are carried in a similar manner.

When a farmer sows his seed it falls any side down, but Nature is more careful in her ways. The long styles of *Protea*, the winged seeds of *Hackea*, the parachutes of the Milk Weeds and of *Urospermum*, so nicely balance the fruits that they come to rest with the radicle pointing downward. The styles of *Erodium* and other members of the Geranium family coil tightly and screw the seed into the ground. Breathe on these pretty fruits and see how the dampness causes them to uncoil. Watch them as they dry.

When walking through the veld, we come home with our clothing covered with "burrs." As we pick them off the seeds are scattered far from home. Take a little time before throwing them away to see by what ingenious methods they have attached themselves. The spirally twisted legumes of *Medicago* are furnished with a border of firm little grappling hooks. The two sharp-pointed awns of Bidens pierce our clothing, and the reflexed bristles prevent them from brushing off again. Fruits of Burr Weed (*Xanthium*) and Klis Grass (*Panicum verticillastre*) become very troublesome when the fruits become fastened into the wool of sheep or goats. Fig. 167 shows the "wool spiders" of the "Grappling Plant" (*Uncaria procumbens*).

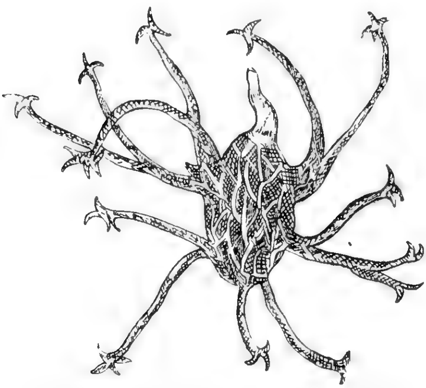


Fig. 167.—Seed of *Uncaria procumbens* ("Grapple plant" or "Wool spider.")

Seeds of orchids and *Streptocarpus* are so light that a breath of wind will blow them away.

The whole plant of *Brunsvigia* breaks off close to the ground, goes rolling over the veld, scattering the hard, smooth seeds as it tumbles along.

Many seeds are covered with an edible pulp, and so are scattered by birds or other animals.

One little species of Mistletoe (*Viscum minimum*) is independent of any outside aid. It grows as a parasite on *Euphorbia*. The stem is less than half an inch high, and bears three flowers. The large berries grow several times the length of the stem. When they are ripe, without falling from the stem, they each send out a long radicle which turns around and plants itself upon the same *Euphorbia*.

Some fruits explode and send their fruits forcibly away. A choice legume was ready to be mounted on a herbarium sheet; suddenly it exploded, twisted back, and all but one seed disappeared. *Euphorbia* fruits similarly set up quite a bombardment when they are ripe.

New plants sometimes enter a country in forage. Along railways we sometimes see flower faces that seem to have lost their way. The little white clover clinging close to the

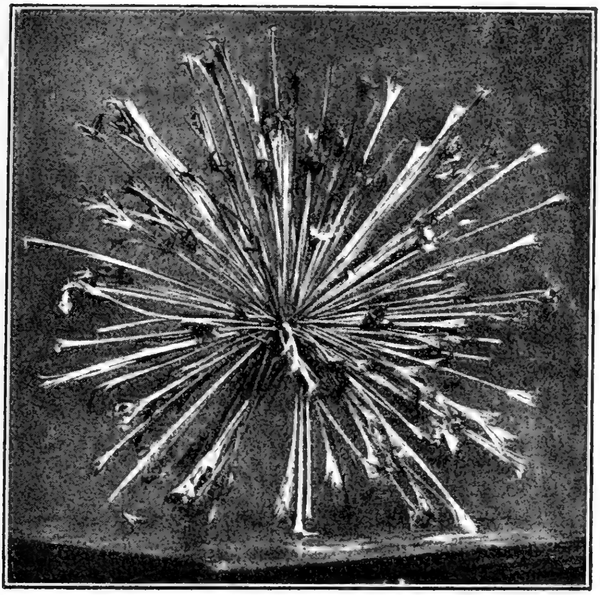


FIG. 168.—*Buphane* scatters ts seeds by breaking trom its moorings and rolling over the veld. (Photograph by L. Grant.)

sod by the grassy borders of sluits lifts up its head, and its delicate breath reaches us freighted with a message from home.

CHAPTER XVIII

KUKUMAKRANKA

"Did you ever hunt for Kukumakrankas? Here is one."

From a respectful distance it looked loaded, but the bearer disarmed me of suspicion.

"We do go hunting for them sometimes. You find them sticking out of the ground."

By this time information was coming from other sources.

Fig. 169.—Kukumakranka fruit.

"You keep them to enjoy their perfume." "You wear them in your hat." "Or press them in a book!"

The specimen shown was soft, light brown, and tapered at one end. It *was* loaded with seeds which showed through the thin covering, and was evidently the ovary of some plant.

"What kind of a flower has it?"

"It never flowers," replied a chorus of voices; "that is all there is of it."

Here was a puzzle. It was then in May, and since the seeds were quite ripe the flowers could probably not be found that season. Nor were they the next, nor the next. At last, at Stellenbosch, one Christmas holiday, my hostess brought in a flower—a beautiful, cream-white, six-pointed star, borne at the top of a long tube.

"That is surely a Kukumakranka," I exclaimed. "You have left part of it in the ground—the Kukumakranka—the part we hunt to wear in our hats and enjoy the scent, and press in books."

No time was lost in seeking out the place where it was found, and there, in the rich brown carpet under the pines, the stars were glowing in profusion. Several inches below the pine-needles a slender ovary was unearthed, concealed in the dry brown scale-leaves of a bulb, from which were extended some long, dried-up, brown remnants of last year's green leaves.

The flower had a long slender style, leading down through the tube to the ovary. It was crowned with a cushion-shaped

FIG. 170.—Flower of Gethyllis (Kukumakranka).

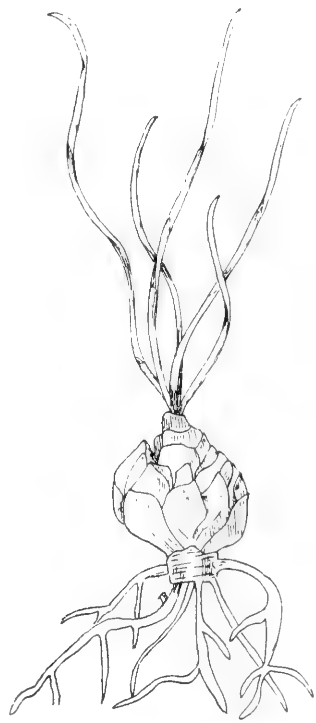


FIG. 171.—Bulb and leaves of Gethyllis.

stigma. There were six filaments borne at the throat of the tube, divided near the middle into two branches, each bearing an anther.

On looking for it in FLORA CAPENSIS among the Amaryllideæ, its book name was found to be *Gethyllis*. There are nine different species bearing the name, the number of stamens varying from six to twenty. The leaves of some are spirally twisted, others are rolled back spirally from the tip like a watch spring. By degrees the beautiful curious plant revealed the secret of its success in making the most of a warm, sunny climate. When the winter rains provide sufficient moisture, the full-grown leaves, like those of "April Fool," appropriate it for preparing the year's food supply, which is stored in the bulb for future use in forming and ripening the seed. Christmas is its coronation time, when there is little else to lure us on to the parched veld. All through the summer months, in the centre of its protecting leaves, the fruit can ripen underground, and with the May or June rains it grows longer and longer, till it projects above ground with all its seeds ready to scatter and germinate. Sheep eat the fruit, and so possibly help to scatter the seeds. How does the pollen get from the anthers to the style? Does some night moth, poising for a sip of nectar, carry the golden Christmas gift from flower to flower?

It is a widespread family, extending from the Cape to Graff Reinet, and from Mossel Bay up through the Karroo to Little Namaqualand.

One is almost inclined to wonder just wherein lies the delight in hunting for the odd fruits. Maybe the enjoyment has been inherited, but, at any rate, there would be a sense of something lacking if, in their season, a few were not brought in from the veld.

CHAPTER XIX

CLASSIFICATION OF PLANTS

WE have seen in earlier lessons how plants change their forms and habits of growth to suit different conditions of life. Probably none of the familiar plants of the veld look to-day just as they did when they were first created. More than 125,000 species or kinds of plants have been described or named, but since differences in soil, the amount of water, or sunlight available now bring about a change in the plants, it is often difficult to say just how many species there are in a district.

Species are not fixed by absolute characters. Any kind of plant which can reproduce its like by seed, which is fairly constant over a considerable territory, and can be described so that it may be distinguished from others, is known as a **Species**.

A group of species which are more like each other than they are to other species is called a **Genus**, or a genus may comprise but a single species if it has a combination of characters not found in any recognized species.

Just as species are grouped into genera, so genera are grouped into **Orders**. The many kinds or species of heaths are grouped into the genus *Erica*. The genus *Macnabia* is similar to Erica, but instead of the showy corolla that makes Erica beautiful, the calyx is much longer than the corolla. Other genera may have but four stamens instead of eight, as found in *Erica* and *Macnabia*, or the number of seeds may differ. Yet these genera have enough conspicuous characters in common to place them all under the one order *Ericaceæ*. These groupings into orders, genera, and species have been made so that we may think and speak of them more easily.

Of late years the collecting and naming of plants in schools has gone out of fashion. This is unfortunate. To know the name is not enough, but it helps us to know the plant. One who has made a collection has found how and where the plants grow, when they blossom and fruit, and it is to be hoped has gained some general ideas as to how their forms and markings, colours, and odours are related to their benefactors of the animal world. Not only the flower, but the whole aspect of the plant, tells how it has survived the wind and weather, how it has battled with unfavourable conditions of soil and drought and its sturdier neighbours in the struggle through the ages toward self-expression and perfection. It is hardly worth while knowing that the stamens of some flowers are declinate while others ascend and arch downward, unless we see how the declinate stamens in the one serve as a resting-place for the insect in lieu of the firm corolla of the other.

The first attempt at classifying plants came about through their real or supposed medicinal values. For this purpose they were classified as trees, shrubs, and herbs. From the time of Aristotle until the sixteenth century students began to arrange plants into groups which were very artificial. The most famous of these groups was that of the Swedish botanist, Linnæus. This system was used until the middle of the seventeenth century. In constructing these keys, plants were grouped according to some evident characters as the number of parts of the flower, which enabled students to refer plants readily to their proper orders. Since then efforts have been made to so classify plants that those plants shall be brought together which are naturally related. The study of plants has shown how they have developed from the simple thread-like forms which pass their entire lives in water to the more conspicuous ones that live in moist places but bear their spores up in the air. Later came the seed-bearing plants. Of these the Gymnosperms came first, as their imprints in the older rocks show. The first land plants had no need to flaunt gay petals, for there were neither bees nor butterflies to attract. The early Angiosperms had very simple flowers with neither calyx nor corolla, as the willow and wax-bush (*Myrica*). The flowers were imperfect as well as incomplete as their descendants have remained up to the present time. Later flowers like Protea had a simple perianth. When plants attained complete flowers the parts were at first distinct, as in the Anemone family (Ranunculaceæ).

As flowers developed along with insects, parts combined in various ways. A gamopetalous corolla gave a firmer support to the winged guest. If a tubular flower hangs obliquely, the fact of visiting insects always lighting on the same place might account for the irregularity of the blossom. Parts of the flower became developed into cunningly devised nectar cups or for some other special purpose, as, for example, in the calyx of Compositæ.

In learning to distinguish plants, it greatly simplifies matters to be able to group those which seem to be related; but we must remember that outward appearance is often deceitful, and that plants, like people living under the same conditions, come to clothe themselves alike.

A Protea is taken for a cactus by a stranger, but it would be hard to find a common ancestor for these two families. The first thing to be learnt is the conspicuous characters of the larger groups of families.

In classifying a plant, a key is useful for identifying the genus to which it belongs. After a little practice the order or family characters will be recognized at a glance without the key.

Key for determining the Orders.

The orders of flowering plants in this key are arranged after the system of Bentham and Hooker, which is used in the "Genera of South African Plants" and in "Flora Capensis."

DICOTYLEDONS.

Group I.—*Polypetalæ.*

Sub-class I.—Thalamifloræ.

Sepals usually separate, free from the ovary.

Ovary superior.

A. Carpels separate; stamens many . . Ranunculaceæ.

AA. Carpels united.
B. Stamens free.
C. Ovary 1-celled, or with false partitions. Fls. regular.
D. Leaves alternate. Ovules borne on the walls of the ovary.
Petals 4; stamens 6, tetradynamous . CRUCIFERÆ.
,, 4; ,, many; ovary stalked . . . . . CAPPARIDEÆ.
,, 5; ,, 5; plants insectiverous . . . . . DROSERACEÆ.
DD. Leaves opposite. Ovules borne on free central placenta . . . CARYOPHYLLACEÆ.
CC. Ovary 2-celled; flowers irregular . POLYGALACEÆ.
BB. Stamens united (monadelphous), or free in Tiliaceæ; petals twisted in the bud. Leaves stipulate.
Stamens joined to the petals; anthers 1-celled . . . . MALVACEÆ.
Stamens joined to the petals or free; anthers 2-celled . . . . . STRECULIACEÆ.
Stamens free; anthers 2-celled, opening inward . . . . TILIACEÆ.

Sub-class II.—DISCIFLORÆ.
Sepals separate or united, free from the ovary. Ovary superior. Disc usually conspicuous as a ring or cushion at the base of the ovary or broken up into glands. Ovary superior.
Flowers often irregular. Leaves not gland-dotted.
Disc prolonged through the centre of the ovary . GERANIACEÆ.[1]
Disc a cushion beneath the ovary. Leaves gland-dotted . . . . RUTACEÆ.
Disc often at one side. Petals one less than sepals . . . . SAPINDACEÆ.

Sub-class III.—CALYCIFLORÆ.
Sepals united, rarely free, often united with the ovary. Ovary often inferior.
A. Pistil apocarpous, superior except in some Rosaceæ.
B. Pistil of one carpel, fruit a legume . . LEGUMINOSEÆ.
BB. Pistil of two or more carpels (S. A. genera).
Stamens numerous . . . . . ROSACEÆ.
Stamens 4–7; ovary of 4–7 carpels . . CRASSULACEÆ.

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[1] Including OXALIDACEÆ.

AA. Pistil syncarpous, ovary inferior (except in some Ficoideæ).

Petals (staminodia) numerous. Embryo curved. Plants with fleshy leaves . FICOIDEÆ.

Petals 4; ovary inferior; calyx (receptacle) with a long tube extending beyond the ovary . . . . . ONAGRARIÆ.

Petals 5; ovary inferior, 2-celled, 2-seeded flowers in umbels . . . . . UMBELLIFERÆ.

GROUP 2.—*Gamopetalæ.*

Sub-class IV.—GAMOPETALÆ.

A. Ovary inferior.

B. Stamens inserted on the corolla tube.

Ovary 1-celled, with one ovule; embryo filling the seed . . . . . COMPOSITÆ.

Ovary 2 or more celled; seeds albuminous; leaves opposite . . . . . RUBIACEÆ.

BB. Stamens epigynous, free from the corolla; ovary 2–10-celled; fruit a capsule . CAMPANULACEÆ.

AA. Ovary superior.

B. Flowers regular.

C. Leaves alternate.

Flower parts in 4; fruit a capsule . . ERICACEÆ.

Perianth 5-parted; fruit a berry or capsule SOLANACEÆ.

Perianth 5-parted; fruit an achene . . PLUMBAGINACEÆ.

CC. Leaves opposite.

D. Pollen grains collected in masses. Herbs often with milky juice . . ASCLEPIADACEÆ.

DD. Pollen grains separate.

Shrubs with milky juice; seeds usually hairy; fruit a berry or follicles; leaves alternate and stipulate in Pachypodium . . APOCYNEÆ.

Herbs with bitter juice; corolla withering on; fruit a berry or follicles; seeds not hairy . . GENTIANACEÆ.

BB. Flowers irregular. Corolla 2-lipped.

C. Ovary 2-celled; fruit a capsule.

Disc absent. Seeds many, not winged . SCROPHULARIACEÆ.

Disc present. Seeds winged except in *Kigelia* . . . . BIGNONIACEÆ.

CC. Ovary deeply 4-lobed or 4-celled, with one ovule in each cell.

Fruit of 4 separable nuts.

Leaves opposite; stem square; strong odour . . . . LABIATÆ.

Leaves alternate; stem round . . BORAGINACEÆ.

Group 3.—*Incompletæ.*

Sub-class V.—Incompletæ.

A. Perianth present.	
Flowers regular. Perianth tubular, its lobes imbricate in bud. Shrubs . . .	Thymeleæ.
Perianth more or less irregular, 4-cleft or 4-parted, imbricate in bud. Trees or shrubs	Proteaceæ.
Perianth 4–8-parted; ovary inferior. Fruit a berry. Parasites on trees . . .	Loranthaceæ.
Perianth 3-parted, becoming woody; root parasites	Hydnoraceæ.
AA. Perianth absent.	
Flowers imperfect (sometimes with sepals). Fruit a 3-celled schizocarp. Plants usually milky	Euphorbiaceæ.
Flowers imperfect. Staminate flowers in catkins. Trees	Amentaceæ.

Sub-class VI.—Gymnosperms.

Flowers monœcious or diœcious. Ovules not enclosed within the ovary. Flowers in cones	Coniferæ.[1]

Monocotyledons.

Group 1.—*Petaloidæ.*

A. Ovary inferior.	
Stamens 1, joined to the style; ovary 1-celled	Orchidaceæ.
,, 3; ovary 3-celled	Irideæ.
,, 5; ,, ,, ...	Musaceæ.
,, 6; ,, ,, ...	Amaryllidaceæ.
AA. Ovary superior.	
B. Flowers perfect.	
Perianth coloured; stamens 6 . . .	Liliaceæ.
Calyx green; corolla coloured; anthers differently formed	Commelynaceæ.
Perianth coloured; ovary inferior or superior, stamens 3–6	Hæmodoraceæ.
BB. Flowers imperfect.	
Flowers diœcious. Perianth of 6, rarely 4 glumes	Restiaceæ.

Group 2.—*Glumaceæ.*

Stem solid. Sheath of leaf not split, without a ligule	Cyperaceæ.
Stem hollow. Leaf-sheath split. Ligule present	Graminaceæ.

[1] Including Cycadaceæ and Gnetaceæ.

SYNOPSIS OF ORDERS.

The arrangement of flowering plants is adapted from the more natural system of Engler.[1]

CRYPTOGAMS.—Plants without seeds, scattered by spores.

- A. Plants green.
  - B. Spores borne in water.
    - Leafless water plants . . . . . ALGÆ.
  - BB. Spores borne in air.
    - Leafy plants. Spore cases borne at the end of a stalk . . . . . MOSSES.
    - Plants with roots and wood vessels. Spore cases on the under side of the leaves . . . . . . FERNS.
- AA. Plants not green.
  - Parasites and saprophytes . . . . BACTERIA and FUNGI.

PHÆNOGAMS.—Plants scattered by seeds.

GYMNOSPERMS.—Seeds naked, borne in berries or cones.

- Woody plants; trunk unbranched; leaves divided . . . . CYCADACEÆ.
- Trees; trunk branched; leaves undivided . CONIFERÆ.
- Flowers with perianth. Plants without resin GNETACEÆ.

ANGIOSPERMS.—Seeds enclosed in ovaries.

Class I. *Monocotyledons.*—Embryo with one cotyledon. Leaves mostly parallel veined, with broad sheathing bases. Flowers on the plan of three.

- A. GLUMIFLORA.—Flowers without perianth, or if present bristle-like, in the axils of dry chaffy scales; arranged in spikes or spikelets.
  - Anthers joined at base to filaments; stem solid; sheath of leaf not split; no ligule; phyllotaxy $\frac{1}{3}$ . . . . CYPERACEÆ.
  - Anthers swinging (versatile). Stem usually hollow, leaf sheath split; ligule present; phyllotaxy $\frac{1}{2}$ . . . . GRAMINACEÆ.
- AA. PETALOIDEÆ.—Flowers usually with perianth, either showy or chaffy. Carpels united into a compound ovary.

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[1] Since the synopsis is greatly condensed, orders which show the relationships are often necessarily omitted.

B. Ovary superior.
C. Ovules orthotropous; endosperm mealy.
Plants grass-like, diœcious; perianth chaffy . . . . RESTIACEÆ.
Flowers irregular; sepals green; stamens 6, differently formed . . COMMELYNACEÆ.
CC. Ovules anatropous; endosperm fleshy.
Flowers regular; sepals coloured; stamens 6, similar . . . LILIACEÆ.
BB. Ovary inferior.
Stamens 6 . . . . AMARYLLIDEÆ.
,, 3 . . . . IRIDEÆ.
,, 3 or 6; ovary inferior or superior HÆMODORACEÆ.
,, 5; seeds with arils . . . MUSACEÆ.
Stamen 1, borne on the pistil (gynandrous) . . . . ORCHIDACEÆ.

Class II. *Dicotyledons*—Embryo with two cotyledons. Leaves mostly with netted veins; flowers usually 5- or 4-parted.

Series I. APETALÆ and CHORIPETALÆ.—Perianth either (1) absent; (2) simple, in one whorl, petal-like or sepal-like; (3) in two whorls, the inner polypetalous; (4) in two whorls, the inner gamopetalous (in forms whose nearest relatives are polypetalous; (5) in one whorl, because of the disappearance of the inner whorl.

A. Petals none (except in Caryophyllaceæ).
B. Calyx none.
Flowers diœcious, in catkins; fruit a many-seeded capsule . . . SALICINEÆ.
Flowers diœcious or monœcious; fruit 1-seeded, dry or covered with fleshy scales . . . . . MYRICACEÆ.
BB. Calyx present in staminate flowers.
Flowers monœcious; fruit a nut . FAGACEÆ.
BBB. Calyx present. Flowers perfect.
C. Seeds without endosperm.
Sepals 4, petal-like; anthers opposite and attached to the sepals PROTEACEÆ.
CC. Seeds with endosperm.
D. Embryo straight. Ovary inferior.
Tree parasites with opposite leaves or scales; fruit a sticky berry . . . . . LORANTHACEÆ.

Root parasites. Fruit dry, woody, many-seeded . . . . . HYDNORACEÆ.

DD. Embryo curved. Ovary inferior or superior.

Fruit 3- to many-celled; ovary inferior or superior.

Stamens sometimes petal-like . . FICOIDEÆ.

Fruit 1-celled; petals mostly present . CARYOPHYLLACEÆ.

AA. Petals present (wanting in Rosaceæ).

B. Ovary superior, free from the calyx.

C. Carpels several, separate; stamens many, below the ovary; sepals separate . . RANUNCULACEÆ.

CC. Carpels 2 or more, united into a compound ovary. Stamens beneath the ovary. Receptacle not cup-shaped. Ovules borne on the walls of the ovary. Sepals mostly separate.

Petals 4; stamens 6, tetradynamous . CRUCIFERÆ.

,, 4; stamens many; ovary raised on a stalk . . . . CAPPARIDEÆ.

Petals 5; stamens 5; insectiverous plants DROSERACEÆ.

CCC. Carpels one or several, distinct or united; stamens around or upon the ovary; sepals mostly united or joined to a hollow receptacle.

D. Seeds with endosperm; leaves without stipules; fleshy plants . . . CRASSULACEÆ.

DD. Seeds without or with very little endosperm; leaves mostly with stipules.

Carpels usually several; if 1, fruit a drupe or achene . . . . ROSACEÆ.

Carpel 1; fruit a legume or loment; flowers irregular or regular in **Mimoseæ** . . . . LEGUMINOSEÆ.

CCCC. Carpels united; often splitting apart when ripe; sepals mostly separate, united more or less in **Euphorbiaceæ** and **Polygalaceæ**.

D. Stamens few. Outer stamens alternate with the sepals, or opposite the petals when present.

E. Flowers perfect, regular, or nearly so; petals as many or fewer than sepals. Stamens usually alternate with the sepals, or opposite the petals when present.

F. Leaves not gland-dotted; disc broken up into separate glands.
- Capsule splitting into 5 carpels . . GERANIACEÆ.
- Capsule not splitting; styles of three lengths . . . . OXALIDACEÆ.
- Capsule not splitting; style 1; disc often at one side, not surrounded by the stamens . . . . . . SAPINDACEÆ.

FF. Leaves gland-dotted; disc conspicuous, cushion-shaped . . . RUTACEÆ.

EE. Flowers always imperfect, the staminate and pistillate flowers on the same or on different plants.
- Carpels 3, separating; frequently milky plants . . . . . . EUPHORBIACEÆ.

DD. Stamens usually very numerous, more or less united; disc inconspicuous or none; sepals valvate; carpels 2–many; seeds 1–many.
- Stamens in several sets; anthers 2-celled; embryo straight . . . . . TILIACEÆ.
- Stamens monadelphous; anthers 1-celled; embryo curved . . . . . MALVACEÆ.
- Stamens monadelphous; anthers 2-celled; embryo curved . . . . . STERCULIACEÆ.

BB. Stamens around or upon the ovary.

C. Petals none; sepals coloured. Ovary surrounded by the hollow receptacle, 1-celled . . . . THYMELEÆ.

CC. Petals present. Ovary inferior.
- Ovules many. Ovary 4-celled . . . ONAGRACEÆ.
- Ovules one in each of the two carpels . . UMBELLIFERÆ.

Series II. SYMPETALÆ. — Petals united (free in some **Asclepiadaceæ** and **Cucurbitaceæ**).

A. Ovary superior.

B. Stamens free from the corolla, as many or twice as many as the petals. Parts of the flowers arranged in fours . . . . ERICACEÆ.

BB. Stamens borne on the corolla, and opposite its lobes.
- Ovary 1-celled, with one ovule growing from the floor of the ovary . . . PLUMBAGINACEÆ.

BBB. Stamens borne on the corolla and alternate with the petals.

C. Carpels 2, separate (united in Gentianaceæ).

Corolla usually convolute, sometimes valvate; flowers regular; leaves opposite, simple and exstipulate.

Carpels united, ovary 1-celled . . . GENTIANACEÆ.

Carpels separate; styles united; stigma 1; stamens separate; pollen granular . APOCYNEÆ.

Carpels separate; styles separate; stigma 1; stamens monadelphous; pollen grains united as in Orchidaceæ . . ASCLEPIADACEÆ.

CC. Carpels 2, united; flowers regular or irregular; stamens mostly joined to the corolla tube as far as the middle or beyond.

D. Carpels 1–2-seeded.

Ovary not lobed, 2–4-celled, tipped by the style; carpels not separating. Flowers regular . . . . CONVOLVULACEÆ.

Ovary usually 4-lobed. Flowers more or less regular. Leaves alternate; stem round . . . . . . BORAGINACEÆ.

Ovary 4-lobed. Flowers more or less irregular. Leaves opposite; stem square; strong odour . . . LABIATÆ.

DD. Carpels several or many seeded.

E. Placenta axile. Herbs, trees, or shrubs.

Perianth regular. Stamens 5, sometimes 1 without pollen. Fruit a 2-celled berry or capsule . . SOLANACEÆ.

Perianth more or less irregular. Stamens 2–4, didynamous. Fruit a capsule . . . . . . SCROPHULARIACEÆ.

EE. Placenta parietal (on the outer wall). Trees or shrubs.

Ovary on a disc. Stamens didynamous. Seeds winged except in *Kigelia*. Fruit a capsule . . BIGNONIACEÆ.

AA. Ovary inferior.

Anthers separate. Stamens joined to the petals. Leaves always opposite and stipulate . . . . . . RUBIACEÆ.

Anthers united or separate. Leaves alternate, exstipulate. Flowers not in heads . . . . CAMPANULACEÆ.

Anthers united. Flowers in involucred heads COMPOSITÆ.

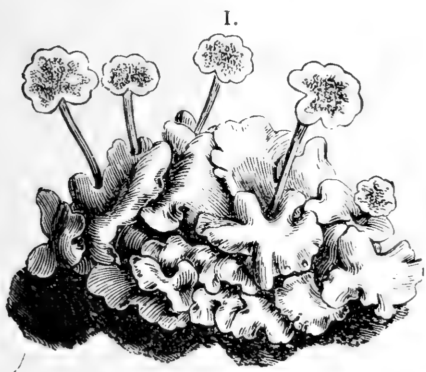
CRYPTOGAMS, OR SPORE-BEARING PLANTS.

NOTE.—The words **Cryptogam,** referring to the fact that the fruiting parts are hidden, and **Phænogam,** to signify that the parts are showy, were coined before microscopes had revealed much that was "hidden" in Cryptogams as well as in Phænogams. The words may still stand to distinguish those which do not bear seed from the seed-bearing plants.

While Cryptogams are as numerous as seed-bearing plants, and are of great interest and importance, they are, in many cases, so small and so unfamiliar to those for whom this book is intended, that they can be but briefly mentioned.

ALGÆ.—Most of the green floating scum on ponds, which is sometimes called "Frog spittle," are Algæ. Others are found on damp walls, on stones, or moist earth. All the sea-weeds are Algæ. These plants may be but single cells, long threads or filaments of cells, or masses of cells. The filaments may break apart, and so form new plants, or the cell contents may round off and form **spores**. The spores of pond scums are preserved in the dried mud during the dry months, and when the rains come they grow into new plants. A microscope is necessary to see how delicately beautiful Algæ are. What a lot of beauty on the earth is never seen! Algæ absorb into their living substance all kinds of decaying animal and vegetable matter, and help to keep pools fresh and sweet.

LIVERWORTS are often flattened green plants, growing in moist kloofs and other damp, shady spots. One of the most familiar liverworts is *Marchantia*. It has a flat, leaf-like, forked **thallus** growing close to the soil. On the under side are thread-like **rhizoids**, which serve the purpose of roots. On the thallus are little cups, containing small green bodies. They are buds which grow from the bottom of the cups. They become loosened, and are washed out to other places, where they form new plants. Umbrella-like bodies are often to be found growing up from the thallus. These stalks are of two kinds. At the top of some are stars of nine or more rays. Others have round scalloped tops. Sunken in them are club-shaped bodies called antheridia (*anther-like*). They contain many little cells, which escape when the antheridia are ripe, and swim about by means of tiny lashes attached to them. They are extremely small, and can only be seen by means of a microscope. Underneath the stars on the other stalks, protected by delicately fringed curtains, are bottle-shaped bodies, each containing a tiny egg-cell. These are sought out by the little swimming bodies, which unite with them just as the nucleus in pollen grains unites with the egg-cell in an ovule of higher plants. As a result



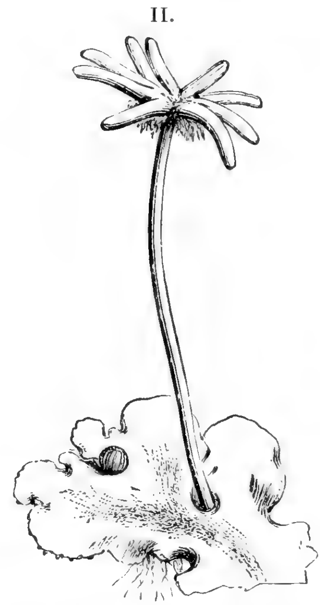


FIG. 172.—*Marchantia polymorpha*. I. Thallus with five anther-bearing umbrellas. II. Thallus with an umbrella bearing the egg pockets beneath. (From Thomé and Bennett's "Structural and Physiological Botany.")

of this union, the egg produces a little oval body on a short stalk. When this ripens it bursts open, and a golden dust of spores is blown about. These spores grow into new plants, just like the little buds.

In moist greenhouses a liverwort is often found, that depends wholly on the buds for starting new plants. They are held in crescent-shaped cups. The name of this Liverwort is *Lunularia*.

MOSSES, like liverworts, grow best in moist, shady places. We can find mosses on the ground under the shade of bushes and trees, or on the trunks of trees, but they grow best in moist woods or ravines. If no woods are near, look on thatched roofs, which are often beautifully green with moss on the shaded southern slope.

Mosses have leafy stems, and by examining the tips of these stems in early spring, sharp eyes, with a hand lens, can just detect in the tops of some of the stalks little bodies, surrounded by a rosette of leaves. These correspond to the antheridia of the liverwort.

Fig. 173.—I. Moss plant. II. Swimming sperm cell (magnified). (From Thomé and Bennett's "Structural and Physiological Botany.")

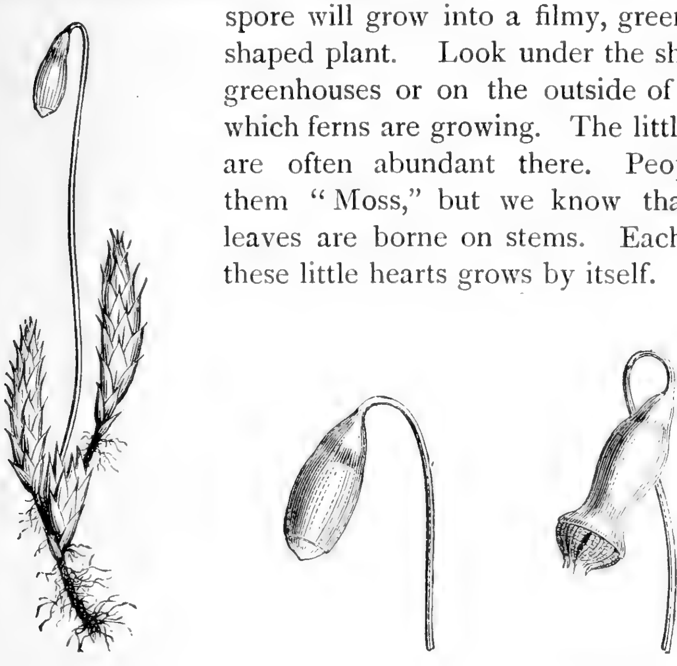
The egg-cell pockets, usually borne on separate stems, are more difficult to find. They are not surrounded by so conspicuous a rosette.

The little sperm-cells escape, and swim to the egg-cells in much the same way as they do in *Marchantia.* When the egg-cells have become fertilized, they send up stalks, which are tipped by little capsules. Look for them. You can find them in great numbers when the mosses are fruiting. Some of the capsules will have little hoods, the remains of the egg-pocket which has been carried up. Remove one. On the capsule is a tiny lid. Take it off with a needle. Under the lid is a little mouth with a row of teeth. Breathe on them several times. What happens? They open and close. When ripe the capsule is filled with spores. They sift through the teeth during the summer, and when rain comes, or when they lodge in a moist place, they send out thread-like plants very much like an alga; it is from these threads that the leafy stems grow.

Ferns.—What pains we take to get ferns to grow in our greenhouses, and how beautiful they are! You may have often seen Maiden Hair growing by a stream.

Maiden Hair and most of the South African ferns have short creeping stems, but *Hyathea* of Natal, and the beautiful *Hemitelia,* of Knysna and the West, have woody stems which grow to quite a height.

On the under side of most fern leaves you will find little brown spots. Some people cut their ferns down and burn them when they find these spots there, thinking that they are scale bugs. When the spots get quite brown, gently shake a leaf over white paper. A brown dust will appear on the paper. These are the fern spores, contained within clusters of spore-cases forming the dots. A dot is called a **sorus** (plural, *sori*). When the spores are ripe and have fallen in moist places, they burst their brown walls and begin to grow. In a few weeks a spore will grow into a filmy, green, heart-shaped plant. Look under the shelves of greenhouses or on the outside of pots in which ferns are growing. The little hearts are often abundant there. People call them "Moss," but we know that moss leaves are borne on stems. Each one of these little hearts grows by itself.



I. II. III.

FIG. 174.—I. A moss plant (*Bryum argenteum*). II. Capsule enlarged. III. Capsule open for the spores to escape. (From Thomé and Bennett's "Structural and Physiological Botany.")

How does the fern plant come? On the under side of the plants which are called **prothallia** are rhizoids and two kinds of little pockets, resembling those in the liverwort and the moss. The germ- or egg-cells are in the pockets near the notch in the prothallium; those containing the sperm-cells are down near the point among the rhizoids. A sperm-cell swims into the germ-pocket, unites with the germ-cell, and then the germ-cell grows into a leafy fern plant, just as the stalked capsule of the moss grew out of the pockets hidden among the leaves. The fern plant, though, soon gets able to take care of itself, while the moss capsule always depends upon the leafy part for its food. In the liverworts, mosses, and ferns, the germ-cell has to swim to reach its sperm-cell, but the spores are borne up into the air, and are scattered by the wind.

These plants have two generations: the part bearing the sperm- and germ-cells, and the part bearing the spores. The higher plants also have two generations, but the generation corresponding to the prothallium of the fern is hidden away, partly within the seed and partly within the pollen grains. The sperm-cells are contained in the pollen, and are carried down in the pollen-tube. By this time they have lost the power of swimming.

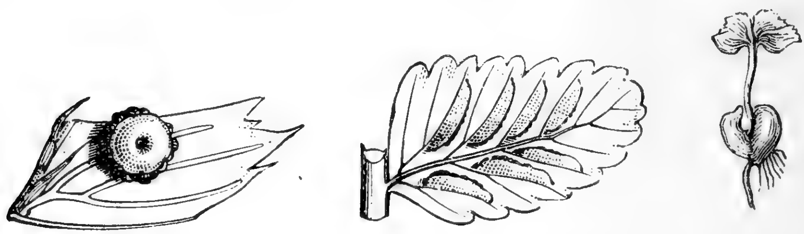


FIG. 175.—Pinnæ of fern leaves. I. *Aspidium* with a single sorus; the spore cases may be seen around the edge of the indusium. II. *Asplenium* with several sori. III. A young fern plant growing from the heart-shaped prothallium. (From Thomé and Bennett's Structural and Physiological Botany.")

Hemitelia capensis, the tree fern, the most beautiful fern in South Africa, extends from Table Mountain to Natal.

Pteris aqulina grows commonly on hills.

The spore cases of Pteris are continuous along the margin of the leaf which is folded over to protect them.

Osmunda regalis is a stately fern also extending across South Africa. The fruit-bearing part is quite distinct from the leafy part, forming a plume-like panicle.

Schizea pectinata is a curious fern, which might easily be mistaken for a grass. The frond or leaf is just a wiry stalk with very small comb-shaped lobes at the top.

Unlike so many ferns which thrive best in shady ravines, it can grow in very dry, hot situations. It is found on mountain tops and down nearly to the sea level.

Gleichenia is a slender little fern with wiry stalks and fronds, silvery at the back.

Lomaria capensis, a large coarse fern with rope-like spreading stems, may be known by the whole under surface of the fertile fronds being covered with fruit-dots.

Hymenophyllum and *Trichomanes* are found in deep ravines, washed by the spray of waterfalls. The beautiful little fronds are almost transparent, and the delicate creeping stems are like threads. The spore-cases are clustered on a stalk, enclosed in a tubular or cup-shaped **indusium.** The indusium

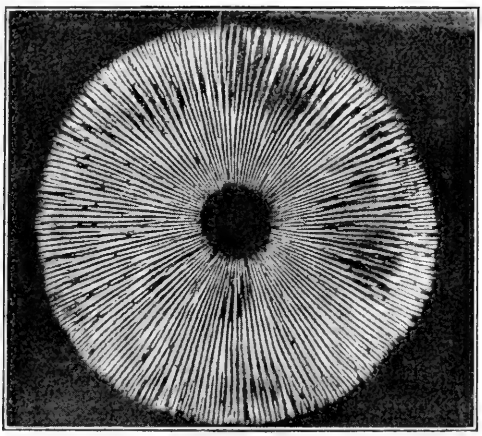


FIG. 176.—Spore print of a mushroom. (Printed and photographed by Ethel M. Doidge.)

of *Hymenophyllum* is deeply two-lobed. That of *Trichomanes* is not slit, and the fronds are less divided.

Adiantum, the Maiden Hair, may be known by the slender black leaf stalks and the fan-like veining. The sori are on the margins of the fronds, and the recurved edge of the frond forms an indusium. The sori are not continuous, as in *Pteris*.

FUNGI.—Mushrooms and moulds are spoken of as saprophytes and parasites in terms of reproach by the thoughtless, but as they are so necessary in preparing material for soil, so that it can be used for other green plants, do you not think that they earn the right to have their food prepared for them in return?

We have read in Chapter I. a little of the work of bacteria and moulds; mushrooms also share in this work.

Where do mushrooms bear their spores? Cut off the stem of a common mushroom. Lay the cap carefully on a sheet of paper, gills downwards. After several hours there will be a pretty spore print on the paper. The fine powder is the spores. When the spores lodge in a place with sufficient moisture, they send out delicate white threads, which grow mostly underground, but you can see them on the surface under

FIG. 177.—Photograph of a mushroom (*Amanita*), showing the ring (*annulus*) and cup (*volva*).

trees during the rainy season. They look like masses of wet cotton-wool. This is what mushroom gardeners call **spawn.** It takes up moisture and food from the soil, and as it may grow underground for months, it is no wonder that when mushrooms come they seem to "spring up in a night." They start as buttons on the spawn, and may get quite large before we notice them.

One common mushroom, which is often cultivated for the table, has pink gills (the spores are at first pink), which after a time turn brown. It has a white or brownish cap and a ring around the stem.

The mushroom in Fig. 177 has a ring which shows in the one at the left. The one at the right shows that this ring was a remainder of a veil formed of threads, which grew up to protect the young gills. The stem of this one stands in a cup which, like the ring, is the remains of a protecting veil. But this one extended over the cap. When the cap pushed through, parts of the veil made the rough patches on the cap. Don't eat this kind. The rough cap tells of the cup below, and a mushroom is quite apt to be poisonous if it has a cup at the base.

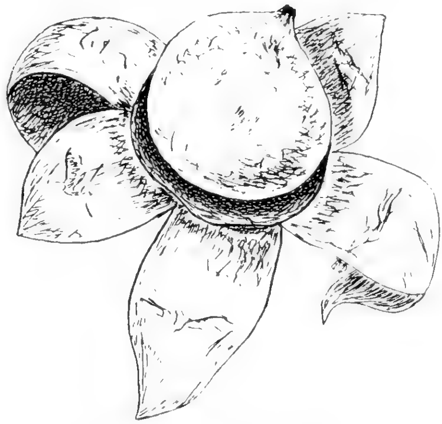


FIG. 178.—Geaster (earth-star).

Puff balls are a kind of mushroom. When you pinch them the spores come out in a cloud. The earth star is a pretty little puff ball, which looks like a star, and grows close on the earth in the spring.

PHÆNOGAMS, OR SEED-BEARING PLANTS.

GYMNOSPERMS.

Gymnosperms are woody plants storing resin or mucilage. The flowers are diclinous (male and female separate), and the plants are either monœcious or diœcious.[1]

This group of plants is named from the fact that the seeds are not covered by an ovary, but lie on a flat scale or carpel.

Three orders of Gymnosperms are found in South Africa—**Cycadaceæ**, **Coniferæ**, and **Gnetaceæ**. These orders include five genera.

CYCADACEÆ.—The two South African genera of this order are often mistaken for tree ferns or palms, until the large cones

[1] On the same plant or on different plants.

a foot or more long are seen among the crown of pinnate leaves.

Encephalartos.—Stem cylindrical ; pinnæ of the leaves without midrib, finely parallel veined.

Stangeria.—Stem short, swollen ; pinnæ midribbed with forked veins.

Encephalartos (*Zamia*).—The stamen-bearing cones are long and slender, and the scales are covered on the under

FIG. 179.—*Encephalartos*.

surface with one-celled anthers. The ovule-bearing cones are shorter and thicker, each scale bearing a pair of ovules. The thick unbranched trunk, rough with the bases of fallen leaves, has a palm-like appearance.

There are twelve species found in the Eastern Province and Natal. They are found along ledges in ravines, and extend as far west as the Kroome River. They form quite a special feature of the Fish River Bush, and extend from near the sea-level to an altitude of 5000 feet.

Stangeria is a curious plant, with a few leaves crowning its turnip-shaped trunk. It dwells in Natal, and comes as far south as Lower Albany.

The Cycadaceæ come of a very ancient lineage, for their fossil forms are found in older rock formations than those of any of their Gymnosperm relatives.

Coniferæ.—Unlike the Cycadaceæ, the Coniferæ have much-branched trunks and small simple leaves.

Podocarpus, or Yellow Wood, is the monarch of the eastern forests, attaining a height of 50 to 80 feet.

The stamen-bearing catkins are about an inch in length. The ovule flower is reduced to a single ovule borne upon a

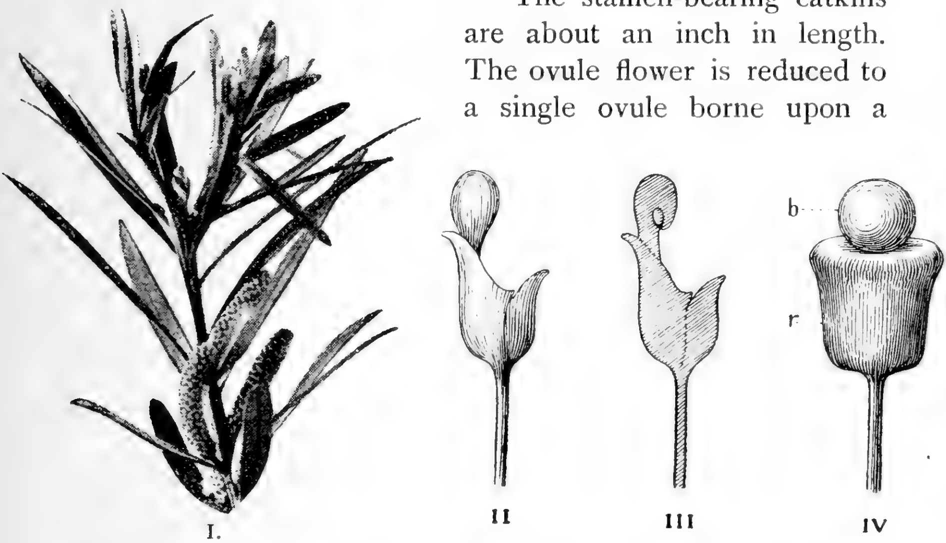


Fig. 180.—*Podocarpus elongatus*. I. Branch (½) with 3 stamen-bearing spikes. II. Ovule-bearing scale. III. Section through the latter, showing one ovule. IV. Ripe pseudocarp: *r*, fleshy receptacle; *b*, seed enclosed in green resinous scale. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

scale. (There is a scale facing this one which sometimes bears an ovule.) The cones are reduced to their lowest terms. These fleshy scales form the receptacle for the drupe-like fruit with its fleshy covering and hard inner coat.

P. thunbergii (true Yellow Wood) has lanceolate shining leaves and dark blue receptacles.

P. elongata (Outeniqua Yellow Wood) has narrow leaves and a small crimson receptacle. These monarchs of the East attain a girth of 23 feet.

Callitris (*Widdringtonia*) is the other genus of this order. It extends from Natal to the mountains of Clanwilliam, where it is found at its best. In the East it grows five or six feet high. The leaves are needle-shaped, becoming scale-like in the older plants. The cones are large and hard, formed of a few woody scales. The winged seeds of this tree may account for its wide distribution, although its range of altitude is limited, as it is generally found growing on mountain heights.

The Order Gnetaceæ is represented by one genus, *Welwitschia.* This plant is well adapted for its life in the Damaraland desert, to which it lends an additional weirdness. The trunk is very short, sometimes two or three feet thick, and grows mostly under the soil. The large tap-root extends deep down in the sand. It has but two leaves six feet or more in length, which become split into narrow shreds as they are lashed by the wind. Like other leaves found in deserts, they have a very thick covering. The large two-lobed summit of the trunk bears the crimson cones. The fruiting cones are about two inches long.

The extensive fir plantations on the slopes of Table Mountain show that the soil is no less congenial to them than that of their ancestral homes in Southern Europe. *Pinus pinea*, the Stone Pine, and *P. pinaster*, the Cluster Pine, are the species usually found in plantations. The annual rings of some trees cut on the market-place at Cape Town indicated an age of 209 years.

Angiosperms.

Sub-class I.—**Monocotyledons.**

Section I.—*Glumaceæ.*

Order Cyperaceæ, the Sedges or Nut Grass Family.

This family consists of tufted wiry herbs with creeping rhizoids. Stem 3-angled and solid. Leaves all 3-ranked with an entire sheath. Flowers in the axils of glumes; perianth of bristles, hairs, or none, in spikelets. Stamens 3; anthers basifixed, 2-celled; ovary 1-celled; fruit an achene.

Cyperus.—Glumes in two ranks. *C. textilis* (Matjesgoed) is used for thatching and baskets. The tubers of *C. esculentis* are eaten by natives of the north.

Carex.—Glumes overlapping, placed all around the stem. The flowers are usually imperfect.

Order GRAMINACEÆ, the Grass Family.

Stem cylindrical or compressed (not 3-angled), hollow (not in Indian corn or sugar cane), with solid nodes. Leaves 2-ranked, sheath split, ligule present. Flowers in the axils of glumes; perianth of two minute lodicules; stamens 3 (sometimes 6); anthers versatile. Fruit an achene (caryopsis).

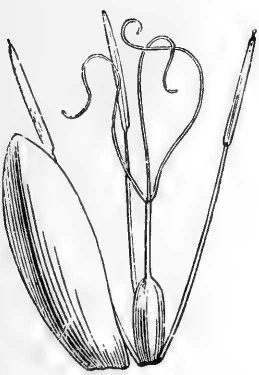


FIG. 181.—Flower of *Cyperus*, with the parts separated.

I. II.

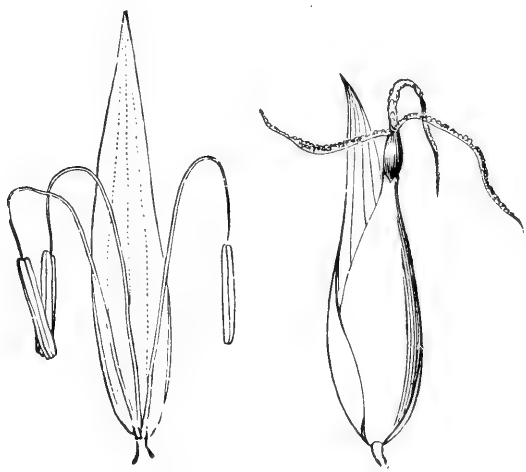


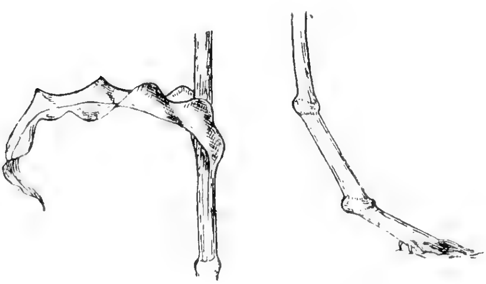
FIG. 182.—I. Staminate flower. II. Pistillate flower of *Carex*.

(From Thomé and Bennett's "Structural and Physiological Botany.")

The number of genera of this large order found in Cape Colony is not great. In temperate regions grasses are low and spreading; in tropical countries the canes and bamboos form tall forests; while in dry regions grasses usually grow in tufts, which allow the bare ground to be seen between them.

This order is one of the most important groups of plants. To it belong all the grains—wheat, rye, barley, oats, rice, and millet. The sugar obtained from sugar-cane and the pasturage afforded to stock are among the benefits conferred on mankind by this order.

These plants are of world-wide distribution, and are well fitted for their battle in life. The bracing roots and hollow stems help to support the weight of grain, which becomes heavier by careful selection of seed in cultivation. When beaten down by heavy rains, the lodged grain is brought up from the ground by means of an unequal growth of the stem at the nodes. Just as the hollow stem gives strength, so the hollow leaf-sheath is able to withstand great force brought to bear upon the leaves by the wind. The split sheath and fluted edges of the lower part of the blade allow the leaves to wave in the wind without danger of breaking. The little outgrowth called the **ligule** at the union of the sheath and blade turns off the water caught by the leaves, which is led down to the fibrous roots. The stomata are protected in the creases



I. II.

FIG. 183.—I. Fluted leaf of *Zea mais*. II. Stem, straightening up after a storm.

FIG. 184.—Panicle of *Briza maxima*. (After "Botanical Magazine.")

of the stems and leaves, or on the upper sides of leaves which roll up in dry weather.

Briza maxima, the pretty quaking grass, will be good for studying the flowers, as it is found so generally distributed. The oval spikelets are borne in racemes or panicles. At the lower end of the spikelet are two short green glumes of unequal size, with 5-7 nerves. They are keeled, that is, like the bottom of a boat. They have no flowers in their axils, but protect the whole spikelet. The glumes above them all contain flowers. For each flower there is one outer heart-shaped rounded glume, also keeled, and an inner, much smaller, flat, and two-nerved glume or **palea** (the flowering glumes are called paleæ to distinguish them from the empty glumes), which clings closely to the grain. When the three stamens are ready to shed their pollen, the glumes open, and the slender filaments hang out the swinging anthers. The ovary has two feathery stigmas. The fruit, a **caryopsis**, is an achene in which the ovary becomes attached to the seed-coat,

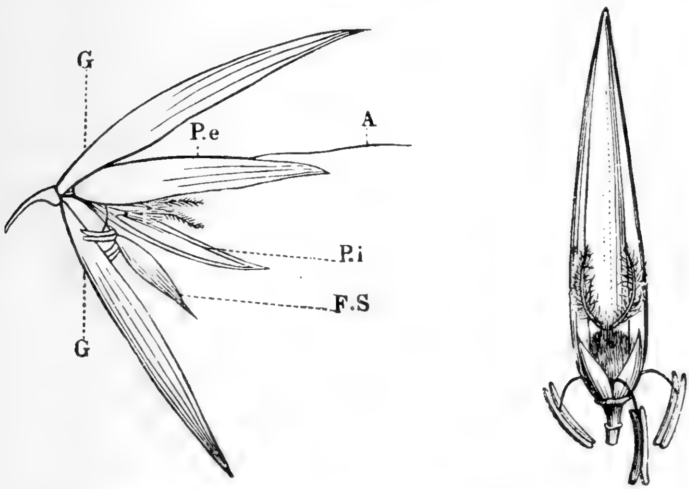


FIG. 185.—I. Expanded spikelet of the Oat, with a fertile and barren flower, FS; G, glumes; P*e*, outer pale, with awn, A; P*i*, inner pale; within are the feathery stigmas. II. Fertile flower with outer pale removed. (From Thomé and Bennett's "Structural and Physiological Botany.")

so that they seem like one covering. Between the ovary and the outer glume there are two very small bodies called **lodicules.**

In the bamboos there are three, longer than the ovary, which suggests that the grasses may once have had a perianth. The showy spikelets nod gracefully on slender pedicels, whence the name, meaning, in Greek, *to slumber*.

Large as the order is, the flowers are very similar in the different genera. The outer glume is awned in the oat (*Avena*); that is, it has a long twisted spike extending from the midrib. The awn is common to other genera. Rice has 6 stamens. In *Coix*, "Job's Tears," and maize the flowers are monœcious. The stamens here are toward the top of the panicle, and the pistillate flowers below. In maize the stigma is neither branched nor feathery. When the seed is shed, the spikelets in some genera break off just above the empty glumes, sometimes below them.

Tricholæna is a beautiful grass with soft silky glumes. In *Tricholæna rosea* the glumes are rose-coloured.

Phragmites communis is a common reed used for thatching.

Coix lachryma is a curious but pretty grass. The pistillate flowers are enclosed in a hard bony covering. The flowers containing stamens are borne on a stalk up through an opening in the top of this bead-like involucre. The popular name of this grass is "Job's Tears."

Order RESTIACEÆ.

This order is frequently confused with the grasses. A comparison of the two will show how they differ.

Restiaceæ.	*Graminaceæ.*
Flowers diœcious.	Flowers perfect or monœcious.
Perianth of 6 glumes in two whorls	Perianth of two or three lodicules.
Anthers 1-celled.	Anthers 2-celled.
Ovary 1 to 3-celled, dehiscent or indehiscent.	Ovary 1-celled, indehiscent.

Both grasses and Restiaceæ have leaves with split sheathes. The blade of the leaf in Restiaceæ usually falls, leaving the sheath.

The Restiaceæ are much more difficult to determine than the grasses or sedges, as the different species grow intermingled on the veld, and it is difficult to determine which staminate plants fertilize a given pistillate form. To add to the difficulty, the inflorescences are different in the pistillate and staminate flowers of the same species.

Like the rushes, they grow most luxuriantly in moist places, especially along the rivers' edge, where they reach a height of 6 to 10 feet. The Restiaceæ are peculiar to Australia and South Africa, where they are most

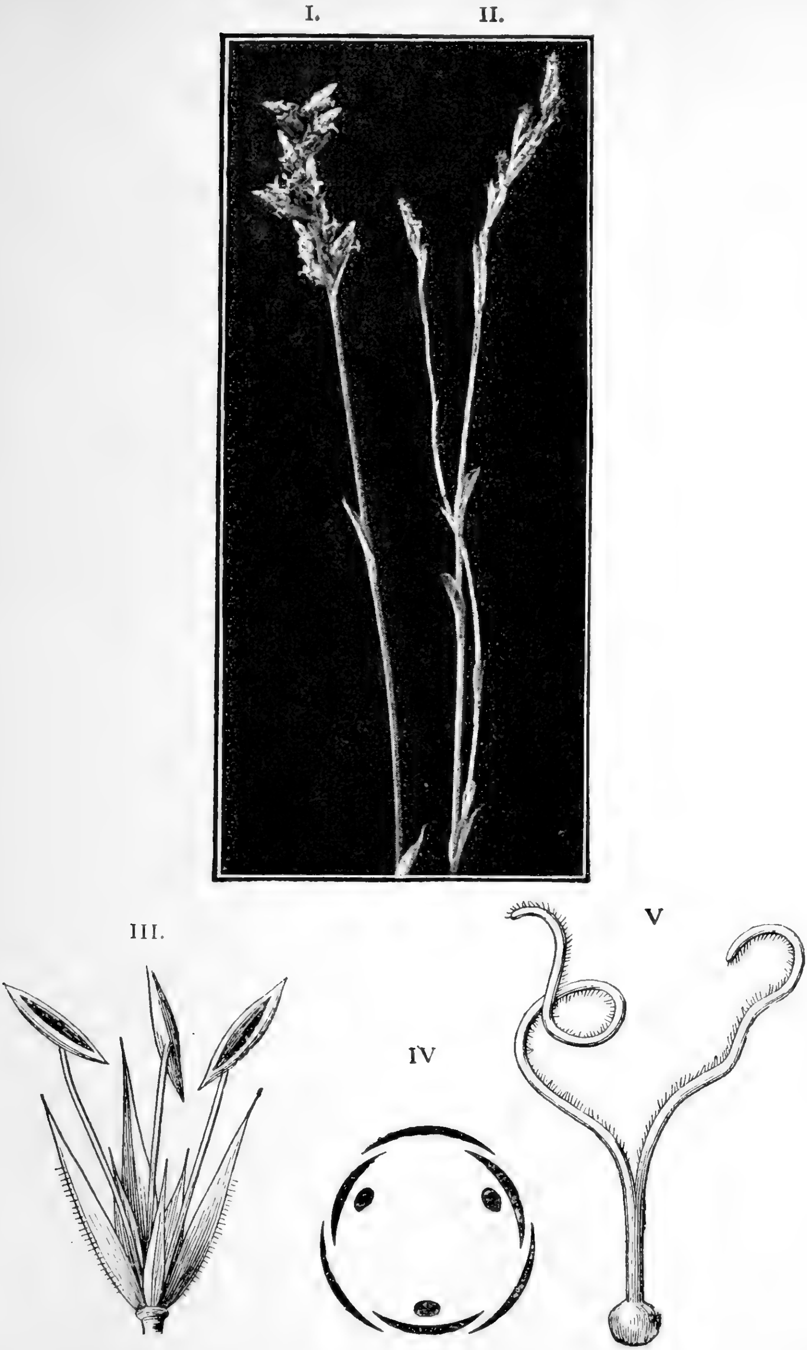


FIG. 186.—*Restio cuspidatus.* I. Stamen-bearing plant (½). II. Pistil-bearing plant (½). III. Staminate flower (× 4). IV. Diagram of staminate flower. V. Pistil (× 4). (From Edmonds and Marloth's "Elementary Botany for South Africa.")

abundant in the western portion. One species is found in Chili. They differ from the true rushes to which Palmiet belongs (*Prionum palmita*). This plant is the large rush with the thick black spongy stems and leaves something like a pineapple. It sometimes nearly fills rivers. The order contains eleven genera, of which the following six are the most familiar :—

Fruit dehiscent.

Restio . . . . . Sheaths persistent.

Dovea . . . . . Sheaths deciduous.

Fruit indehiscent. Flowers in dense spikes.

Leptocarpus . . . . Fruit angular.

Thamnochortus . . . . Fruit flattened.

Pistillate flowers solitary.

Hypodiscus . . . . Flowers on a fleshy stalk.

Elegia . . . . . Flowers in panicles.

Order Commelynaceae.

This order consists of a few genera of creeping or spreading herbs with sheathing leaves and jointed stems. The flowers wither quickly, and, unlike most monocotyledons, the calyx is green and the corolla only is coloured. Anthers of some filaments are either wanting or some are differently formed from the others. Fruit a 3-celled capsule or indehiscent.

Flowers issuing from folded spathe-like bracts.

Commelyna.—Petals separate, the side ones clawed. Filaments smooth.

Cyanotis.—Petals united by their claws. Filaments bearded.

Flowers without an involucre.

Aneilema.—Ovary 3-celled, with 2 or more ovules in a cell.

Dithyrocarpus.—Ovary stalked, 2-celled ; ovules 1 in a cell.

Linnæus, with all his love for study of plants, enjoyed a joke. He tells us that he named this genus after three Dutch botanists, the brothers Commelyn, because two of them, likened to the two showy blue or yellow petals, were industrious, and published their works on Botany. The third, Kaspar, lacking in ambition, amounted to nothing, like the third insignificant white petal. Fortunately, poor brother Kaspar was dead before the birth of the joke.

There is an interesting division of labour between the stamens. The upper three stamens furnish little or no pollen, but the anthers contain honey. The lower middle stamen bends up opposite the centre of the flower. Bees collect pollen from this stamen for their bread, are dusted with pollen from the side stamens, which they carry to other flowers, and then climb up and pierce the upper anthers for honey.

In the morning the bright little flowers open; in the afternoon, or as soon as the bees have visited them (female bees

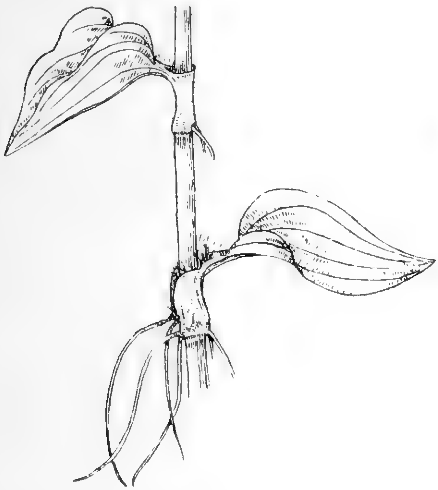


FIG. 187.—Sheathing leaves and adventitious roots of Commelyna.

FIG. 188.—Flowering shoot of Commelyna, showing two-stalked petals and different kinds of stamens.

are said to be their chief benefactors), the flowers quickly roll up and wither into a moist shapeless mass.

Cyanotis (*Tradescantia*) also blossoms for a day and then perishes or "dissolves in tears," whence it is known as "Job's Tears." The hairy filaments serve as a foothold for bees. The anthers are similar.

Aneilima has differently formed anthers, as in Commelyna.

Dithyrocarpus has six similar stamens, beardless with three of the filaments shorter.

The species are chiefly Eastern, though the first two are found throughout the Colony.

Order Liliaceæ.

Flowers perfect; calyx and corolla similarly coloured, usually regular. Perianth lobes separate or united in a tube. Stamens 6. Ovary superior. Fruit a 3-celled capsule or berry. The flower-stalks are usually jointed, just under the flower, at the middle or near the base. The stalk separates here when the seeds are ripe, or if the ovules are not fertilized.

This large order includes trees, shrubs, or bulbous or fibrous rooted herbs. The flowers may be large and showy or small and greenish. They may be arranged in umbels, spikes, racemes, or panicles.

Series I.—Fruit a berry. Anthers opening toward the pistil.

Smilax.—Stems woody, climbing. Leaves normal, net-veined. Flowers diœcious.

Asparagus.—Stems generally woody, climbing or erect. Leaves small, bract-like, with one or several leaf-like branches in their axils.

Series II.—Fruit a capsule. Anthers versatile, opening toward the pistil.

A. Rootstock not bulbous. Perianth lobes united.

B. Flowers in racemes

Kniphofia.—Leaves not fleshy. Perianth tube long.

Aloe.—Leaves fleshy. Perianth with a short tube.

BB. Flowers in umbels.

Agapanthus.—Flowers blue.

AA. Rootstock not bulbous. Perianth tube cut down to the base. Anthers swinging.

Bulbinella.—Flowers yellow or white. Filaments smooth.

Bulbine.—Flowers yellow. Filaments bearded. Ovules more than two in a cell.

AAA. Rootstock bulbous or tuberous. Flowers in racemes or spikes.

B. Perianth cut down to the base.

Bowiea.—Rootstock bulbous. Stem climbing. Leaves and branches Asparagus-like.

Eriospermum.—Rootstock tuberous. Stem erect. Seeds woolly.

Albuca.—Rootstock bulbous. Petals conniving but not united. Seeds flattened, crowded.

Eucomis.—Seeds not crowded. Raceme crowned by a rosette of leafy bracts.

Ornithogalum.—Perianth lobes spreading. Raceme not crowned with bracts. Flowers never blue.

BB. Perianth lobes united.

Lachenalia.—Perianth cylindrical. Outer segments usually shorter.

Series III.—Fruit a capsule. Anthers opening outward.

A. Rootstock a bulb or corm. Perianth segments narrowed into a distinct claw.

Wurmbea.—Flowers spicate. Perianth segments joined at the base. Capsule opening at the septa.

AA. Rootstock not bulbous. Capsule dehiscing loculicidally.

Gloriosa.—Stem climbing by leaf tips. Perianth segments free spreading.

Sandersonia.—Stem erect. Perianth tubular with short free tips. Flowers solitary, hanging on slender pedicels from a few of the upper leaves.

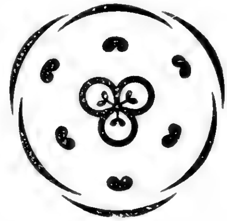


FIG. 189.—Floral diagram of Aloe. (From Edmonds and Marloth's 'Elementary Botany for South Africa.")

Smilax. — Flowers diœcious, small, greenish, borne in umbels. Staminate flowers with 6 slender filaments and erect anthers. Pistillate flowers with 6 thread-like staminodia.

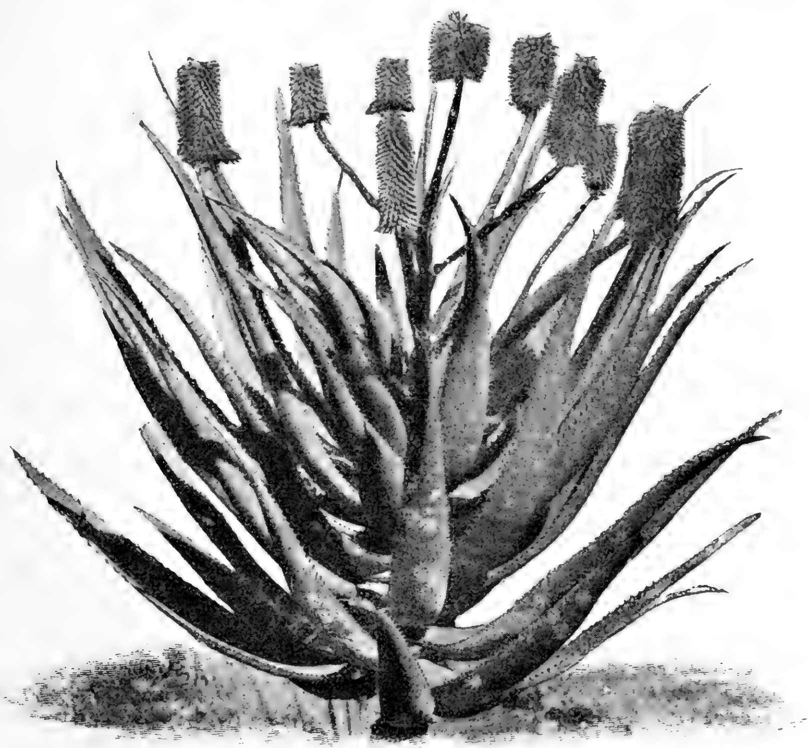


FIG. 190.—*Aloe rupestris.* (Photograph by Dr. Marloth.)

Berry round, often only 1- or 2-seeded. A climbing shrub, supported by stipules, which are rarely found in monocotyledons. The many-ribbed stem is often armed with prickles, which help the stipules to support the plant. Leaves oval, glossy, net-veined. In woods, usually on mountains.

Kalahari region: Transvaal, around Barberton. Eastern region: near Durban, Port Natal, Inanda. South Western region: about George and Bedford.

Asparagus.—Flowers perfect; stamens with versatile anthers. Berry round, seeds often solitary. Stem woody, erect or climbing, or spreading by means of spines produced from the base of papery scale-like leaves. Clusters of small green branches (**Cladodia**) take the place of foliage leaves. In some species a single flattened branch is borne in the axil of a leaf. These species are often called "Smilax." The thorny species are known as "Waacht een bietje."

Forty-four species of this large genus are found in South Africa. They do not favour one locality, but are found in all the five botanical regions.

Kniphofia.—Perianth with a long tube. Stamens slightly curved toward the lower side of the flower (declinate), those opposite the petals longest. Ovary with a long style; ovaries many-seeded; seeds 3-cornered.

A genus of handsome African plants with a short rootstock, long, narrow, radicle, leaves and scapes bearing dense racemes of yellow or scarlet flowers. *K. alooides*, "The Red Hot Poker" is the most familiar. Many species are cultivated.

They occur from the Transvaal and Natal to the Cape Peninsula, and are also found in Tropical Africa and Natal.

Aloe.—Perianth a short tube and long overlapping segments spreading only at the tips. Three outer lobes swollen at the base. Stamens equal to or longer than the perianth; filaments sometimes curved. Ovary somewhat 3-angled. Seeds many, flattened or winged.

Aloes are more numerous in the East, but *A. rupesis* is found as far west as Port Nolloth, and forms a characteristic feature of the scenery in the Grahamstown region. They grow over the sun-burned hills, and like especially to cling along low broken sandstone ledges. Some have thick stems, shaggy below, with blackened remains of leaves, crowned with a bunch of spear-like leaves, above which rises a majestic stalk of flaming red or yellow flowers. **A. arborescens** grows to a height of 15 feet. **A. minima**, which grows in grass, has a spike only 6 or 9 inches high, rising from a rosette of leaves.

The so-called American Aloe (Agave) belongs to the order Amaryllidaceae. It is native of Central America. In the dry climate of that country it has acquired similar habits of growth to the Aloes.

Agapanthus.—The large umbels of bright blue flowers (or rarely white) are subtended by two broad papery bracts, which fall early. Rootstock tuberous, with fleshy fibres. Leaves radical, fleshy, 6–8 scape; 3–4 feet long.

Found in the Coast, Central, Kalahari, and Eastern regions. A handsome plant, frequently cultivated.

Bulbinella.—Perianth lobes 1-nerved, remaining on after withering. Ovules 2 in a cell; seeds sometimes solitary. Leaves all radical; scape usually unbranched. Flower-stalks with a joint at the apex. Root of fleshy fibres. Chiefly Western.

Bulbine. — The bright yellow flowers may be known from Bulbinella by the pretty feathery stamens and numerous ovules.

Stem sometimes branched and leafy. A widely distributed genus, from near the sea-level to an altitude of 4000 feet.

Fig. 191.—*Ornithogalum thyrsoides*, var. *aureum*. (After "Botanical Magazine.")

Bowiea. — A peculiar plant with a large green tuber-like bulb on the surface of the soil, a slender wavy stem with many pinnate branches bearing slender Asparagus-like branchlets, which are subtended by scale leaves. Flowers small, $\frac{1}{3}$ to $\frac{1}{2}$ inch in diameter, borne from the main stem on long slender curved pedicels. Found in the Eastern and Kalahari regions.

Albuca.—Outer perianth lobes spreading, inner shorter, having a hood-shaped process at the tip, and furnished with a large gland. Stamens all fertile, or the three anthers of the outer small or wanting; filaments often winged at base. Leaves all radical. Flowers in racemes, large yellow or white, banded with green or brown, rarely quite green.

Found in the Coast, Central, Eastern, and Kalahari regions.

Eucomis may be easily recognized by its crown of leafy empty bracts. Perianth segments joined just at the base. Stamens borne on the perianth; flowers greenish, marked with purple.

FIG. 192.—*Lachenalia tricola.*

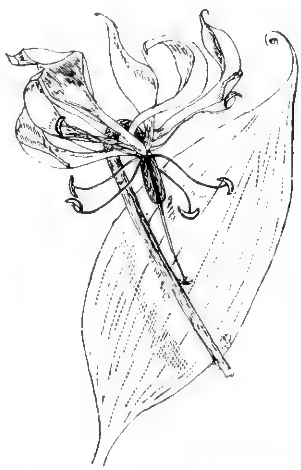


FIG. 193.—*Gloriosa superba.*

FIG. 194.—*Sandersonia aurantiaca.*

From the Malmesbury district to Natal.

Ornithogalum.—Perianth withering on the stalk. Stamens hypogynous. Style short. Leaves all radical. Flower in a raceme. The lower flower-stalks lengthened so as to make a flat-topped corymb, which lengthens after flowering.

About 70 species are found in South Africa. The large bulbs of some species store so much food that if the bulbs are gathered in early flowering time and placed in the dark, the flower will continue to open for several months. They are called "Chinkering Chees" because of the sound made by the scapes when rubbed together. The Greek name means "Bird laughter."

Gloriosa.—Perianth segments clawed, spreading. Filaments slender; anthers versatile. Style long; stigma 3-lobed. Seeds many, bright red. Flowers large and handsome. Rootstock tuberous; stem slender, climbing like Littonia by the curled leaf tips.

From Albany to Natal. Sandy hills.

Sandersonia.—Perianth tube tapering toward the throat, globose. Flowers bright yellow, hanging on slender stalks from the upper axils of the leaves. Leaves sessile alternate, 2 to 4 inches long, $\frac{1}{4}$ to $\frac{3}{4}$ inch broad.

Found in the Eastern region.

Order AMARYLLIDACEÆ.

Flowers perfect, regular, or nearly so. Outer segments of the perianth coloured. Stamens usually 6, rarely 3 or many. Anthers long or short, basifixed or swinging. Ovary inferior, 3-celled; placentation axile; style none; stigmas three. Fruit usually a 3-valved capsule, sometimes a berry. Capsule opening midway between the partitions (loculicidal), or splitting around at the centre. Seeds usually many.

Usually stemless herbs with radical leaves. Rootstock a bulb or corm. Flowers in umbels, corymbs, racemes, or single. Distinguished from the lily family by the inferior ovary.

Tribe I. HYPOXIDEÆ.—Rootstock a corm. Flowers without a spathe below, usually yellow, and hairy outside.

Pauridia.—Stamens 3.

Curculigo.—Stamens 6. Fruit indehiscent, produced into a long beak.

Hypoxis.—Stamens 6. Perianth without a tube. Capsule splitting around at the centre.

Tribe II. AMARYLLIDEÆ.—Rootstock a bulb. Leaves all radical. Flowers never hairy outside, usually in an umbel with a spathe below.

* Anthers basifixed.

Hessea.—Anthers small. Perianth cut down to the base.

Carpolyza.—Anthers small. Perianth with a tube.

Anoiganthus.—Anthers long, arrow-shaped. Flowers in umbels.

Gethyllis.—Flowers solitary, with a long tube and a flat spreading limb. Stamens in a single row; anthers linear.

Apodolirion.—Flowers solitary; perianth funnel-shaped. Stamens in two rows; anthers linear.

** Anthers attached at the back, swinging.

Fruit indehiscent, bursting irregularly. Seeds one or few, bulb-like.

Crinum.—Segments of the perianth broad. Stamens declinate (filaments bending down toward the lower side of the flower, and then curving upward toward the anthers). Leaves persistent (with the flowers).

Amaryllis.—Lobes of the perianth broad. Stamens declinate. Leaves short-lived, withering before flowering.

Ammocharis.—Lobes of the perianth narrow. Stamens erect.

Fruit a 3-parted capsule. Seeds many, flattened.

Brunsvigia.—Perianth cut down to the ovary. Style not swollen at the base. Capsule turbinate (top-shaped), sharply angled.

Nerine.—Perianth cut down to the ovary. Style not swollen, and 3-angled near the base.

Strumaria.—Perianth cut down to the base. Style swollen, and 3-angled near the base.

Vallotia.—Perianth with a tube rather shorter than the limb.

Cyrtanthus.—Perianth with a tube longer than the limb.

Fruit a berry or capsule. Ovules 2 or 3, clustered at the middle of the placentas.

Clivia.—Bulb imperfect. Bracts below the umbel, several. Fruit a berry.

Hæmanthus.—Bulb large, with thick scale leaves in two ranks. Bracts under the umbel, several. Fruit a berry.

Buphane.—Fruit a capsule. Bracts 2.

Tribe III. VELLOZIEÆ.—Rootstock not bulbous; leaves leathery, persistent. Flowers solitary.

Vellozia.—The only genus.

Pauridia.—Perianth with a short tube and spreading lobes. Stamens opposite the inner segments. *P. hypoxidoides* is the only species. It has a corm $\frac{1}{4}$ inch in diameter, crowned with a rim of bristles. Leaves 6–12, sickle-shaped, 1–2 inches long. Scapes several, about as long as the leaves. Perianth yellow, tipped with green.

This little plant, which is found about Cape Town on the hills and flats, has had difficulty in finding a habitation. Lacking the usual number of stamens, it was formerly placed among the Irideæ. Linnæus called it *Ixia*. It has since been known as *Romulea*, *Galaxia*, and *Hypoxis*.

Curculigo.—Perianth cut down to the ovary, filaments short, anthers long, basifixed. The ovary is narrowed into a long beak resembling a perianth tube. Rootstock a rhizome or tuberous, wound about with many fibres.

The flowers, yellow within and pale green without, resemble those of Hypoxis. Western (near Okiep), Coast, Central, and Eastern regions.

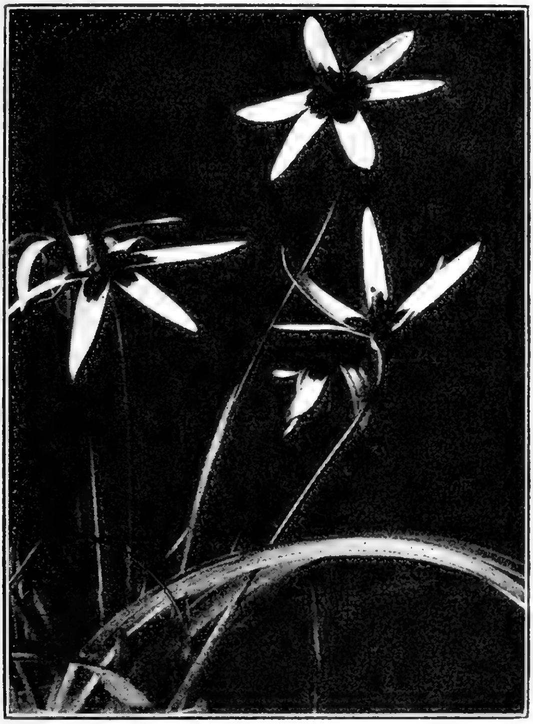


Fig. 195.—*Hypoxis stellata*, var. *elegans*.

Hypoxis.—Perianth cut down to the ovary. Filaments short; anthers long; ovary rarely beaked; stigmas 3. Capsule usually splitting around near the middle. Corms in the Western species, $\frac{1}{4}$ to 1 inch in diameter; in the East some species have corms from 2 to 4 inches in diameter. Leaves plaited, found with the flowers.

Plants often growing in moist places. Flowers usually yellow. *H. stellata*, var. *elegans*, the most beautiful of the species has large white star-like flowers, beautifully marked at the centre with a splash of iridescent colour.

Gethyllis (Kukumakranka).—Perianth white with a long slender tube, spreading limb. Stamens 6–20. Ovary hidden among the sheaths of the bulb, ripening partly underground. Fruit a yellowish, fragrant, edible berry, 2–3 inches long; leaves frequently spirally twisted, generally appearing after the flowers, with the fruit or later. Flowering in December. Coast, Central, and Western regions.

Amaryllis.—This plant gave the name to the whole order, and its flowers are certainly beautiful enough to deserve the honour. There is but one species, *A. belladonna.* Flowers 6–12 in an umbel. Pedicels 1–1½ inch long. Ovules many; capsule large, round; seeds few. Leaves 7–9, growing after the flower, 1 foot long and ½ to ¾ inch broad. The flowers are nearly regular, but the declinate stamens serve as a landing-place for insects. Coast region, flowering in March.

Nerine.—Tube cut down nearly to the ovary; lobes curved and frequently waved along the edges, bright red or pink, sometimes flecked with gold. Stamens of two lengths, slightly declinate. Bulbs near the surface; leaves produced with or after the flowers. Umbels 10–40 flowers. In some species the flowers open from the centre of the umbel; in others the central flowers of the umbel are the last to open.

Western, Central, Eastern, and Kalahari regions.

Hæmanthus.—"The April Fool" merits its name, as we think when we find that what we took to be a single flower is really a dense umbel of many flowers surrounded by bright red bracts. After the bracts and flowers have withered and fallen, the bright red berries appear. Later come the leaves. They make enough food during the rainy season for the flowers and fruit of the next year, which is stored in the large bulbs. About thirty species are found, both Eastern and Western. Flowering in April.

Buphane is often confused with **Brunsvigia** and **Cyrtanthus,** the flowers of each genus being in dense umbels on short stout scapes. The differences may be seen by referring to the characters in the key. *Brunsvigia* has a long ovary tapering down into the stalk. *Cyrtanthus* may be known by its long perianth tube and hollow scape. The flowers are slightly protandrous, but in *Buphane* the stigma is bent, and can, if necessary, brush out the pollen from its own or neighbouring flowers.

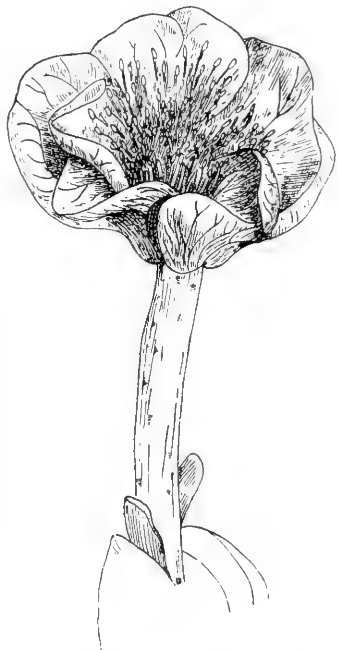


FIG. 196.—*Hæmanthus coccineus.*

Order IRIDEÆ.

Besides the characters given in the key, the ovary of the Irideae is 3-celled with many ovules. Fruit a 3-celled capsule splitting down the centre of each carpel. The Irideæ are mostly perennial herbs with dry narrow leaves. Rootstock a corm, rarely a rhizome or fibrous.

Differing from the Amaryllidaceæ in the absence of the inner circle of stamens.

Sub-order I. MORÆÆ.—Flowers in corymbs; fading quickly, each flower appearing one after the other from one bract. Stamens opposite the style branches and pressed closely against them.

Moræa.—Style-branches of large petal-like crests with a horizontal stigma on the under side at the base of each crest.

Homeria.—Crests of style branches small, spreading, shortly fringed around the edges.

Ferraria.—Crests of style small, petaloid, 2-lobed, deeply fringed around the edges.

Hexaglottis.—Style branches long and slender, deeply forked.

Sub-order II. SISYRINCHEÆ.—Flowers in corymbs, fading quickly. Stamens alternate with the style branches.

Tribe I. Galaxieæ.—Bracts with one flower.

Galaxia.—Bracts down in the centre of a rosette of leaves. Stamens monadelphous. Stigma shield-like.

Syringoidea.—As in Galaxia, but stamens free. Style with three wedge-shaped branches.

Romulea.—Bracts raised on a scape.

Tribe II. **Aristeœ.**—Bracts usually more than 1-flowered.

Bobartia.—Style branches long, awl-shaped.

Witsenia.—Style branches shorter. Perianth lobes equal, shorter than the tube.

Cleanthe.—Style branches short. Perianth without a tube, outer lobes much smaller than the inner, black.

Aristea.—Style branches short. Perianth lobes nearly equal not narrowed into a claw.

Klattia.—Style branches short. Perianth lobes nearly equal, longer than the tube, narrowed into a claw.

Sub-order III. IXIEÆ.—Flowers in spikes, not withering quickly, each one subtended by a pair of bracts.

* The three style branches undivided. Flowers regular. Stamens bending to one side of the flower—

Schizostylis.—Style short; branches long, awl-shaped. Root fibrous.

Hesperantha.—Like Schizostylis, but rootstock, a flattened corm.

Geissorhiza.—Style longer than Hesperantha, branches short, awl-shaped. Bracts green or membranous at the tip.

Ixia.—Style long; branches short, awl-shaped. Outer bract short, brown, notched.

Streptanthera.—Style long; branches short, wedge-shaped. Bracts both papery, lacerated. Leaves short.

Dierama.—Style long, branches short, wedge-shaped. Bracts both papery, not cut. Leaves long, rigid.

** Three style branches, each bifid. Stamens bent toward one side of the flower—

Lapeyrousia.—Perianth tube slender, with the stamens borne at the throat. Ovules many.

Micranthus.—Perianth tube cylindrical. Stamens borne at the throat. Ovules 2, side by side.

Freesia.—Perianth tube broad. Stamens borne below the throat. Bracts small, green.

Watsonia.—Perianth tube widened at the middle where the stamens are borne. Bracts large, rigid, brown or green.

*** Three style branches undivided. Stamens arched toward one side of the flower—

Babiana.—The genus may be known by its hairy accordion-pleated leaves.

Melasphœrula.—Perianth without a tube, lobes long, pointed.

Sparaxis.—Perianth regular, with a short funnel-shaped tube. Bracts papery, deeply fringed or lacerated.

Tritonia.—Perianth nearly regular, with a short tube. Bracts small, brown, notched.

Crocosma.—Perianth nearly regular, with a cylindrical tube. Bracts short, oblong. Capsule inflated, deeply 3-lobed.

Acidanthera.—Perianth nearly regular, with a long tube. Bracts long, green.

Synnotia.—Perianth irregular. Bracts papery, deeply cut.

Gladiolus.—Perianth irregular, with a funnel-shaped tube. Bracts large, green, lanceolate.

Antholyza.—Perianth irregular ; tube swollen at the middle. Bracts oblong, lanceolate.

Moræa.—Flowers without a tube, regular, but the petals are much smaller than the sepals. Sepals showy, usually

FIG. 197.—*Moræa tripetala.*

FIG. 198.—*Gladiolus gracilis.*

narrowed into a claw. Petals lanceolate, sometimes minute with a long tapering point.

The genus is known from the other genera by the large petal-like stigmas. It is nearly like the Iris, "The fleur-de-lys," which is the flower of chivalry, the emblem of the Crusader, Louis VII.

The anthers turn back from the stigmas to discharge their pollen. The moist stigma is placed in position to receive pollen brought by bees from other flowers. Like other flowers of this group, their beauty is fleeting, as theywither quickly.

Homeria, formerly called *Moræa*, has a much smaller pistil. *H. Collina* is the "Tulp" which is poisonous to cattle. Dr. Pappe writes of a whole family being killed by eating the little bulbs which are produced in great abundance

FIG. 199.—*Gladiolus alatus.*

in the bulbs and axils of the leaves. This flower covers large areas in the western region.

Romulea ("Frutang").—Flowers reddish-purple lilac, or yellow. Leaves narrow, usually over-topping the flowers.

Aristea is a widely distributed genus, with bright blue flowers, which twist up in a spiral and become inky after flowering. The inner bract is papery, brown or white, and often deeply fringed. Rootstock of slender fibres or a rhizome, never bulbous. Leaves in a dense two-sided rosette.

A. fruticosa and *A. corymbosa* have tall shrubby stems rough below with the scars of fallen leaves.

Hesperantha ("Avond-bloemetjes").—Perianth with a tube and regular limb. Stamens borne on the throat of the tube. Style as long as the tube, with three long, slender, curved branches. Flowers white or yellow. The sepals frequently red outside. Delightfully scented at evening when their insect guests are abroad.

Ixia.—Perianth tube long and slender, with a regular spreading limb. Stamens borne on the throat. Style longer than the perianth tube, with three short, spreading, recurved branches.

Flowers in simple or panicled spikes of beautiful and varied colours. The Ixias are abundant in the west. *I. viridiflora* has a pale green perianth with a purplish black throat. One variety of this species has a pale lilac flower with a black centre; another has a pale blue perianth with a green centre. *I. maculata* has orange or yellow flowers with a dark purple-black centre. Several species are found in the Transvaal and Natal.

Watsonia.—Perianth tube long, curved, widened toward the upper half. Flowers more or less regular. The stamen in front of the flower is bent backward in line with the other two, which are twisted halfway around on their filaments, so that all are placed in position to shed their pollen on the bee's hairy backs. The flowers often live in moist places. Water is necessary for making the honey, which sometimes half fills the long tube.

Rootstock a corm. Leaves ensiform (sword-shaped with their edge toward the stem). Flowers bright red, rose-pink, or white.

Babiana.—Flowers usually regular, frequently violet, sometimes milk-white or sulphur-yellow. *B. ringens* is very irregular and bright red. *B. plicata* has a delicate daytime odour. The genus may be known by its plaited hairy leaves, which are often on petioles.

Tritonia.—Flowers nearly regular, varying in colour, bright red or yellow, white, pale pink or green. Three lower lobes, sometimes marked with deep splashes of colour, sometimes furnished with conspicuous projections. Leaves few or in a fan-shaped rosette. Both Western and Eastern.

Gladiolus.—A great variety of colours is found in the flowers. Perianth tube curved, limb irregular, lobes often narrowed into a claw, the three lower often vividly marked. Seeds flattened, winged, numerous. "Painted Ladies" and "Kalkoentjes" belong here. Eighty-one species of this large genus are found in South Africa.

Antholyza.—Perianth tube suddenly widening at the middle, often twisted below. Seeds large, globose, not winged.

Order Hæmodoraceæ.

("The blood roots.")

Flowers perfect. Perianth regular or nearly so. Stamens 6, or 3 opposite the petals. Ovary wholly or partly superior or inferior. Fruit 3-celled or becoming 1-celled. Seeds one, few, or many. Herbs often covered with dense hairs. Never bulbous. Leaves often in two rows and firm. Roots often with a blood-red juice. Flowers in panicles. The order forms a connecting link between Liliaceæ and Iridaceæ, Amaryllidaceæ and Orchidaceæ.

Perianth remaining hairy.

- **Wachendorfia.**—Stamens 3. Fruit free, 3-celled.
- **Barberetta.**—Stamens 3. Fruit free, 1-celled.
- **Dilatris.**—Stamens 3. Fruit inferior, 3-celled.
- **Lanaria.**—Stamens 6. Fruit inferior, 1-celled.

Perianth not hairy.

- **Sansevieria.**—Perianth with a long tube. Fruit free.
- **Cyanella.**—Stamens unequal. Ovary half inferior. Perianth deciduous.

Wachendorfia.—Perianth funnel-shaped; sepals hairy outside. Stamens opposite the sepals. Capsule 1-seeded, splitting at the midrib of each carpel. Plants with yellow or brownish flowers, tuberous roots lance-like, plaited leaves and redjuice. Malmsbury to Uitenhage.

Lanaria ("Cape Edelweiss").—*L. plumosa* is a plant densely coated with white, soft-spreading, plume-like hairs on branches and flowers. Flowers in a dense panicle. Rootstock of fleshy fibres. Leaves several, in a rosette at the base of the stem, together with the fibrous remains of old ones.

Found about Port Elizabeth, Riversdale, and in Bain's Kloof.

Cyanella has racemes or panicles of delicate blue or yellow flowers, and may be easily recognized by the peculiar hand-like centre composed of the stamens, one of which is much larger than the others. Stamens opening by terminal pores. Leaves appearing before or with the flowers. Rootstock a corm, deeply sunk in the soil.

Order MUSACEÆ.

Perianth 6-parted; both sepals and petals coloured. Stamens 5. Ovary 3-celled. Fruit a berry, or capsule. Large

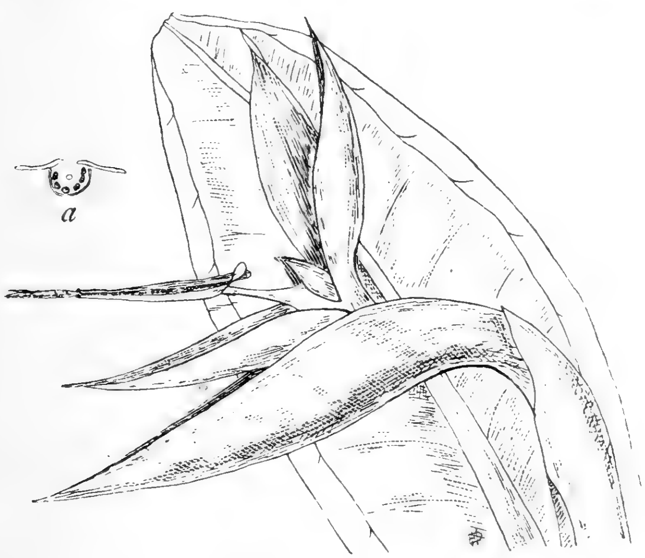


FIG. 200.—*Strelitzia regina.* *a*, cross-section of odd petal.

herbs with a rhizome and leaves rolled in the bud. The leaves are large, oval, with a stout midrib and parallel veins running from it to the edge. As they do not join as in Dicotyledons, they easily tear and become very ragged. The flower-stalk comes from the rhizome, and is surrounded at base by the leaves. The flowers are with large brightly coloured bracts.

Strelitza has large elliptical leaves on long petioles arranged in two ranks. The flower-stalks push through the sheathing petioles. The curious flower consists of three bright orange sepals, two standing erect. Two small blue petals form an archway over the entrance to the nectar, the other large arrow-shaped petal forms a lip containing the five stamens and style within a central groove. Beyond the lip the stigma is exposed. *Nectarinia afra*, one of the sun-birds, corresponding in colour to the flowers, probes for the honey with its long slender beak, and rubs first the stigma and then the anthers, which are exposed, by pressing down on the lip. The fruit is a capsule containing several black seeds with a bright orange feathery arillus. Eastern plants.

Musa (banana).—The sheaths of leaves, rolled around one another, give the appearance of long stems. The flowers are enclosed in brightly coloured bracts, and are also pollinated by birds. In the cultivated plants no seeds are developed from the ovules. Fruit a berry.

Order Orchidaceæ.

Strange and grotesque as the orchids often are, by careful study the same parts can be found as are present in the Iridaceæ. In the bud, three parts, the sepals overlap the petals. Two sepals are similar to each other, as are also two of the petals. The odd sepal may be, and the odd petal (the **lip**) is nearly always, peculiar in shape. These parts may be either very large and showy, or so reduced in size as almost to escape notice. As in the Iridaceæ, the inner circle of stamens is wanting in South African orchids. Of the outer circle, only one bears pollen. It is always opposite the odd sepal. The other two are peculiar staminodia. All three are joined with the style to form the **column**. Two of the stigmas are usually joined, forming a cushion-shaped body for receiving the pollen, while the third is enlarged and forms the rostellum. It furnishes a sticky fluid, which fastens the pollen grains together in bundles (pollinia). The three carpels unite to form a single chambered ovary, which is filled with an immense number of ovules. The fruit is an inferior capsule.

Dr. Bolus mentions that, with all the wonderful provisions for insect pollination, some orchids produce new plants entirely by tubers. This is possibly owing to the dying out of the insects which could effect pollination, owing to bush fires or other causes. The Western orchids are usually tuberous-rooted. Many in the East send up new shoots from creeping rhizomes, the food being sometimes stored in the lower swollen parts of stems.

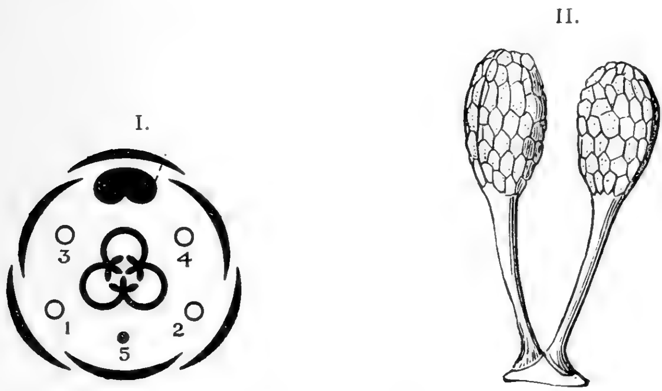


FIG. 201.—I. Floral diagram of *Disa*. (From Edmonds and Marloth's "Elementary Botany for South Africa.") II. Pollen masses of an orchid joined to a single gland. (From Thomé and Bennett's "Structural and Physiological Botany.")

KEY TO SOME OF THE LARGER GENERA OF ORCHIDS.

A.—Anthers lid-like.

Liparis.—Pollen masses waxy, without a gland.

Pollen masses joined to the rostellum with a gland—

Eulophia.—Lip with a short sac or spur.

Lip with a long spur—

Angræcium.—Pollen masses joined to one gland.

Mystacidium.—Pollen masses with two glands.

AA.—Anthers without a lid. Pollen masses granular, attached to a stalk.

Sepals and petals free from each other.

Sepals green, lip 1-spurred—

Bartholina.—Flowers solitary, lip deeply fringed.

Holothrix.—Flowers spiked, lip not fringed.

Sepals petaloid—

Satyrium.—Lip at the back, 2-spurred or saccate.

Disa.—Lip mostly in front, never spurred or saccate; stem straight.

Schizodium.—Lip in three distinct sections, base, middle, and apex; stem bent at the nodes.

Odd sepal and petals cohering together.

Side sepals free—

Disperis.—Side sepals spurred or saccate.

Side sepals not spurred or saccate—

Habenaria.—Odd petal with a long spur.

Odd petal not spurred—

Pterygodium.—Hood erect.

Ceretandra.—Hood nearly flat and horizontal.

Corycium.—Side sepals joined to form a lower lip.

FIG. 202.—*Eulophia.*

Eulophia.—Sepals and petals nearly equal. Lip saccate or with a short spur, smooth or crested or bearded on longitudinal furrows. Lip sometimes in front, sometimes at the back of the opened flower, its position depending upon whether the ovary is straight or twisted. Pollinia attached to one gland. Flowers small, dull coloured, shaded with purple, green, or white. The base of the leaves often forms a bulb-like swelling above ground.

Extending from Cape Town to Natal, but more common in the East.

Angræcium and **Mystacidium** are genera with much the same habit and appearance. They are epiphytes, often festooning the trees with beautiful showers of white blossoms. The flowers are sometimes yellowish, and very small. Eastern districts and Natal.

Fig. 203.—*Mystacidium filicome.* An epiphytic orchid with aerial roots.

Bartholina is one of the prettiest and daintiest of orchids. It may be known at once by the peculiar lip, with its many long, slender projections. There are two species: in *B. pectinata* the lashes are pointed and curve downward; in the rarer species they curve upward, and each is tipped by a tiny knob. The solitary flowers are white, delicately tinged with purple. Leaf solitary, radical, flat on the soil. *B. pectinata* extends from the Cape peninsula to Grahamstown. Flowering in November and December.

Satyrium is distinguished from other orchids by the two spurs of the hood-shaped lip at the back of the flower (*i.e.* next to the stalk). The sepals and two petals form the lower portion of the flower. The anther is in front, as the ovary is not twisted, and the glands of the pollinia lie in the notched rostellum. In *S. rhyncanthum* the two pollinia are joined to one gland.

Leaves two or one lying flat on the ground, or more than two erect. Flowers in dense spikes, white, brilliant yellow, orange, or a beautiful rose colour or dull brown. Different species may be found in flower from July till December. A widely distributed genus.

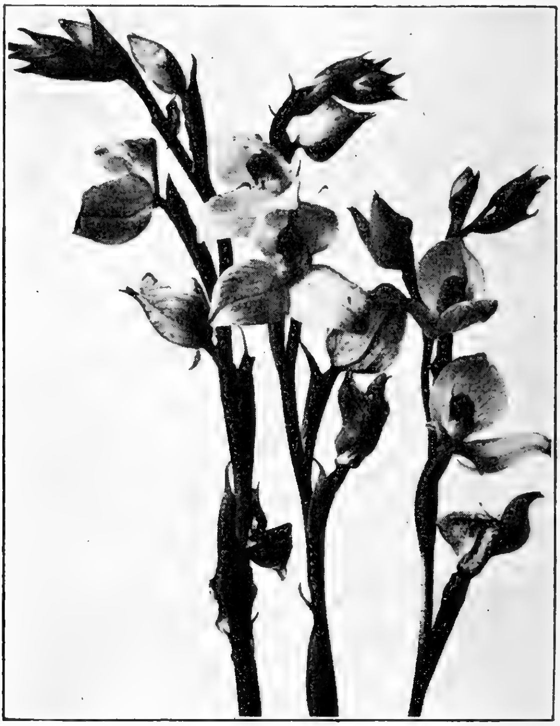


FIG. 204.—*Disa racemosa.*

Disa.—Sepals nearly equal and separate; the odd one, which is usually at the back, and forms the conspicuous part of the flower, is helmet-shaped, 1-spurred or saccate. The lip in most species is small. In the blue Disa it is quite showy. Scapes leafy, or the leaves reduced to bracts. Roots tuberous. *D. uniflora* (usually called *grandiflora*) is the finest one, although others are quite beautiful if less showy.

Schizodium is similar to *Disa*, but the sharp angles at the nodes will tell this genus. Petals narrow, 2-lobed at the tip, or twisted, and often eared at base. The lip is another distinguishing feature. It is as long as the sepals, narrowed above the base and often pointed, or the tip may be broad and waved, marking the lip into three distinct parts—a lower, upper, and middle.

FIG. 205.—*Disa melabenca.*

Disperis, Pterygodium, and **Ceretandra** are nearly allied genera with the differences given in the key. In *Disperis* and *Ceretandra* the lip is clawed. Pterygodium has a sessile lip, and, like that of Disperis, it is often bent back over the column into the helmet.

Habenaria is a large genus found chiefly in the East. It may be recognized by the long spur of the three-parted lip and the usually 2-parted petals. The lip is sometimes entire.

Stem either leafy at the base or the entire length. Flowers in spikes or racemes, large or small, sometimes quite beautiful, though not bright coloured. Found in February and March.

Corycium is nearly like Pterygodium, but the two sepals join in front to form a lower lip. The stigmas are two, separate, or one 2-lobed. Capsule usually much narrowed toward the apex. Stem leafy. Leaves flat or crinkled.

Order Amentaceæ.

The orders **Salicineæ, Myricaceæ,** and **Fagaceæ** have been united under the one order **Amentaceæ,** since the flowers hang in aments or catkins (except the pistillate flowers of the oak). The flowers are diœcious or monœcious. They are out in good season in the early spring, and are swinging their gold-and-silver tassels before the leaves get large enough to be in the way of the wind-scattered pollen.

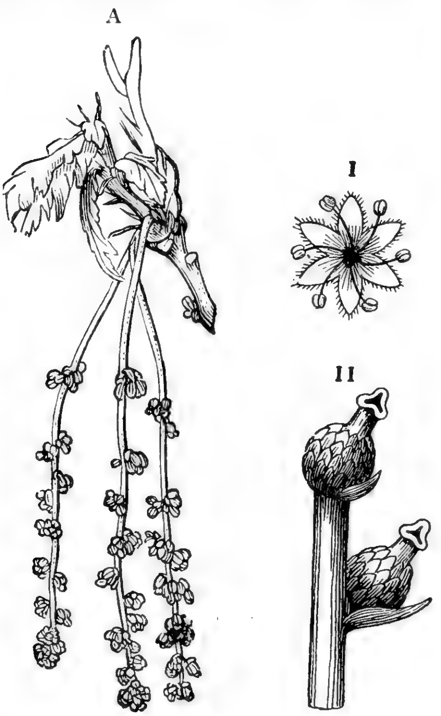


Fig. 206.—A, Catkin or amentum of the Oak. I. Flower of Oak. II. Female flowers. (Both × 3.) (From Edmonds and Marloth's "Elementary Botany for South Africa.")

The flowers of willows, poplars, and Myrica (the Wax Bush) are subtended by a single bract. The staminate flowers of the oak have a greenish 6-parted perianth. The few genera in each order, and the simple flowers, indicate that these orders represent very old families of flowering plants.

Salicineæ. — Flowers diœcious. Capsules containing many minute seeds. The order contains two genera, *Populus* (Poplars), and *Salix* (the Willows). Both consist of deciduous trees, which border the streams in many parts of the country.

They are introduced from the northern hemisphere. *Salix capensis* is a native of South Africa.

Myricaceæ.—Flowers diœcious or monœcious. Fruit indehiscent, dry, or covered with waxy scales. **Myrica**, the wax berry plant, referred to on p. 206, is the only genus.

Fagaceæ.—This order contains trees with scale-like stipules, which drop off as the leaves open. Stamens often surrounded by perianth leaves. Fruit a nut surrounded by an involucre, the cup of the acorn and the burr of chestnuts.

Fig. 207.—*Protea nana.*

Quercus (the Oak) and **Castanea** (the Chestnut) represent the two genera of this order which have been introduced into South Africa.

Order Proteaceæ.

The Proteaceæ, the glory of the Cape, are found also in Australia, the mountains of Tropical Africa, as well as in South America. Most of the plants of this order live in regions where there are long dry summers, and since they are neither succulent nor bulbous plants, their xerophytic habit is shown in their leaves. These meet their need of preventing transpiration in such a variety of ways that the order has received its name from the mythical sea-god Proteus, who delighted in a constant change of form.

A reduction of the leaf surface is a simple mode of preventing transpiration. Australian *Hackea* (used for hedges), *Serruria*, and *Protea nana* adopt this plan. *Protea cynarhoides* has broad leaves, but they are protected by a thick leathery cuticle. The coating of hairs on the silver leaves have a similar use, and, like all white surfaces, reflect the light-rays which would heat the plant. The sugar-bush leaves present their edges to the light by a twist at the base.

Flowers usually perfect. Sepals 4, coloured; petals wanting. Stamens 4. Anthers sessile in the tips of the sepals (except Brabeium). Ovary superior, 1-celled; style long. Fruit an achene in South African species.

A.—Flowers imperfect.
- Staminate flowers in racemes . . . . AULAX.
- Staminate flowers in heads . . . . LEUCADENDRON.

AA.—Flowers perfect.
- Flowers many in a head.
  - Calyx irregular, 2-lipped, 3-sepals or all, cohering.
    - Bracts showy, surrounding the head.
      - Fruit bearded, tailed by the style. . PROTEA.
    - Bracts not showy, subtending each flower.
      - Fruit neither bearded nor tailed . . LEUCOSPERMUM.
  - Calyx regular, 4-parted.
    - Achene not on a stalk; leaves flat . . MIMITES.
    - Achene on a short stalk; leaves pinnate parted, needle-shaped, rarely entire . SERRURIA.
- Flowers in 1-flowered or 2–6-flowered involucred heads, clustered in spikes or heads.
  - Calyx regular.
    - Achene not stalked; upper leaves entire or cut, lower pinnati parted . . . NIVENIA.
    - Achene stalked; leaves linear entire, or some of the lower compound . . SOROCEPHALUS.
  - Calyx irregular, 1 sepal larger . . . SPATALLA.
- Flowers in spikes or racemes (not in heads).
  - Anthers sessile; nut bearded; spikes terminal; leaves alternate, not notched . . . FAUREA.
  - Anthers on short filaments; drupe velvety; racemes axillary; leaves whorled, serrate BRABEIUM.

Leucadendron.—Flowers borne in cone-like heads. Involucre formed by the upper leaves, which give the delicate yellow colour to the veld in spring where these shrubs abound. In some species the involucre is reddish. The fruit may be flat, and distributed by wings or globose, as in the Silver Tree (*L. Argenteum*). Seventy species, chiefly in the Coast region.

Protea may be distinguished by the showy involucres, serving, in some species, as a landing-place for birds which aid in pollination. The involucres of *P. mellifera* (the Sugar Bush) are often half filled with honey in the early morning. Erect or

FIG. 208.—*Protea macrophylla.*

prostrate shrubs or trees. Sixty species. Extending from the Cape up through Central Africa.

Leucospermum.—Trees or shrubs, sometimes trailing with yellow flowers, mostly terminal. Twenty species, chiefly Western.

Mimetes has the habit of Leucospermum, but the flowers are reddish or purple, and the heads small.

Serruria may be known by the needle-shaped, usually divided leaves, and purplish silvery heads, frequently in clusters. Shrubs erect or trailing. Fifty species, chiefly Western.

Nivenia has 4-flowered heads in terminal spikes. Involucres hardened in fruit. Twiggy shrubs, known by the two kinds of leaves. Thirteen species.

Faurea.—The calyx bursts below like that of the Silver Tree, but finally falls off. Nut bearded; style finally falling. Native of Natal and Rhodesia.

FIG. 209.—*Leucospermum conocarpum.*

Brabeium (Kaffir Chestnut or Wild Almond).—Staminate, pistillate, and perfect flowers are found on the same stalk. A shrub with whorled leaves common along streams. The almond-like fruits, when roasted, make a good substitute for cocoa, though they are poisonous if eaten raw.

Order Loranthaceæ.

The order consists of partially parasitic plants, which attach themselves, by means of haustoria or modified roots, to other plants. The leaves (when present) and stems possess chlorophyll. Perianth either sepal-like or petaloid. Stamens joined to the perianth, and as many as its lobes. Fruit a berry, sunk in the fleshy receptacle. Around the seed is a very sticky substance, which prevents it from being swallowed by birds. In freeing its bill from the seed the bird sows the seed on the tree.

Loranthus.—Flowers perfect ; showy style long.
Viscum.—Flowers imperfect ; style none, or very short.

Loranthus.—Shrubby plants, with opposite or alternate leaves. Flowers in umbels, axillary, orange, scarlet, or white with dark tips (see p. 128). Parasitic on Acacia, Rhus, and other plants. Eastern.

Viscum (Mistletoe).—Shrubs with forked, jointed green stems, leafy or leafless. Berries white or reddish. Parasitic on Euphorvia, willows, Crassula, etc. Several species, both Eastern and Western.

Order Hydnoraceæ.

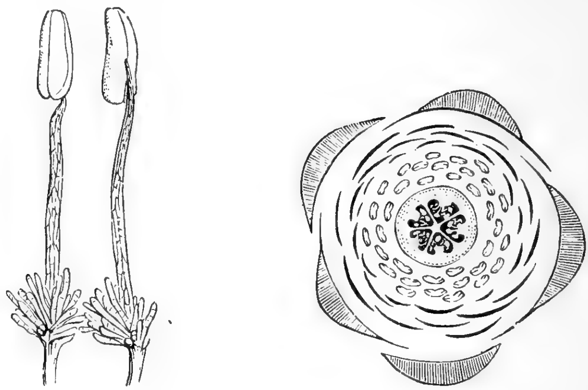
Fleshy, scaly-coloured parasites, becoming very woody. Calyx 3-parted. Fruit indehiscent, many-seeded.

Hydnora is an ill-scented parasite on the roots of Euphorbia.

Order Ficoideæ.

Herbs, usually succulent, with calyx or stamens petaloid. The ovary may be few- or many-seeded, superior or inferior. The most familiar orders are **Mesembryanthemum** and **Tetragonia.**

Mesembryanthemum (Hottentot Fig genus).—The species of this genus are well fitted for their life on the hot, dry sands or sea coast, where they flourish. The leaves store an abundance of moisture, and stand erect, face to face, at the growing point to protect the bud. The leaves of *M. Crystallinum* are covered with globe-shaped hairs, which glisten in the sun. The fruit, unlike most capsules, opens and scatters its seeds only in moist weather, when the seeds can germinate. The parts may be made to open and close again and again by placing them alternately in a glass of water, and then drying them in the sun. Dr. Marloth has called our attention to the similarity of the angular leaves to the rocks and pebbles among which they grow, which is a protection from grazing animals, as is also the astringent juice of the leaves. The showy part



I. II.

FIG. 210.—*Mesembrianthemum.* I. Stamens. II. Diagram. (From Henslow s "South African Flowering Plants.")

of the flower is made of stamens which have changed into petal-like bodies. The ovary is inferior, many-seeded, usually 5 (4–20-celled). The stamens and glandular receptacle secrete honey. Three hundred species. Abundant south of the Orange River and west of the Fish River.

Tetragonia.—Calyx 4-parted, yellow within. Stamens varying in number. Ovary inferior, 1–9-celled (usually 4-celled). Fruit sharply 4-angled, winged or horned; cells 1-seeded. Succulent herbs, spreading, or sometimes erect and shrubby. Fruit often ripening under the protection of the fleshy leaves close to the ground.

Order CARYOPHYLLACEÆ.

Flowers with both calyx and corolla or carolla wanting. Stamens 4–10, free from the perianth. Ovary superior, 1-celled, or at the base 2–5-celled. Styles 2–5. Ovules 2-many-seeded. Placentation, free central. Flowers arranged definitely. Capsule opening by teeth.

Herbs with opposite, usually simple leaves, often stipulate. Stem often swollen at the nodes. Carnations belong to this order.

The order consists of honey-forming plants of two groups, one being polysepalous for short-tongued insects, the other having a gamosepalous calyx in which honey can be reached only by long-tongued butterflies and moths.

I.

A. Calyx gamosepalous. Ovary raised on a stalk (gynophore).

Silene.—Calyx ribbed. Petals on long claws, the limb entire or divided. The flower-stalk is continued a node between the perianth and the other parts of the flower. This node

II.

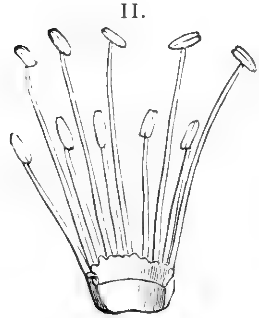


FIG. 211.—*Dianthus caryophyllus.* I. Portion of plant (natural size). II. Stamens (magnified). (From Thomé and Bennett's "Structural and Physiological Botany.")

is called a **gynophore**. Stamens 10. Styles 3, corresponding to the number of carpels.

Small herbs often with sticky hairs, which guard the nectar from pilferers. On account of the small seeds, it is called the gunpowder plant. Children make pretty necklaces of the smooth shiny fruits.

Dianthus (the carnation genus) differs from Silene in the smooth calyx tube, surrounded at base by several bracts. Styles 2. Herbs with generally grass-like leaves.

B. Calyx polysepalous. Ovary not raised.

Spergula, Stellaria, and **Cerastium** are common spreading weeds found in cultivated places. The flowers are small and often self-fertilized.

Stellaria media has small white flowers with 2-parted petals. There is a double row of hairs at each internode, which may be for conveying the water off in drying the plant, or they may absorb the water that runs down the stem.

Order Ranunculaceæ.

Sepals 3–20, mostly 5, usually deciduous. Petals 5–15 or wanting. Stamens and carpels many, stamens ripening first. Flowers visited by various insects. Leaves alternate, except in **Clematis**, with broad sheathing bases. Herbs or twining shrubs, mostly perennial, with rhizomes. Each year's shoot ends in an inflorescence.

A. Climbing shrubs with opposite leaves.
  Clematis.—Sepals valvate, 4–8. Carpels with feathery tails.
B. Erect herbs with alternate or radical leaves.
  * Sepals coloured. Petals none.
    Thalictrum.—Sepals 4–5, shorter than stamens. Carpels without tails.
    Anemone.—Sepals many, longer than the stamens. Carpels tailed.
  ** Sepals green. Petals present.
    Knowltonia.—Sepals 5. Petals many. Carpels juicy.
    Ranunculus.—Sepals 3–5. Petals 5–10, each with a honey scale at the base.

Clematis.—Flowers white or delicate green in definite clusters. No petals or honey secretion. Climbing by means of the sensitive petioles. "Klimop" or "Traveller's Joy."

Each indehiscent fruit is wafted by the feathery styles, carrying the seed to its final resting-place. Found east of Swellendam.

The fleecy clusters of feathery fruits render as much joy to the "traveller" as the flowers themselves.

Thalictrum.—Sepals soon falling, leaving the tufts of purplish stamens with slender filaments and large anthers. Carpels 4–8. Stem 2–3 feet high. Wind pollinated. Kaffirland.

Anemone.—The large delicately tinted calyx makes this one of our most beautiful flowers. The Eastern species, *A.*

FIG. 212.—Flowering branch of Clematis. Two stamens have changed to petals.

caffra, is stemless with lobed leaves. *A. capensis* in the West has much-cut leaves.

Abundant on shady, grass-covered mountains lopes. From Groenkloof to Swellendam.

Knowltonia (Brand blaren).—Petals greenish. Herbs with radical compound leaves. Flowers in branching cymes or umbels. Throughout the Colony.

Ranunculus.—Sepals falling. Petals bright yellow, each with a scale at the base.

Weeds with lobed or divided leaves growing in damp places, sending out rhizomes or runners. Cultivated species become double and showy.

Order Cruciferæ.

Sepals 4, in two whorls. Petals spread in the form of a cross, often clawed. Stamens 6, in two whorls, the two outer

Fig. 213.—*Anemone capensis.*

shorter (**tetradynamous**; four in power). Carpels 2, with parietal placentation. A thin white partition grows up between the carpels. The carpels usually split up from the centre, leaving the placentas surrounding the partition. Fruit a siliqua, silicua, or a lomentum. The stamens have nectaries at the base which pour honey into the pouched bases of the inner sepals. The flowers are often borne in corymbs, which brings a number of flowers close together, so that a good many can be pollinated in a short time. As the flowers blossom the stalk lengthens, and so it forms a simple raceme. The flowers are not subtended by bracts, as is usually the case. Many garden vegetables belong to this order, as the Cabbage, Turnip, Mustard, and Cress.

Heliophila ("the sun-loving plant") is a familiar wild flower of this order. The flowers are bright blue, yellow, or

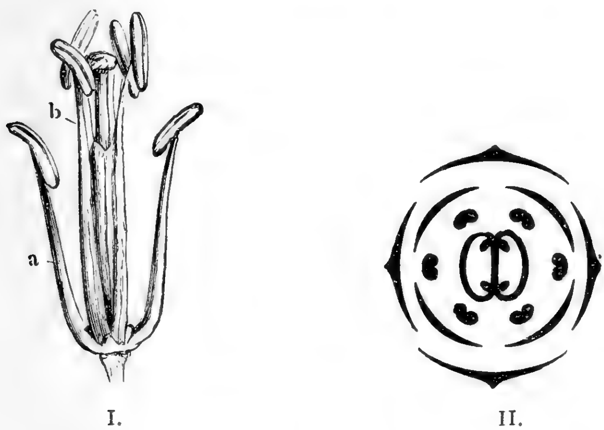


FIG. 214.—I. Tetradynamous stamens and pistil of *Brassica nigra*: *a*, shorter, *b*, longer stamens. II. Floral diagram. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

white. The pods are straight edged, or sometimes constricted between the seeds, forming pretty bead-like siliquas. Delicate herbs or half shrubby plants. About 60 species are known, both Eastern and Western.

Capsella is a common weed with a heart-shaped silicula for a fruit.

Brachycarpea is a handsome Western genus with large purple or yellow flowers. The fruit is indehiscent, the carpels falling apart and carrying the single seed. A twiggy half shrub, 3 feet or more high.

Brassica is a genus of common garden plants. They are interesting in showing how one group of plants can, when cultivated, develop along different lines; the cabbage stores its food in the leaves, the turnip in the root, and cauliflower in the flowers.

Order CAPPARIDEÆ.

This order resembles the Cruciferæ in the 4 sepals in 2 whorls. Four petals. The stamens are sometimes 6 as

FIG. 215.—*Cadaba juncea.*

in Cruciferæ, but vary from 4 to many. The ovary is formed of 2 carpels meeting at their edges with parietal placentation, but there is no false partition or **replum**. The order may be recognized by the long stalk or gynophore which extends the ovary beyond the perianth. The stamens also may be raised on the stalk. Herbs, shrubs, or trees with simple or compound leaves, often with sticky hairs. Fruit a capsule or berry.

A. Fruit a capsule—

Gynandropsis.—Stamens 6. Capsule pod-like, 1-celled, many-seeded. The stem axis is lengthened between the petals and stamens, and also between the stamens and ovary. Herbs with compound leaves, the upper sessile, the lower on long stalks.

B. Fruit a berry—

Calyx persistent—

Niebuhria.—Berry roundish. Calyx funnel-shaped. Petals small or none. Trees or shrubs with simple or compound leaves.

Mærua.—Berry long, many-seeded. Trees with simple leaves. Natal.

Calyx deciduous—

Cadaba. — Stamens 4–8, raised with the ovary on a gynophore. *Cadaba juncea* is shown in Fig. 215. It is a much-branched, twiggy, pale, leafless shrub about 2 feet high. Flowers yellow or purplish. Fruit a long berry with sticky hairs.

FIG. 216.—Flowering branch of *Capparis*. (From Henslow's "South African Flowering Plants.")

A Karroo plant formerly called **Schepperia** "in honour of some obscure botanist whose memory has otherwise passed away."

Capparis (the Caper).—Stamens 8–many, on a slightly raised disc. Ovary on a long gynophore. Trees or shrubs with simple leaves, often climbing by means of thorny hooked stipules.

Order DROSERACEÆ (the Sundew Family).

Flowers regular, perfect. Sepals 5. Petals 5, very delicate. Stamens 5. Carpels 2, 3, 5. Ovary 1–5-celled. Styles long; stigmas simple or branched. Fruit a capsule. Flowers in cymes. Herbaceous plants with a perennial rhizome. Insect-devouring plants. Of the six genera of this order, two are found in South Africa.

FIG. 217.—*Drosera cistiflora.*

Drosera.—Delicate herbs with a rosette of leaves or a leafy stem; covered with curious "tentacles;" or stalks ending in swollen purple heads which glisten with a sticky fluid. Flies, mistaking this for honey, are caught fast. The tentacles are so sensitive to even a gentle pressure that they curve inward and smother their hapless victim. A fluid in the purple heads digests the food containing nitrogen in the insect's body. This is used by the plant especially in seed-making, although the plants can live without insect food. This is why sundews can live in very poor soil which will support nothing else. The genus is found in all parts of the world.

Roridula is a branched shrubby plant. The tentacles do not curve over the victim, as in Drosera.

Order CRASSULACEÆ.

Flowers perfect, regular. Sepals and petals 4–7. Petals separate or united. Stamens as many or twice as many as the petals. Carpels separate, as many as the petals, with a gland at the base of each. Fruit a group of follicles. Flowers in cymes. The plants are mostly herbs or half shrubs, living in hot, dry climates with the necessary outfit for such situations. Water is stored in the stems and leaves. The leaves are often packed closely, as in *Crassula pyramidalis* (p. 77), and have a waxy or a lime-incrusted surface.

FIG. 218.—*Crassula arborescens.* (From "Botanical Magazine.")

A. Stamens as many as the petals—

Grammanthes. — A small annual growing in sandy soil, with orange or cream-white flowers commonly marked with a V-shaped dark spot on each petal. Stems wiry, with distant pairs of leaves.

Rochea. — Corolla gamopetalous. A half shrub with handsome flowers, crimson, white, or yellow. Stamens borne on the corolla tube. Leaves opposite, sheathing or joined at base.

Crassula.—Corolla polypetalous. Shrubby or herbaceous plants, with white, red, or yellow flowers. Flowers smaller than in Rochea, arranged in cymes. Leaves usually opposite, and connate often fringed with fleshy hairs.

AA. Stamens twice as many as the petals—

Cotyledon.—Corolla gamopetalous, showy, with an egg-shaped tube and spreading limb; either in cymes or racemes, hanging. Succulent plants with opposite or alternate fleshy leaves. Mostly Eastern.

Kalanchoe.—Calyx 4-parted. Corolla with an urn-shaped tube and spreading limb; yellow, turning to red. Flowers in closely branched cymes or loose panicles. Succulent half-shrubs with opposite leaves. Eastern.

Bryophyllum differs from *Kalanchoe* in the inflated calyx. *B. prolifera* has both simple and compound leaves on the same plant.

The name means "sprouting leaf." The fleshy leaves fall to the ground, and young plants sprout from the notched edges. These send out roots, and finally the entire plant takes root. See Fig. 93, p. 90.

Order Rosaceæ.

Like the Ranunculaceæ, the Rosaceæ have many free stamens and apocarpous ovaries; but in the Rosaceæ the

Fig. 219.—Flower of Peach with stamens around the ovary. (From Henslow's "South African Flowering Plants.")

receptacle is generally hollowed, and the flowers are perigynous or epigynous. The carpels are often borne on a raised portion of the receptacle, as in Ranunculaceæ. Sometimes the receptacle is free from the carpels, and sometimes joined to them, as in the apple.

The plants of this order are usually trees or shrubs with simple or compound stipulate leaves. To this important order belong many of our fruits, as apples, pears, peaches, strawberries, blackberries, as well as the roses. The flowers are open, and expose their honey to bees and flies.

Our definition of a fruit as a ripened ovary is not satisfactory for such fruits as the apple and strawberry. The fruit is better defined as **that part of the flower which is stimulated to growth because of fertilization.**

The garden fruits and roses have been introduced into South Africa.

Rubus (the bramble) is a native of the Colony and of Natal. The fruit is a cluster of little drupes. Trailing shrubs armed with prickles.

Geum has handsome bright yellow flowers 1–1½ inch across. The achenes are very hairy, tailed with the hooked or curved styles. *G. capensis*, the only species, is a herbaceous plant 1–2 feet high, with large radical leaves and a few small stem leaves. From Grahamstown to Natal.

Cliffortia.—Calyx 3-parted (sometimes 4). Corolla wanting. The flowers secrete no honey, but the stigmas are wind pollinated. The staminate flowers are often found a long distance from shrubs bearing pistillate flowers. Leaves trifoliate, or the three leaflets may be joined into one. Many have reduced leaves tipped with sharp points. A common bush in the Colony and Natal with small greenish axillary flowers.

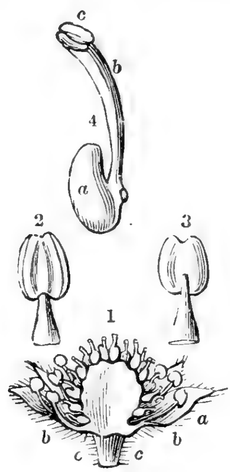


FIG. 220.—1, Flower of strawberry cut through; 2, front; 3, back of stamen; 4, pistil: *a*, ovary; *b*, style; *c*, stigma. (From Henslow's "South African Flowering Plants.")

Grielum is a trailing plant with hoary compound leaves, growing in sandy places and salt ground. Calyx joined with the 5-parted succulent fruit. Corolla regular, 5-parted, with the 10 stamens borne at the throat of the calyx (receptacle), tube. Flowers are large, yellow, and the plant may be mistaken for a geranium.

Order Leguminoseæ.

This order, the second largest in the world, is found in every kind of soil, in any climate, and shows a corresponding variety in habit. Trees, shrubs, herbs, erect, climbing, or prostrate. Because of the bacteria which live in their roots, they can thrive in and enrich very poor soil. The plants climb by leaf tendrils, stem tendrils, by twining, and by hooks. Leaves alternate, stipulate, and nearly always compound. Fruit usually a legume, sometimes a lomentum. Some pods explode and scatter their seeds. *Sutherlandia* has inflated pods which catch the wind. The pods of *Medicago* are furnished with hooks, which catch hold of the passer-by and get free rides.

Inflorescence a raceme. The order is divided into three groups or sub-orders.

Mimoseæ. — Flowers regular. Corolla valvate. Stamens many.

Cæsalpineæ.—Flowers irregular, back petal folded within the side petals, which are overlapped by the front petals. Stamens 10 or fewer.

Papilionaceæ.—Flowers irregular, back petal (standard) folding over the side petals (wings or alæ). The side petals overlap the two front petals, which join to form the keel. Stamens 10.

In some flowers of this group the stamens and pistil are held in the keel, and are released with an explosion, as in *Indigofera*, so that only one visit of the bee is invited. In the sweet pea, a brush on the style sweeps the pollen out of the keel. In the bean and Snail Creeper the stigma is forced out when the bee presses down upon the wings, and returns when it flies away, so that the bee is invited repeatedly.

I.

II.

III.

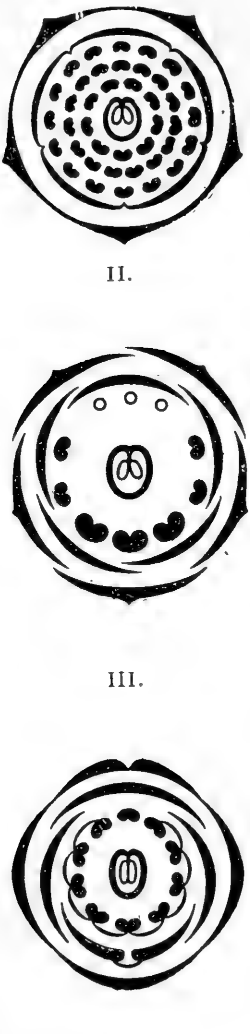


FIG. 221.—Floral diagrams of Leguminoseæ, showing folding of sepals and petals in I. Mimoseæ; II. Cæsalpineæ; III. Papilionaceæ.

Sub-tribe MIMOSEÆ.

Acacia.—The minute flowers are clustered in golden heads. They are delightfully fragrant. The sepals form a short tube.

Trees with twice-pinnate leaves, except in the Australian wattles, which often develop the blade only in the first few leaves. The petiole becomes flattened (Phyllodes) with the edge turned toward the sun.

A. horrida (Karroo Thorn or Doornboom) has ivory-white thorns (stipules). *A. giraffe* has strong brown thorns.

Elephantorhiza (Eland's bontjes) is a small glabrous shrub with very large roots. Stamens 10. Capsule opening like a siliqua.

Sub-tribe Cæsalpineæ.

Cassia.—Flowers nearly regular, yellow. Stamens 10, or the 3 upper wanting. In some the lower anthers are longer, and open by terminal pores. These brush against the insect's body while it is eating pollen from the upper ones. The ovaries bend to the right in some flowers, toward the left in others. Trees or shrubs. Eastern.

Schotia.—A handsome Eastern tree, with panicles of crimson or pink flowers. *S. latifolia* (Boer boom) has monadelphous stamens. Each seed has a yellow cup-like arillus. The pods are roasted for food.

Sub-tribe Papilionaceæ.

A. Stamens free.

Podalyria.—Legume rounded, woolly. Leaves simple or palmately compound.

Silvery-leaved shrubs with deciduous stipules. Flowers purple, rosy, or bluish white.

Virgilia.—Legume flattened, woolly, stuffed between the seeds. Calyx silky. Flowers rosy purple.

V. capensis, the Wilde Keurboom, is a tree found along river-sides throughout the Colony. Leaves compound. Leaflets becoming smooth above, woolly, and rolled beneath.

AA. Stamens monadelphous, forming a split tube. Shrubs or herbs with simple or palmately compound leaves.

Crotalaria.—Legume swollen (not flat), kept sharply beaked.

A large genus of shrubs with simple or compound leaves, and yellow, rarely purple, flowers in few-flowered racemes.

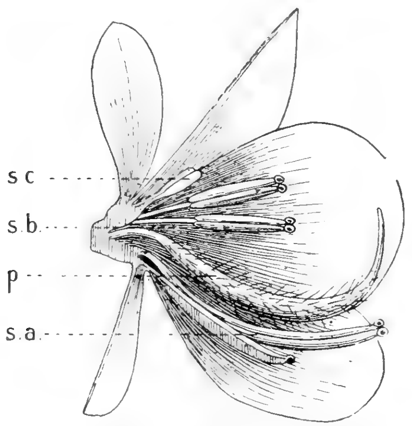


FIG. 222.—*Cassia arachoides.* Vertical section of flower: *sa*, large stamens; *sb*, small stamens; *sc*, staminodes. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

Aspalathus. — Calyx nearly regular. Flowers usually yellow.

Shrubby plants with heath-like tufted leaflets on a prominent cushion, which is often spine-pointed. The stems are often pale with brown markings.

AAA. Stamens diadelphous. Ovary 1-ovuled.

Psoralea.—Calyx concealing the pod, the lower lobe longer and broader than the others. Flowers purple, blue, or white.

A large genus of shrubs or herbs, with pinnate or trifoliate leaves, rarely one foliate, with stipules, and commonly marked with black resinous dots. Strongly scented. Common, often along water-courses.

AAAA. Stamens diadelphous. Ovary 2- to several-ovuled.

B. Small herbs, erect or trailing, but not climbing. Leaves 3-, rarely 5-foliate.

Trifolium.—Calyx showy after flowering, concealing the fruit. Keel joined to the wings. Flowers small, red, white, or yellow, in dense spikes or heads. Leaves usually 3-foliate, stipules joined to the petiole. Herbaceous annual or perennial. The clovers belong to this genus.

Medicago.—Legume not hidden, spirally coiled. Keel free from the wings. Lucerne belongs to this genus.

Indigofera.—Flowers red, purple, or white. Standard bent back. Keel with a spur at each side. Anthers with a small point at the top. Pollen scattered by explosion. Leaves imparipinnate, or 3 to many palmately compound. Legume usually with partitions between the seed.

BB. Trees or shrubs.

Sutherlandia.—Standard shorter than the keel. Legume inflated, papery, indehiscent. A fine shrub with scarlet or bright red flowers.

S. frutescens, the only species, is found throughout the Colony, usually on dry hillsides, sometimes near water.

Erythrina. — Standard very

FIG. 223.—Branch of *Medicago denticulata*.

FIG. 224.—Twisted legume of Lucerne (*Medicago sativa*). (From Thomé and Bennett's "Structural and Physiological Botany.")

much longer than the other petals. The petals forming the keel are not joined to form a support for visitors, as is usually the case, but the flowers are sometimes inverted, so that the standard can serve as a landing. Leaves pinnately trifoliate, the odd one removed from the other two.

Trees or shrubs with large handsome scarlet flowers. Stem and leaves often prickly.

Order GERANIACEAE.

Flowers perfect. Sepals 5. Petals usually 4. Stamens as many, or two or three times as many, as the petals, united at base. The order may always be known by the fruit of five carpels which split from a central beak. Each carpel carries its seed with it, or it may split and throw out the seed.

Herbs or shrubs, often hairy—

A. Flowers regular—

Monsonia.—Stamens 15, in groups of three. Annuals or perennials with usually deeply cut leaves. Peduncles with two bracts above the middle, and one, two, or several flowers in umbels. Flowers large and showy, usually pink or marked with pink.

Sarcocaulon.—Stamens 15, monadelphous. Much-branched, fleshy rigid shrubs, armed with spines, formed from old petioles. The stem is covered with a thick coating of wax and burns with a pleasant odour.

FIG. 225.—*Sutherlandia frutescens.*

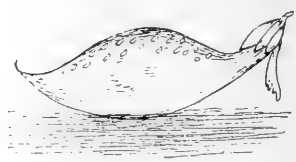


FIG. 226.—Inflated pod of *Sutherlandia frutescens.*

Found in very dry places of Eastern and North-Eastern districts.

Geranium.—Stamens 10, the alternate longer, with honey glands at the base. Herbaceous plants, with alternate or opposite leaves, palmately lobed. A small genus from the Peninsula to Natal.

Erodium.—Stamens, 5 with anthers and 5 without anthers, and gland at the base of the latter. Common weeds with simple leaves. Flowers mostly in umbels. The styles twist like a corkscrew on drying, and are caught fast in the weeds. When rain comes they uncoil, and as they lengthen push the seed into the soil. The downward pointing hairs help in scattering the seed.

AA. Flowers irregular—

Pelargonium.—Filaments 10, unequal in length. From 2 to 7 of them bearing anthers. There is but one gland,

FIG. 227.—*Monsonia speciosa.*

found at the base of the broad sepal. The honey is stored in a hollow spur joined to the flower-stalk.

A large genus, usually half shrubby, often with underground tubers in chains (moniliform). The flowers are often cultivated and are commonly called Geraniums, from which they differ in the irregular flowers, the stamens, and the one gland. The flowers often give forth a delightful odour at twilight.

Order Oxalidaceæ.

Flowers regular, perfect. Calyx imbricate; petals twisted in the bud, clawed, deciduous. Stamens 10, the 5 opposite the petals shorter. Ovary 5-celled, with styles of different lengths in different flowers. Fruit a fleshy capsule. The seed has a fleshy cup or arillus at the base. When ripe, this turns suddenly inside out, and the seed is shot off some distance.

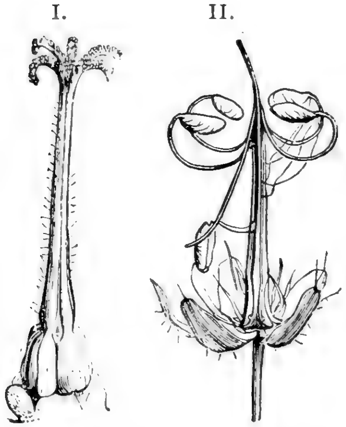


FIG. 228.—*Geranium*. I. Pistil with honey-glands below the ovary. II. Carpels splitting from the central column of coherent margins. (From Thomé and Bennett's "Structural and Physiological Botany.")

Oxalis.—Usually stemless herbs with compound leaves of 3 to many leaflets. The leaves sleep at night and on very cold days, and the flowers on very bright days as well.

Many species have underground bulbs and fleshy stems. Oxalis is one of our brightest winter flowers. Peeping out in April and May, they clothe the veld

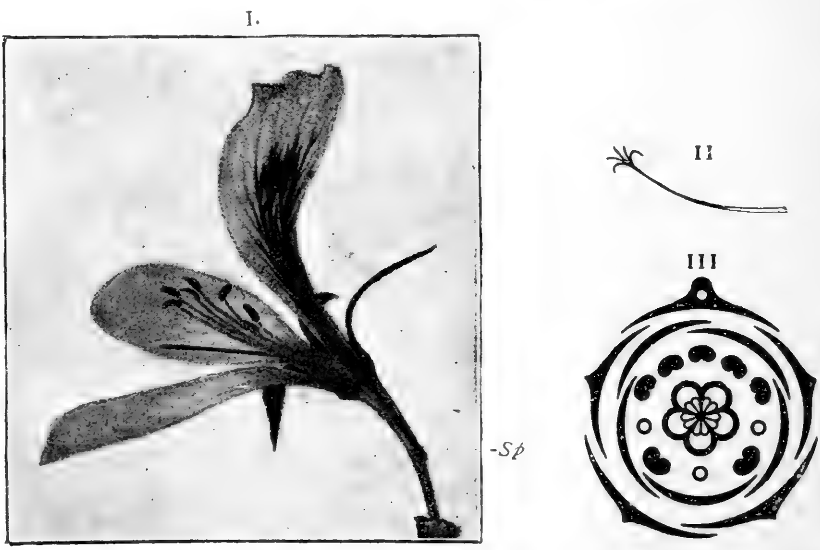


FIG. 229.—*Pelargonium cucullatum*. I. Section through flower, 2½ sepals and 2½ petals being removed; *Sp*, hollow spur of upper sepal. II. Style with stigmas ready for pollination. III. Diagram of flower. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

with masses of yellow, or stud it with white and red in many shades during July and August.

Order Sapindaceæ.

Flowers regular, or often quite irregular, with the ovary at one end of a boat-shaped flower, with a disc at one side of the ovary, between the stamens and petals. The

I. II.

Fig. 230.—The Oxalis. I. Awake. II. Asleep.

flowers are perfect or diœcious. The staminodes in the pistillate flowers are often so well developed as to be taken for perfect stamens. Stamens 4 to 10, more or less united at the base. Ovary usually a few-seeded capsule. Trees, shrubs, or half shrubs.

Aitonia.—Dear to the children's hearts is the "Christmas Tree" of the Oudtshoorn, Uitenhage, and Albany districts. Flowers more or less regular, with 8 monadelphous stamens bending toward one side of the flower. The scalloped disc is surrounded by the stamens. Flowers purple.

Of even more interest than the flowers are the gay clusters of balloon-like fruits, hanging purple and yellow and red among the narrow evergreen leaves. Such bright little lanterns are just the thing for lighting Christmas trees. The leaves come from clusters of dwarf cushion-like branches.

Melianthus may be mistaken for *Aitonia* from the similarity of the inflated fruit, but the leaves are compound, the petiole usually winged between the pinnæ. The flower has from 4 to 5 stamens. A horseshoe-shaped disc lies between the stamens and petals. During flowering the flowers turn on their axis halfway around. *M. dregeana* has a woody capsule.

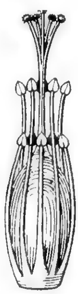


FIG. 231.—Stamens and pistil of Oxalis. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

FIG. 232.—*Aitonia capensis* (the "Christmas Tree").

Ptæroxylon (Sneezewood) and **Sapindus** (Wild Plum) belong to this order. Sneezewood furnishes beautiful wood, which takes a polish like mahogany.

Order RUTACEÆ.

Flowers perfect, regular. Sepals 4 or 5. Petals 4 or 5, twisted or imbricate. Stamens as many, or twice as many, as the petals. Those opposite the petals may be without anthers. Honey is made in a ring or cup-shaped disc around the ovary. Handsome heath-like shrubs often known by their gland-dotted leaves. The dots are cavities containing a strongly scented oil. Leaves opposite or alternate, without stipules.

FIG. 233.—*Melianthus minor.*

FIG. 234.—Woody capsule of *Melianthus dregeana.*

Some of the more familiar genera :—

Fruit a 5-celled capsule.
  Without staminodia.
    Diosma.—Petals neither clawed nor bearded.
  Staminodia 5.
    Ovary raised on a stalk.
      Calodendron.—A handsome tree.
    Ovary not raised.
      Style short.
        Adenandra.—Petals not clawed, or but slightly clawed.
        Acmadenia.—Petals clawed, the claw bearded.

Style as long as the petals.

Barosma.—Petals sessile. Flowers axillary.

Agathosma.—Petals clawed. Flowers terminal.

Fruit a many-celled berry.

Citrus.—Trees, often with axillary thorns.

The orange and lemon belong to this genus, which is not native in South Africa.

Diosma.—Petals and capsule longer than the calyx. Anthers tipped by a gland. Ovary sunk in the disc.

Small shrubs with alternate or opposite heath-like leaves. Flowers white or reddish.

Calodendron (Wilde Kastanien) is found in forests of the Eastern districts and Natal. Petals much longer than the

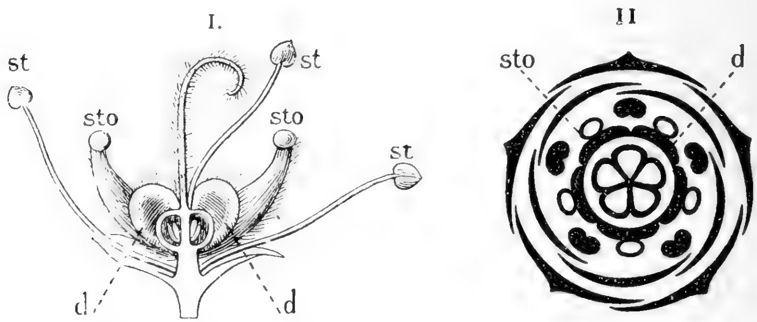


FIG. 235.—I. Section through flower of *Barosma crenulata* after the removal of the petals (magnified): *st*, fertile stamens; *sto*, barren stamens (staminodes); *d*, lobes of disc. II. Diagram of flower: *sto*, staminodes; *d*, disc. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

calyx. Staminodia petaloid. Leaves opposite and decussate, evergreen. Flowers white or purplish, in showy panicles terminating the branches.

Adenandra ("Shepherd's Delight").—Petals broad. Stamens and staminodia tipped with a gland. Capsule gland dotted. Small shrubs, with alternate or rarely opposite eaves, and pretty white flowers flushed with red at the back.

Barosma.—Petals much longer than the calyx. Stamens longer than the thread-like or petaloid staminodia, both bearing glands at the tip. Capsule eared at the tip. Small shrubs, leaves mostly opposite, bordered with glands. *B. crenata* is the true "Buku."

Agathosma.—Petals longer than the calyx. Staminodia, like slender clawed petals. Ovary 2–4-lobed. Small shrubs, with alternate or rarely opposite leaves. Flowers in heads or umbels (axillary in one species), white or reddish purple.

Order Polygalaceæ.

This order is often mistaken for Leguminoseæ, as the flowers suggest a gay swarm of little butterflies ready for flight. A difference in the flowers will be brought out by comparing

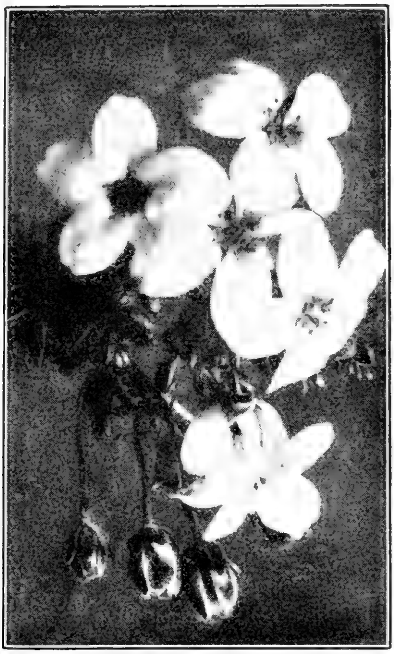


Fig. 236.—*Adenandra serpyllacea.*

the floral diagrams. Instead of a large standard at the back, the Polygalaceæ have two small petals. One large one in front forms the keel. The two side petals are often absent, and the wings are formed by the two broad coloured side sepals. The stamens are usually 8. The fruit a 2-celled capsule or a 1–2-seeded drupe.

Sepals very unequal, the two side ones wing-like.
Polygala.—Fruit a 2-celled, heart-shaped capsule.
Mundtia.—Fruit a juicy drupe.
Securidia.—Fruit a winged achene.

Sepals nearly equal, similar.

Muraltia.—Capsule flattened with 4 horns at the top.

Polygala is a large genus of shrubs or herbs, with showy mauve or white flowers in racemes, spikes, or heads. The stamens are concealed within the keel away from rain or marauder. As the bee lights on the fringe of the lower petal, its weight bears down upon the keel, so that the pollen, which has been caught in the spoon-tipped pistil, is pushed out and rubbed off on the bee's body. It is then carried to another flower and brushed off on the stigma, which is on the lower side opposite the spoon-tip.

FIG. 237.—*Polygala bracteolata*: *a*, section of fruit; *b*, stamens; *c*, section of flower. (After "Botanical Magazine.")

Mundtia spinosa is a stiff bush, with spine-tipped branches, 2 to 3 feet high. Flowers red or white. The berries are eaten by birds and children. Common in dry, rocky places and on the seashore.

Muraltia.—Usually small, rigid, twiggy shrubs. Leaves often ending in a sharp point. Capsule furnished with four horns. Flowers purple, or two petals white.

Order EUPHORBIACEÆ.

This large order is very prominent in South Africa. The plants, found in dry, rocky places, frequently resemble Cactus, which is not represented in the flora of this country. Unless the plants are in flower, it is often difficult to distinguish the two orders. The flowers of the Euphorbia family are inconspicuous and always imperfect. Both corolla and calyx may be absent. The fruit is a 3-celled capsule, which often bursts with an explosion and scatters the seed.

Euphorbia is the most familiar genus of the order. Like the Cactus plant, the stem may be reduced to a roundish or club-shaped body, with leaves reduced to spines. What at

FIG. 238.—*Euphorbia lathyris*. I. Part of a plant. II. Inflorescence. III. Male flower (magnified). (From Thomé and Bennett's "Structural and Physiological Botany.")

first seems to be a single flower is an inflorescence consisting of a group of staminate flowers and a single pistillate flower. The pistillate flower is raised on a stalk, and is reduced to an ovary. Each staminate flower is also raised on a little stalk or pedicel, and consists of one single stamen. The central stamens ripen first. The whole inflorescence is surrounded by a cup-shaped involucre of 4 or 5 united bracts. The delicate green *E. helioscopia* is a common weed. The *Euphorbia* often found in gardens (*Poinsettia*) is showy, with the large bright red bracts underneath the inflorescences. The genus has a milky juice.

Ricinus communis, the Castor-oil plant, is partly naturalized in the Colony.

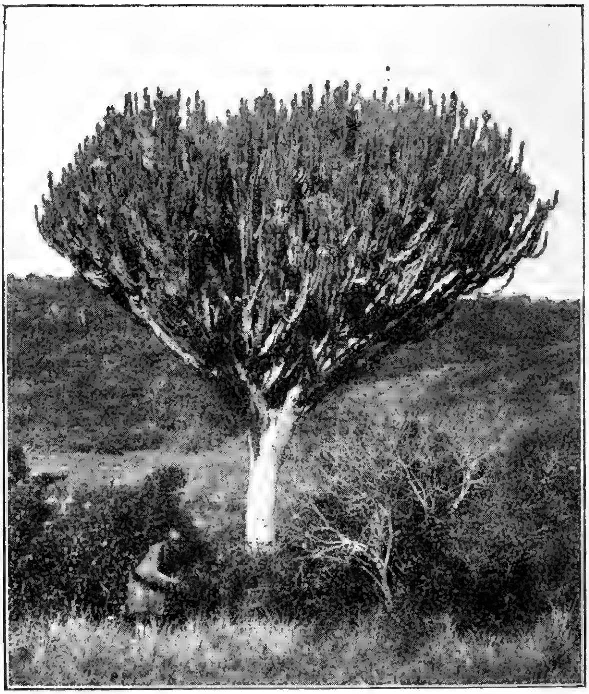


FIG. 239.—*Euphorbia* tree in Natal. (Wm. Laws Caney, Maritzburg.)

Order TILIACEÆ.

Flowers perfect. Sepals valvate. Stamens usually many, free or united in groups. Ovary superior. Fruit of 1–4 hard-shelled drupes or a capsule with hooked bristles. Trees or herbs, mostly with star-like hairs and stipulate leaves. Flowers in cymose umbels.

Flowers 4-parted—

Sparmannia is a handsome tree growing from George to

Natal. The flowers are showy, with white or purple sepals and petals. The stamens are sensitive, and spring outward on being touched. The outer filaments are staminodia. In South Africa the stamens are yellow, the staminodia purple-tipped.

Flowers five-parted—

Grewia.—Trees or shrubs with purple or yellow flowers and a 4-lobed drupe, containing 2–4 hard-shelled nuts.

Triumfetta.—Shrubs or herbs with small yellow or orange flowers. Capsule covered with long hooked or straight bristles.

Corchorus.—Herbs or shrubs. Leaves alternate, often bordered with long sharp points. Flowers yellow, on simple or branched stalks. The plants are cultivated in India for their fibres, which are woven into coarse cloth for gunny sacks.

Order MALVACEÆ.

Flowers perfect, regular. Sepals valvate, often surrounded by a circle of bracts (epicalyx). Petals 5, twisted in the bud. The stamens are always joined to form a tube (monadelphous), and attached to the petals at the base, so that at first the corolla seems gamopetalous. The stamens branch at the top, so that a great many half anthers are present (anthers with but one cell). The fruit is a capsule or a schizocarp with several carpels. The flower-stalk is jointed below the flower. The cotton plant (*Gossypium*) belongs to this order.

A. Fruit of separate carpels. Stamens bearing anthers at or to the very top.
  B. Stigmas as many as the carpels.
    C. Styles thread-like.
      Althea.—Epicalyx 6–9-leaved.
      Malva.—Epicalyx 3-leaved.
    CC. Stigmas cushion-like.
      D. Epicalyx present, 3-parted.
        Malvastrum.—Carpels with 1 ovule.
        Sphæralcea.—Carpels with 2–3 ovules.
      DD. Epicalyx wanting.
        Sida.—Carpels 1-seeded.
        Abutilon.—Carpels 3–12-seeded.

BB. Stigmas twice as many as the carpels.

Pavonia.—Epicalyx of 5–20 leaves.

AA. Fruit a capsule. Stamen tube 5, toothed at the apex. Stigmas cushion-shaped.

Hibiscus.—Ovary 5-celled. Epicalyx of 5–many bracts.

Malvastrum.—A shrub or herb with purple flowers (rose-red or red and white), borne on short stalks in the axiles of the leaves, singly or in racemes. The leaves and stems are often sticky, softly downy, or covered with bristles.

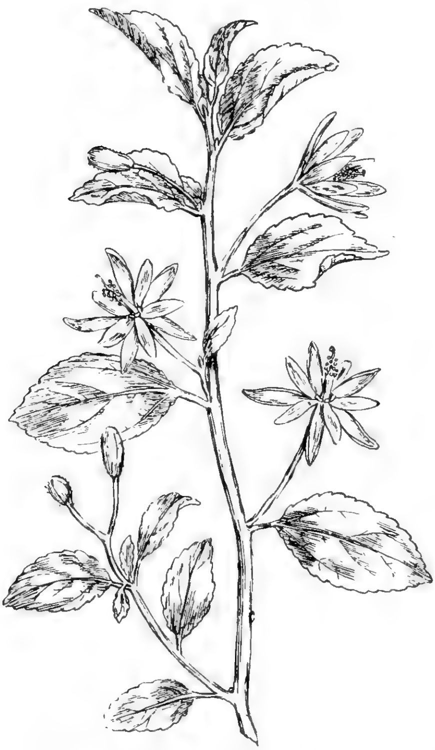


FIG. 240.—*Grewia occidentalis.* (After "Botanical Magazine.")

Sida. — A low-growing shrubby plant with small white or yellow flowers (rarely purple). The flowers open for a short time about noon. The stigmas ripen at the same time as the anthers. The stigmas reach out among the anthers and help themselves to pollen. Flies sometimes visit the flowers.

Abutilon. — Shrubs or herbs, erect or prostrate, with soft velvety stems and leaves. Pale yellow flowers an inch or more across. They are sometimes visited by birds.

Hibiscus. — Several species of this genus are cultivated in the garden. *H. rosa* **sinensis** has large brilliant scarlet flowers. *H. calycinum* and *H. ludwigii* are tall shrubs with large yellow flowers and dark purple centres. Some species are low herbs with smaller flowers.

The larger flowers are much frequented by sugar-birds, which sip the honey on the wing. The fact that the birds do not alight on the flowers may account for the fact that these obliquely hanging flowers are so nearly regular. The smaller herbaceous flowers, like those of *Sida*, have short stamen tubes, and stigmas that can curve over and help themselves to the pollen which ripens with the stigmas.

I II

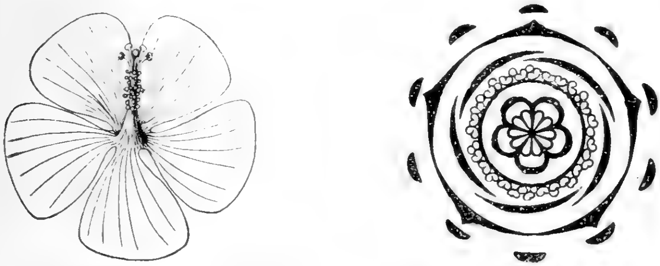


FIG. 241.—*Hibiscus*. I. Corolla, with petals adherent to monadelphous stamens. II. Diagram. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

FIG. 242.—*Malva*. I. Portion of plant (reduced). II. Pistil. (From Thomé and Bennett's "Structural and Physiological Botany.")

Order STERCULACEÆ.

Flowers regular. Calyx lobes united, valvate. Petals 5. Stamens monadelphous (sometimes merely joined at the base)

Ovary superior, of 1, 2, or 5 carpels. Fruit a capsule, or indehiscent.

Trees, shrubs, or herbs with alternate exstipulate leaves. The order is closely related to Malvaceæ, from which it may be known by the 2-celled anthers. **Theobroma**, from which chocolate is derived, belongs to this order.

A. Flowers imperfect—

Sterculia.—Calyx coloured. Petals none. Carpels separate or partly united. A tree is found about Uitenhage, the only species.

AA. Flowers perfect, staminodia alternating with the stamens—

FIG. 243.—*Hermannia althæfolia: a*, stamens. (After "Botanical Magazine.")

FIG. 244.—*Maherina*: *a*, stamens.

Dombeya.—A 3-leaved, 1-sided, deciduous involucre subtends the flowers. Calyx bending back as the flowers open. Petals twisted, unequal-sided. Stamens 10–15, alternating in parcels of 2–3 with 5 slender staminodia. Small Eastern trees with an abundance of white or rosy flowers. The petals become papery and enlarged, remaining on.

AAA. Flowers perfect, no staminodia—

Hermannia is a very common, more or less prostrate, weed with the habit of shrubs or undershrubs. The calyx is often inflated. The flowers red, orange, or creamy white. Stamens 5, opposite the petals, broad, narrowed toward the top or bottom. Leaves entire or toothed, often plaited. The entire plant often covered with stellate hairs, woolly, velvety, or sticky.

Mahernia is another plant commonly found. It resembles *Hermannia*, but the stamens are suddenly broadened at the middle. Peduncles mostly 2-flowered, opposite the leaves or tipping the stem. Flowers nodding.

Order Thymeleæ.

Flowers perfect, with a long coloured tube and a 4-parted perianth (sometimes 5). The perianth lobes are spoken of as calyx. The petals are wanting, or possibly represented by 2 or 8 scales at the throat of the long calyx tube or hollow receptacle. The ovary is an achene, or a berry which fits so closely within the hollow receptacle that it looks like an inferior ovary. The tube often breaks off just above the ovary. Stamens 4 to 8, borne on the tube.

Mostly slender shrubs with very tough bark and heath-like leaves. The flowers are arranged in heads, umbels, racemes, or leafy spikes. Honey may be found at the base of the tube by long-tongued insects.

A. Calyx without scales or glands.
  B. Flowers in stalked umbels 4–5-parted.
    Peddiea.—A glabrous shrub with obovate shining leaves, found in Natal.
  BB. Flowers in heads or spikes, or in the axils of the leaves.
    C. Anthers concealed within the tube on short filaments.
      Arthroselen.—Flowers in heads or axillary. Leaves sessile.
    CC. Anthers on slender filaments showing above the tube.
      D. Stamens 10. Flowers in heads.
        Dais.—Flower heads surrounded by a 4-leaved involucre. Leaves large, flat. Eastern district and Natal.
      DD. Stamens 8. Flowers in spikes within axils of leafy bracts.
        Passerina.—Nut dry, with a hard shell. Leaves opposite and decussate.
        Chymococca.—Berry fleshy, containing a hard seed, similar to *Passerina.*

AA. Calyx having scales or glands in the throat, or more or less concealed in the tube.

Cryptadenia.—Stamens 8. Glands in the middle of the tube. Flowers purple or rosy, single or few. Leaves opposite. Western.

Lachnea.—Stamens 8. Glands in the upper part of the tube, partly hidden among bristles. Flowers in heads. Scales 8, below the stamens. Shrubs with slender branches and opposite or scattered leaves. Flowers in umbels with or without an involucre (sometimes solitary).

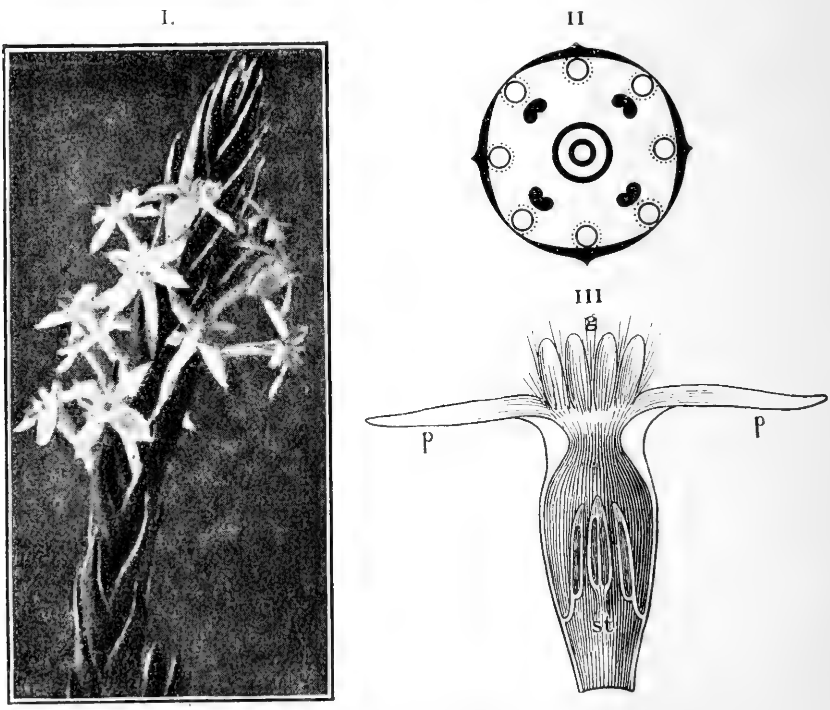


FIG. 245.—*Struthiola*. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

Struthiola.—Glands at the top of the tube, conspicuous. Filaments very short. Calyx 4-parted. Stamens 4. Heath-like shrubs with linear leaves.

Gnidia.—Stamens 8. Glands petaloid or fleshy, 4 or 8. Heath-like shrubs, with rarely broad leaves. Flowers in spikes or solitary. A large genus.

Lasiosiphon.—Calyx 5-parted. Stamens 10. Tube hairy at base. Shrubs with the habit of *Gnidia*. Flowers in heads on a hairy receptacle. Mostly Eastern.

Order ONAGRARIACEÆ.

At first one would hardly suspect the members of this order found in South Africa to be the near relatives of the well-known Fuchsia. But the flowers agree in an inferior ovary, usually 4-celled, with axile placentation and many seeds; a 4-parted valvate calyx, 4 petals usually twisted. Fruit usually a capsule. Perennial herbs or shrubs.

Jussiæa.—A genus of land or floating plants. Calyx persisting as a crown on the inferior ovary. Flowers built on the plan of 4 and 5. Sepals 4–5. Petals 4–5. Stamens 8–10. Capsule 4–5-celled. Flowers yellow, white. Seeds small. Herbaceous or shrubby. Leaves alternate. Eastern.

Œnothera (Evening Primrose).—Naturalized near Cape Town. The flower has a very long calyx tube, admitting only the long tongues of moths, which fly at night about the spikes of delicate yellow flowers, attracted by the evening scent. After a night of revelry the flower withers and falls, leaving the long green ovary, which looks like a flower-stalk. If the flower does not succeed in attracting the moths it stays open for awhile the following day.

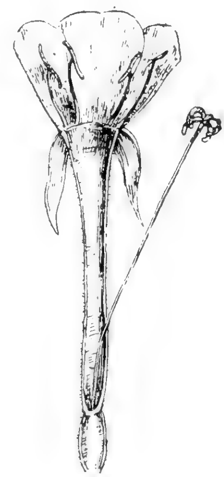


FIG. 246.—*Œnothera biennis.* Section of flower.

Epilobium can be distinguished from *Œnothera* by the smaller rosy purple blossoms and beautiful hairy seeds which, after the capsule has burst, are sent adrift far and wide. In *E. hirsutum* the stigmas and stamens ripen together. If put to it the stigmas can roll back and pollinate themselves. In other species the stigma is undivided, and since the stamens ripen first the flower cannot fertilize itself. It was *Epilobium* which led Conrad Sprengel to make the discovery of dichogamy, or the unequal ripening of stamen and pistil.

Montinia, which is described in Chapter XIV., also belongs to this order.

Order Umbelliferæ.

Plants of this order can usually be easily recognized. They are herbs with stout stems hollow between the nodes. In South Africa, as in the case of so many other plants, the flowering stalks often appear after the leaves, which have prepared food to be stored in underground reservoirs. They have alternate, exstipulate, much-divided leaves sheathing the stem. Or the leaves may be entire with narrowed petioles. The flowers are usually arranged in compound umbels with an involucre. Sepals 5, small. Petals 5, or none, usually regular, but the outer petals of the outer flowers are often longer, reminding us

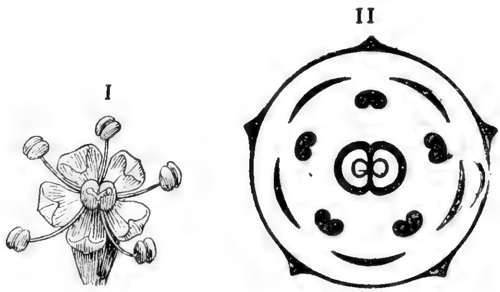


Fig. 247.—*Bubon galbanum.* I. Flower. II. Floral diagram. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

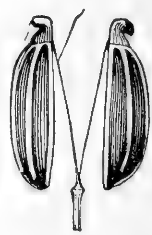


Fig. 248.—Fruit of the Fennel: *a*, carpophore. (From Thomé and Bennett's "Structural and Physiological Botany.")

of the ray flowers of the Sunflower family. Stamens 5. Ovary inferior, 2-parted. On the top of the ovary is a disc where the honey is exposed to short-tongued flies, though bees visit the flowers also. When ripe, the dry shizocarp splits apart; the two carpels are supported on a forked stalk which runs up between them. The fruit may be flattened on both sides or at the backs of the carpels. A strongly scented oil is contained in cavities extending the length of the fruit.

Hydrocotyl differs in habit from the usual plants of this order, but may be recognized by the inferior, 2-parted fruit. The umbels are simple, about 3-flowered, only one of the flowers bearing seed. The involucre is 4–6-leaved. Slender herbs or creeping shrubs.

H. verticillata is common by furrows with pretty peltate leaves. *H. solandra* is adapted to the sandy hillsides where it is found. It has white woolly leaves, which come up in tufts from underground stems. Some species have linear leaves.

Bubon.—Umbels large, many rayed, yellowish green. Involucre and involucel of many linear leaves. Carpels flattened at the back, with narrow wings at the side. *B. galbanum* (wild celery) is a common shrub with wedge-shaped leaflets. Some people are poisoned by touching the leaves.

Buplerum has compound umbels of yellow flowers. Fruit

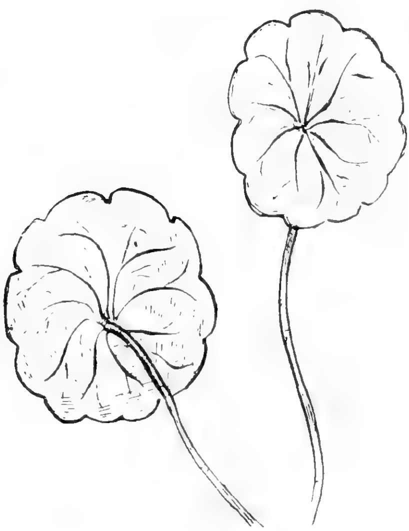


FIG. 249.—Pellate leaves of *Hydrocotyl.*

flattened at the sides. First leaves divided, upper ones simple, linear. The petioles may become changed into phyllodes.

Arctopus is a common, low-growing plant with a rosette of leaves flat on the ground. The flowers are diœcious, but the two plants are not far apart. The involucre leaves are sometimes large and spine-tipped.

Hermas is a large almost shrubby plant, with entire leaves and large compound umbels of white or purple flowers. The leaves are large, simple, clothed on one or both sides with white woolly hairs. **Hermas gigantea** is the " tundelboom."

Garden vegetables are parsnip, carrot, celery, caraway.

Order ERICACEÆ.

Flowers (in South Africa) 4-parted, gamopetalous. Stamens 4–8, anthers usually opening by pores, often horned at base in the wide-mouthed flowers. Ovary 1–4–8-celled with one or many seeds. Fruit a capsule. A gland below the ovary secretes honey. When bees visit the flower they touch the hanging stamens, or their horns, and are dusted from the pores. The stigma, being longer, is touched first. The horns also prevent the entrance into the flower of unwelcome visitors. The heaths are small shrubs with needle-shaped leaves often rolled backward to form an air-chamber on the under side.

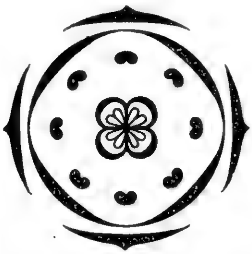


FIG. 250.—Floral diagram of Erica. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

FIG. 251.—*Erica massoni.*

Stamens 8—

Macnabia.—Calyx much longer than the deeply lobed corolla. Style hooked. Flowers white, leaves by threes.

Erica.—Calyx usually much shorter than the corolla. Seeds light and very numerous. A large genus of over 400 species. The flowers are beautiful and of a great variety of shapes and colours.

The finest heaths are found at Riversdale and Caledon. A few are found as far east as Natal. Some are sticky on the outside of the flower, and so ward off ants. The stems, closely beset with small leaves, perform a similar service. The leaves are often bordered with hairs, which are always a severe trial to ants.

Eremia.—Seeds one in a cell. Flowers small, bell-shaped, in terminal umbels. Chiefly Western.

Stamens 4—

Blæria.—Small shrubs resembling *Erica.* Western.

Grisebachia. — Small shrubs differing from *Eremia* in the number of stamens.

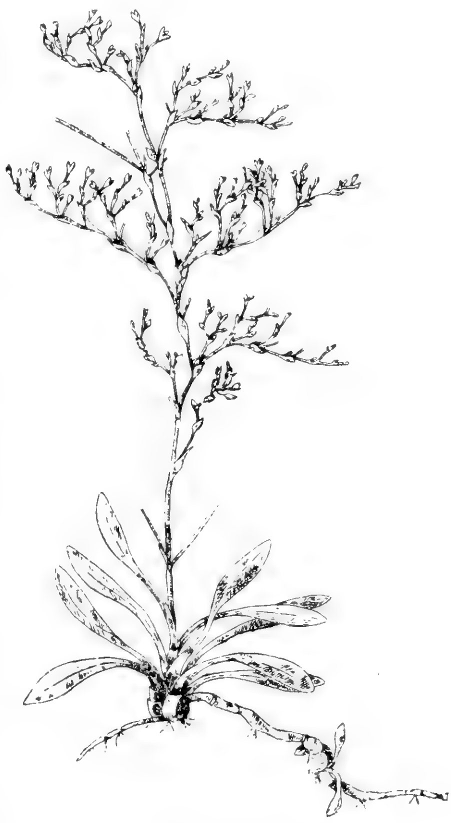


FIG. 252.—Statice.

Order PLUMBAGINACEÆ.

Calyx remaining on. Corolla gamopetalous. Stamens 5, opposite the petals. Ovary 1-celled, superior, with one ovule. Herbs or half shrubs, often growing near the sea.

Plumbago.—Calyx with sticky hairs along the ribs, which help to scatter the seed. Corolla tube much longer than the calyx; limb spreading. Stamens free from the petals. Herbs or shrubs, often climbing, with alternate, stipulate leaves thickly encrusted with lime on the under surface. The spikes of pale blue flowers brighten the roadsides in the East. Often used for hedges. Two species.

Statice.—Corolla nearly polypetalous, bearing the stamens. Calyx coloured. Halophytes or plants growing in salt ground, by the sea. Since they cannot absorb much water without getting too much salt, such plants conserve water by the same means used by plants in dry situations. *Statice* has dense rosettes of leathery leaves and underground stems.

Order Gentianaceæ.

Calyx 5-lobed, persistent. Corolla 5-lobed, the limb twisted, remaining on and withering (marcescent). Stamens 5 on the corolla, alternate with the petals. Ovary 1-celled, many-seeded. Parietal placentation. Fruit a capsule or berry. Leaves opposite without stipules (alternate in water plants). Flowers arranged in cymes like those of Caryophyllaceæ. Plants with very bitter juice.

A. Leaves opposite. Corolla twisted in the bud—

B. Flowers pink or purple, rarely white—

Chironia.—Anthers straight, very large, yellow. Fruit a capsule. Flowers very handsome. Growing near the sea.

Orphium.—Anthers spirally twisted. Flowers handsome, rosy. A much-branched shrub with long narrow leaves. Common on the Cape Flats. When near the sea the growth is very compact and the leaves become thick and fleshy.

BB. Flowers yellow—

Sebæa.—Calyx 4–5-parted; the sepals keeled, or 4-leaved and not keeled. Corolla funnel-shaped or salver-shaped, the tube becoming inflated. Anthers appearing above the tube, Annuals with much-branched cymes.

Belmontia.—Calyx as in Sebæa, much enlarged at base. Corolla with a slender tube, wider at the top. Anthers within the tube. Annuals with much-branched cymes and distant opposite leaves. Flowers very bright yellow.

AA. Leaves alternate—

Corolla in the bud with incurved edges. Water or marsh plants—

Villarsia.—Erect marsh-growing plants with entire alternate leaves. Flowers yellow. Capsule 1-celled, opening at the top. Common in the Colony.

Limnantheum.—Floating plants with leaves on very long petioles, shield-shaped or heart-shaped. Flowers yellow, springing from near the upper end of the petiole.

Order Apocyneæ.

Calyx deeply 5-lobed. Corolla salver-shaped. Petals twisted in the bud. Anthers 5, alternating with and upon the petals, with short filaments. Disc usually present. Carpels 2, separate or united. Fruit a capsule, berry, or drupe. Shrubs with opposite leaves and usually poisonous, milky juice.

The Oleander and Periwinkle belong to this genus.

Carpels united into a 2-celled berry or drupe—

Carissa.—Milky shrubs with forked spreading branches, opposite rigid leaves, and forked or twice-forked spines in the axils. Berry delicious. From Knysna district to Natal.

Carpels separate; style single—

Not spiny or fleshy—

Strophanthus.—Glands at the base of the calyx. Corolla funnel-shaped. Petals with very long points. Throat furnished with a 2-parted scale between the petals. Stamens closely surrounding the stigma, taper-pointed and often bearded. Follicles with long hairy seeds.

Climbing or erect shrubs with opposite or whorled leaves. Eastern.

Fig. 253.—*Strophanthus capensis*, and a corolla laid open showing scales at the throat.

Spiny shrubs with succulent stems—

Pachypodium.—Shrubs armed with twin spines in the place of stipules. Fruit of lanceolate follicles, many-seeded; seeds hairy at one end.

Small shrubs with large tuberous roots. Flowers white or red, toward the end of the branches. Two or three species found in he Karroo.

Order Asclepiadaceæ.

This order is like Apocyneæ in general habit, milky juice, opposite leaves, follicles, and hairy seeds. But the stamens are united at base. In most flowers each stamen bears a petal-like or tongue-like process at the back, forming a crown.

Fig. 254.—*Pachypodium*. I. Branch showing spinous stipules and follicles with hairy seeds. II. Flower.

The pollen grains are not powdery, but united in masses, as in Orchidaceæ. Around the stigma five little, dark brown, hard glands may be seen, to which the pollinia are attached. By placing a needle under the glands they may be withdrawn, as they are when an insect frees its foot from the slit between the anthers. The glands are between the stamens, and the pollen masses on either side come from the halves of two adjacent anthers.

The flowers are in umbels. Many are climbing, some are fleshy and leafless. A large order, of which 48 genera are found in South Africa.

Pollen masses 20, very small; anthers 4-celled—

Secamone, the "monkey-ropes" of the East. Loose climbing plants with leathery leaves. Flowers small.

A. Pollen masses 10, hanging, forming an inverted y-shaped yoke—

B. Stamens without a crown—

Microloma.—Corolla urn-shaped, lobes twisted to the left. Tube furnished within with tufts of downward pointing hairs. Usually twining. Umbels of beautiful little waxy bells, scarlet, or pale red with green tips.

BB. Stamens with a single crown—

Gomphocarpus.—Crown single, of 5 petal-like bodies, the edges folded toward the stigma. Umbels at the nodes or tipping the stem, many flowered. Flowers greenish. Petals bending backward.

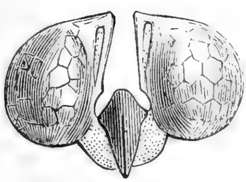


FIG. 255.—Pollen mass of *Stapelia*. (From Henslow's "South African Flowering Plants.")

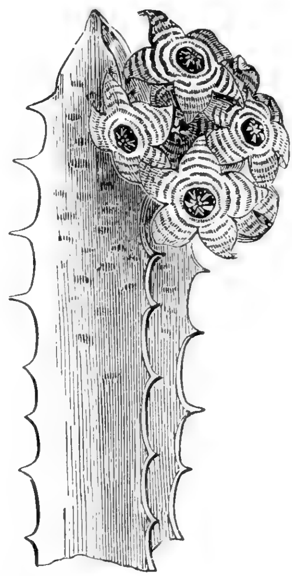


FIG. 256.—*Stapelia*. Stem and Flowers. (From Henslow's "South African Flowering Plants.")

Shrubby or herbaceous. *G. fruticosus*, with large spiny follicles and linear leaves, is common in the Karroo.

Pachycarpus has larger bell-shaped or globose flowers, and a different corona from Gomphocarpus.

BBB. Stamens with a double crown—

Sarcostemma.—Corona of an outer fleshy ring and 5 inner leaves. Erect or climbing leafless shrubs, with fleshy jointed stems and wheel-shaped corollas.

AA. Pollen masses 10, erect, with the gland below. Corona double—

Riocreuxia.—Corolla bell-shaped, swollen at the base, the slender tips meeting to form an arch.

Half shrubby graceful climbers, with heart-shaped petiolate leaves and greenish or dark purple flowers.

Stapelia.—Flowers large, star-shaped, greenish purple, mottled. Their strong and disagreeable odour attracts carrion

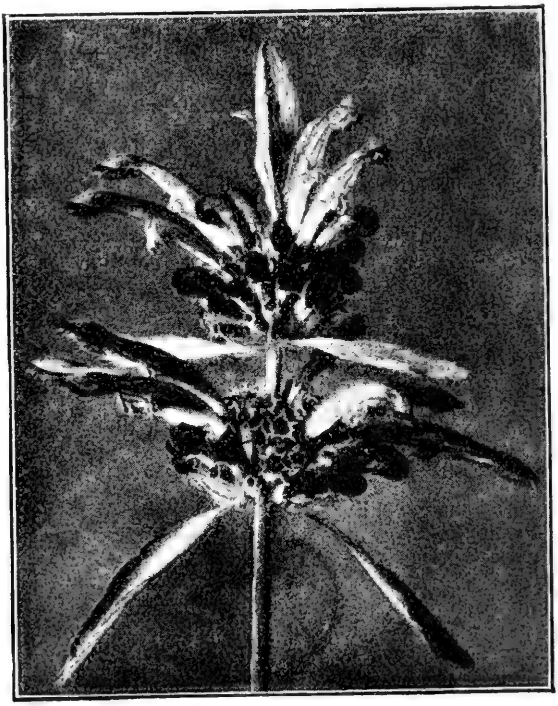


FIG. 257.—*Leonotis leonorus.* (From Edmonds and Marloth's "Elementary Botany for South Africa.")

flies, which aid in fertilization. The tufted stems are leafless, 4-angled, and swollen. In the central portion water is stored.

Order LABIATÆ.

Calyx gamosepalous, 5-toothed, remaining on, and often showy after flowering. Corolla more or less irregular, and 2-lipped. Stamens 2 or 4, of two lengths or nearly equal, borne on the petals. Ovary of 2 carpels, becoming 4-celled as it ripens. The style comes from the base instead of the top of the carpels. When ripe the fruit separates into four nuts. The order may be recognized by the four nuts in the persistent calyx, the square stem, opposite and decussate leaves, and strong odour, due to oil secreted in hairs on the stem and leaves. The main stem continues growing, but the branches are tipped by a flower.

There are 8 Eastern genera in which the filaments bend to the lower side of the flower. In the genera in which the lower lip serves for a landing-place for bees the filaments arch toward the upper petals.

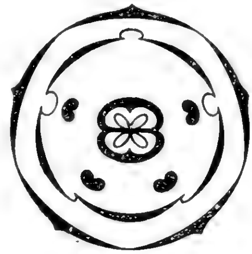


FIG. 258.—Floral diagram of Leonotis. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

In **Mentha** (the Mints) the corolla is nearly regular, and the four stamens spread equally around the flower.

Salvia.—Corolla large, the upper lip sheltering the stamens and stigma. Stamens 2, T-shaped, with short filaments and a long connective hinged to the filament near the centre. In South African Salvias, the half anther on the lower end of the connective bears no pollen. (See p. 129.)

The Blue Sage (**Salvia Africana**) is common throughout the western part of the Colony.

Stachys.—Stamens 2, anthers 2-celled. Upper lip of the corolla spreading, lower longer. Herbs or shrubs with a disagreeable odour.

Leonotis.—Calyx 10-toothed, upper tooth larger. Corolla tube much longer than the calyx; upper lip long, curved, lower short, spreading, 3-lobed. Stamens 4. Anthers in pairs, 2-celled. Herbs or half shrubs, with bright scarlet or orange flowers. *L. leonorus* (Wild Dagga) leaves are smoked by natives.

Order BORAGINACEÆ.

The deeply 4-parted ovary and the more or less irregular flower, suggests the order Labiateæ. The flowers of this order are not so distinctly 2-lipped. The leaves are usually alternate, the stem round, and often succulent, and the strong odour of the Labiateæ is lacking. The flowers are arranged in a coiled cyme, which straightens as it lengthens. Stem and leaves frequently rough with hairs. Fruit of four separable nuts, or a berry.

Calyx 5-parted, sepals lance-shaped.

Lobostemon.—Corolla more or less irregular, funnel-

FIG. 259.—*Anchusa* (Alkanet). 1, Corolla laid open showing corona and stamens; 2, calyx; 3, pistil with 4-lobed ovary; 4, fruit. (From Henslow's "South African Flowering Plants.")

shaped. Stamens joined at about the middle of the corolla, each provided at base with a hairy bordered scale, which protects the honey from short-tongued insects. Fruit of four nuts. Herbs or shrubs with rough leaves and showy pink, purple, or blue flowers.

Echium is similar to *Lobostemon*. The stamens have no scale at base, but its bristly calyx would discourage ants.

Myosotis (Forget-me-not).—Corolla regular; tube closed with scales, serving as a honey-guard. Softly hairy herbs. Radical leaves tapering into petioles, stem leaves sessile. The colour changes as the flowers grow older, from white to rosy buds and blue flowers, or from yellow through bluish to violet. In *Echium* the change is from red through violet to blue. This, says Herman Muller, suggests that white, yellow, and red flowers were the ancestors of violet and blue flowers.

Heliotrope belongs to this order.

Order SOLANACEÆ.

Calyx 5-parted, persistent (except Datura). Corolla convolute. Petals plaited in bud. Stamens 5, alternate with

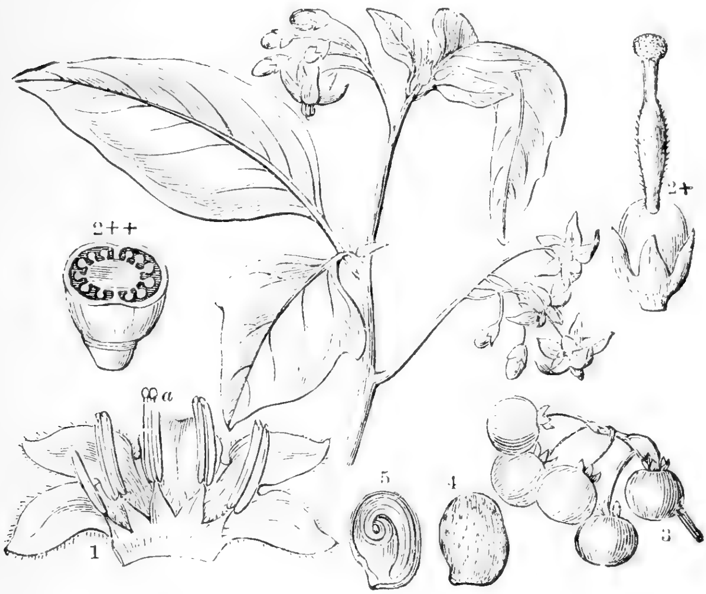


FIG. 260.—*Solanum*. Flowers, fruit, and seed. (From Henslow's "South African Flowering Plants.")

and upon the petals. Carpels 2, placed obliquely in the flower. Flowers solitary or in cymes. Herbs, shrubs, or small trees. Fruit a capsule or berry. A large order abounding in the Southern Hemisphere. But for the position of the ovary, the order might be merged with Scrophulariaceæ.

Fruit a many-seeded berry.
Solanum.—Anthers opening by terminal pores.
Physalis.—Anthers opening lengthwise. Calyx covering the fruit.

Lycium.—Anthers opening lengthwise. Calyx unaltered after flowering.

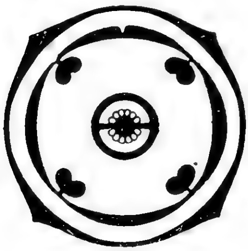
Fruit a capsule.

Datura.—Calyx deciduous. Fruit a thorny 4-celled capsule.

Nicotiana.—Calyx persistent, bell-shaped, 5-fid. Capsule 2-celled, many-seeded.

Retzia.—Calyx deeply lobed. Corolla tubular. Capsule few-seeded

I.



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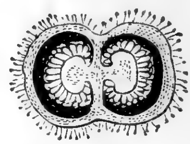


FIG. 261.—I. Floral diagram of Hallena flower. II. Bilocular ovary of *Antirrhinum*. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

Solanum.—Corolla wheel-shaped, white, yellow, or purple. Anthers yellow, forming a cone, as in some of the Boraginaceæ.

A large genus of herbs, shrubs, or trees, often prickly or spiny. Often densely covered with star-shaped hairs. The potato and tomato, natives of South America, belong to this genus. The berries are showy, bright red, yellow, or blue. By cultivation, the number of carpels in the tomato has been increased.

Physalis.—This genus may be recognized by the bladdery calyx. *P. peruviana* is the "Cape Gooseberry." Other species of this genus are native.

Lycium.—Small trees, often with spiny thorns, funnel-shaped. Reddish flowers. **L. afrum** (Kaffir thorn) is used for hedges.

Datura.—The shrub in many gardens with large white hanging bells and thorny capsules belongs to this genus.

D. stramonium.—The purple stramonium grows in waste places. Bees are debarred from this flower by the inward turn of the stamens, but the long tongue of moths can reach the nectar.

Nicotina (Wild Tobacco) is found in many parts of the Cape. Probably no species is native of this country.

Order Scrophulariaceæ.

Flowers perfect in cymes or racemes. Calyx 4- or 5-parted. Corolla 5-parted, or 4 by the union of two back petals, often 2-lipped. Anthers 4, sometimes 2, of two lengths (**didynamous**, two in power). Ovary 2-celled. Ovules many. Fruit a capsule, rarely a berry, with dumb-bell placentation. Below the ovary is a honey-making disc. The flowers are short-tubed and open for flies, or with a long tube for bees, with the stamens placed to brush the back of the insect.

Herbs, trees, or shrubs, found in all countries.

A. Back lobe of the corolla overlapping the front lobes in the bud.

B. Corolla saccate or spurred at base.

C. Corolla with two pouches or spurs—

Hemimeris.—Corolla 2-lipped. Stamens 2. Anthers 1-celled. Two tooth-like bodies at the side of the throat clasp the stamens. Small annuals with opposite leaves and bright little yellow flowers. Western.

Diascia.—Corolla 2-lipped, but more regular than in Nemesia. Upper lip 2-parted, lower 3-parted. Middle lobe often notched. In place of the two tooth-like bodies in Nemesia the two longer stamens curve round and clasp the upper pair.

Annuals often spreading, with dark wine-coloured or purplish flowers. Eastern and Western. In dry, sandy soil.

CC. Corolla with a single pouch or spur at base.

Nemesia.—Upper lip 4-lobed, lower entire. Stamens 4, the lower filaments curved round at the base and clasping the upper, as in *Diasia.* Anther cells clinging together in pairs.

Herbs annual or perennial, bearing racemes of pretty flowers of many hues. Twenty-eight species, both Eastern and Western. Beautiful Nemesias in great abundance are found in the Malmesbury district.

BB. Corolla not saccate or spurred. Stamens 4—

Freylinia.—Calyx 5-parted. Corolla tubular, limb spreading. Shrubs with opposite (or upper alternate), shiny, entire leaves and panicles of orange or lilac flowers.

Halleria.—Calyx cup-like, 3-5-parted. Corolla tubular, widening upwards, and shortly lobed at the tip. Stamens 4. Fruit fleshy, indehiscent. Shrubs with red flowers, hanging in clusters or single from the axils of dark glossy leaves.

Fig. 262.—*Halleria lucida.*

Nycterinia. — Corolla tube long slender; limb 5-lobed, spreading; lobes often 2-fid. Anthers of two upper stamens large, often two lower small or wanting. Herbs, turning black in drying. Flowers light inside, dark outside, opening in the evening.

Lyperia. — Corolla with a long sticky tube, incurved and swollen at the top. *L. crocea* is called "Cape Saffron" (Geele bloemetjes). Herbs or small shrubs, often much branched. Lower leaves opposite; upper alternate, entire, toothed, or much cut.

Manulea is similar to Lyperia, but the tube is not swollen. Common little plants, often covered with woolly hairs. Corolla nearly regular, orange. Found in sandy soil. Herbs, rarely woody.

AA. Back lobes covered by the front lobes in bud. Root parasites—

B. Anthers 1-celled—

Hyobanche.—Calyx deeply 5-parted. Corolla tubular, curved and hooded at the top, without a limb. Stamens of two lengths. Rose-red, thick stemmed. Parasites on the roots of Proteaceæ and other plants. Mr. v. d. Merwe, of Wellington, has found this parasite growing on roots, in an ant heap, 30 feet below the surface.

BB. Anthers 2-celled—

Aulaya. — Corolla with an incurved tube and spreading limb. Stamens as in Harveya. Flowers in leafy spikes or racemes. Stems and flowers orange, scarlet, or purple.

Harveya.—Corolla with a long curved tube, spreading above. Stamens of two lengths, one cell of each anther containing pollen, ovate with long point, the other long and slender, empty. A parasite on roots of grasses and Restiaceæ, with handsome white, rosy, or scarlet flowers.

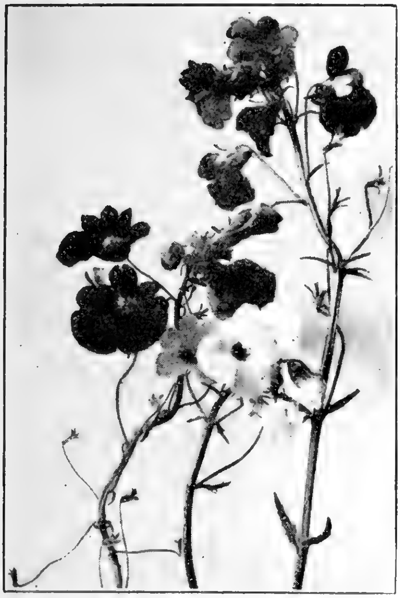


FIG. 263.—*Nemesia.*

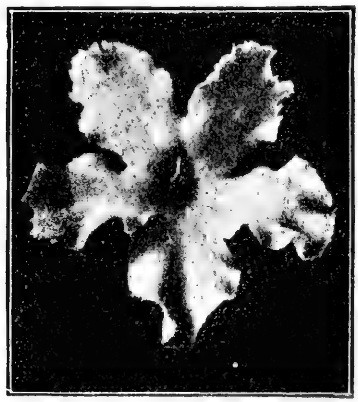


FIG. 264.—*Harveya capensis.* (From Edmonds and Marloth's "Elementary Botany for South Africa.")

Order BIGNONIACEÆ.

The flowers resemble those of Scrophulariaceæ, but the ovaries are on a disc, and the embryos fill the seed. Stamens on the corolla, 4–7. Leaves mostly compound. Trees or shrubs. Many are found in Brazil.

Tecoma is a handsome shrub, with racemes of scarlet flowers. The stamens are didynamous, with a small filament at the back where a stamen is no longer needed. The pod is flattened at right angles to the partition. Seeds winged. The opposite compound leaves are without tendrils. Cultivated throughout the Colony. Wild in the East.

Bignonia has the pod flattened parallel with the partition, and the compound leaves end in a tendril.

Cataphractes is a spiny shrub, with calyx cleft on one side. Corolla white. Stamens 6 or 7. Found in Namaqualand. Leaves simple, tufted.

FIG. 265.—*Tecoma capensis*. *a*, Pistil with disc below.

Rhigozum.—Flowers yellow, borne singly in the axils of alternate leaves. A rigid shrub in the Eastern and Northern districts.

Kigelia.—A Natal tree with panicles of flowers springing from old wood. Seeds wingless. Leaves alternate, simple.

Order RUBIACEÆ.

Calyx above the ovary. Sepals 4 to 5, often very small. Petals 4 or 5. Stamens 4–9, borne on the corolla, alternate with the petals. Ovary 2- or more celled, 2- or many-seeded. The order may be recognized by the opposite entire leaves and stipules. Sometimes the stipules are as large as the leaves, which gives the appearance of a whorl of leaves.

A very large order of trees, shrubs, or herbs. The coffee plant belongs to this order. Twenty-four genera are found in South Africa.

A. Fruit indehiscent, many-seeded. Shrubs or trees—

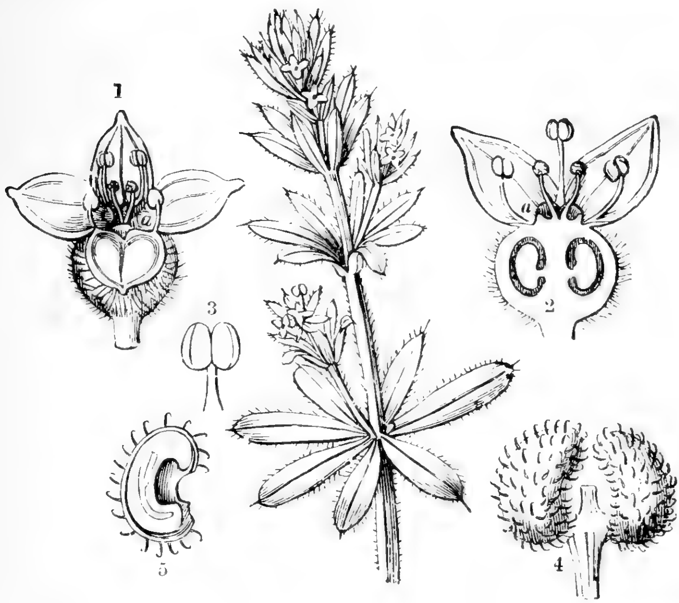


FIG. 266.—*Galium* (Cleavers). 1, flower; 2, section of flower; 3, stamen; 4, fruit; 5, section of 4 showing embryo. (From Henslow's "South African Flowering Plants.")

Burchelia.—Corolla funnel-shaped, with a very short limb. Anthers with the corolla. Berry nearly round, 2-celled, crowned by the calyx.

B. capensis (Buffels doorn), the only species, is a tree 12–14 feet high, with axillary corymbs of deep scarlet or orange flowers, and leaves 3–5 inches long. Frequent in forests east of Swellendam.

Gardenia.—Corolla funnel- or salver-shaped. Anthers extending beyond the tube, 8 or 9; sessile in the throat of the corolla. Trees or shrubs with large solitary white flowers, or marked with red. Often sweetly scented. The berry is very hard.

AA. Fruit a 2-celled capsule—

Hedyotis.—Corolla with a slender tube and spreading 4- or 5-parted limb. Capsule crowned with the calyx, dehiscing at the top. Small herbs with ovate lanceolate or linear leaves and bristle-like stipules.

AAA. Fruit nearly dry, of 2–6 nut-like parts—

Hydrophyllax.—Glabrous, creeping fleshy herbs, growing by the sea, with stipules and leaves united, forming a cup.

AAAA. Fruit 2-parted or 2-celled—

Galopina.—Flowers often diœcious or imperfect and perfect on the same plant.

Galium.—Corolla 4-parted. Fruit dry, separating into two 1-seeded carpels. Branching, erect or spreading herbs, supported by hooks on the stem and leaves. Flowers white or greenish. Leaves 4 or many in a whorl. The enlarged stipules, united in pairs, make a whorl of 4. If each stipule is divided there is a whorl of 12.

Order Campanulaceæ.

Flowers regular or irregular. Sepals not meeting in the bud. Corolla valvate. Stamens 5, free from the corolla. Anthers 5, free or united. Ovary inferior, 2–5-celled. Axile placentation and many ovules. Style simple, stigmas as many as the carpels. Fruit a capsule or berry.

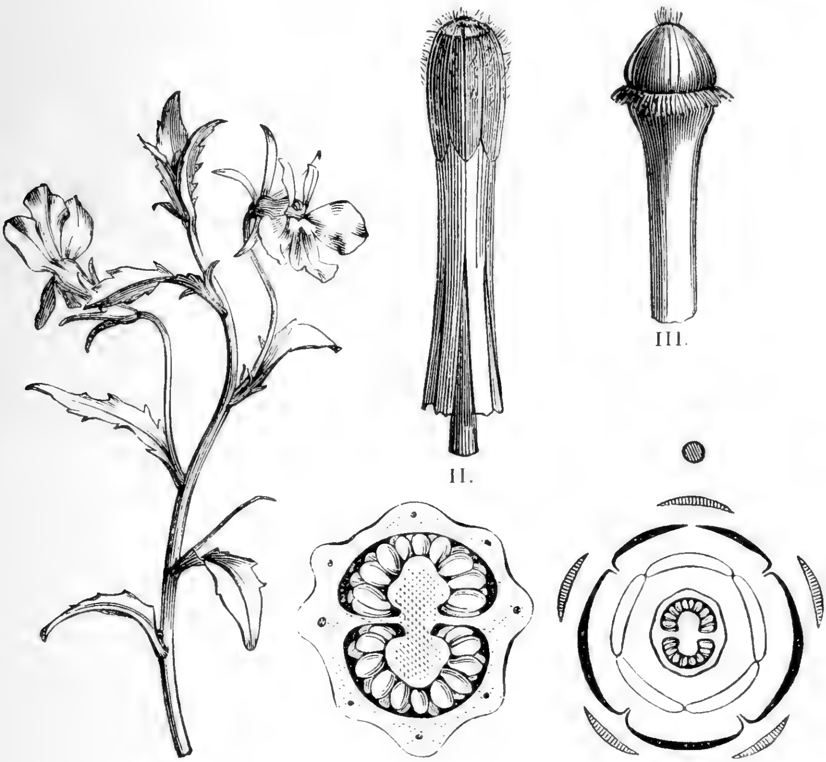
The flowers are very protandrous, and the style has the pollen shed upon it, where it is held by a ring of hairs just below the stigma. In many cases the stigmas turn back and touch the pollen of their own flowers, and so self-fertilization results.

A. Corolla irregular with a split tube; anthers united—

Lobelia.—The flowers are twisted on their axis so that the odd sepal is at the back, and three petals form the lower lip. The two lower or all the anthers are bearded.

Weak herbs or small shrubs, with alternate toothed leaves and blue or violet flowers.

Parastranthus (Inverted flower) has the odd sepal in front and the upper lip of three petals, as there is no twist as in Lobelia. Herbs similar to *Lobelia*, with yellow, white or blue flowers.



I. II. III. IV. V.

FIG. 267.—*Lobelia*. I. Flowering shoot. II. Stamens with syngenesious anthers closed over stigmas in bud. III. Style and addressed stigmas from II. IV. Diagram of flower. V. Transverse section of fruit. (From Henslow's "South African Flowering Plants.")

AA. Corolla regular; anthers separate—

B. Capsule opening at the top by triangular lids—

Lightfootia.—Corolla open to the base, or nearly so. Filaments broad, fringed with soft hairs. Capsule half below the flower. Small shrubs or herbs. Leaves sometimes opposite. Flowers mostly in racemes, blue or white. Eastern and Western.

Wahlenbergia.—Funnel-shaped or tubular. Filaments broad at base. Stigmas 5–3. Herbs with long forked flower-stalks, axillary or terminal. Flowers blue. The drooping flowers protect the pollen. The capsules after flowering stand erect, so that the seeds do not all fall out at once, but blow out a few at a time. Forty-six species.

FIG. 268.—*Wahlenbergia capensis*. The fruit becomes erect on ripening.

Roella.—Corolla large, funnel-, tubular-, or bell-shaped. Ovary 2-celled. Stigmas 2, thick. Capsule opening by a large pore at the top. Rigid undershrubs. Leaves narrow, crowded, often tufted in the axils. Flowers sessile, blue, white, or pale yellow with a dark centre.

AAA. Flowers more or less irregular. Anthers free—

Cyphia. — Petals 5, separate, or partly clinging by the upper part of their claws. Capsule 2-celled, half superior opening at the top.

Erect or climbing herbs, mostly with succulent or tuberous edible roots. Flowers blue, white, or pink.

Order COMPOSITÆ.

This is the largest order of flowering plants. The flowers are massed together in heads, as in *Protea*, and surrounded by an involucre. Since the flowers are thus protected, as in Proteaceæ, there is no need of a double perianth, consequently the calyx is either wanting or very much reduced, or it is constructed for another purpose—that of distributing the seed. The calyx is known as the **pappus**. After flowering, it may enlarge into a parachute for carrying the seeds in the wind, or it is developed into bristles, which seize hold of animals and so obtain a free ride. The corolla is gamopetalous. All the flowers may be tubular and regular or all may be strap-shaped, or the central disc flowers may be tubular and surrounded by the strap-shaped (**ligulate**, "little tongue") ray flowers. The

FIG. 269.—*Cypia zeyheriana*.

ray flowers are usually developed at the expense of the stamens, and contain only pistils. Stamens 5, alternating with the petals, cohering by their anthers (syngenesious), as in Lobelia, forming a tube around the style. Ovary inferior, of two carpels with a simple style forking into two stigmas. The one-celled ovary contains one ovule, growing from the base of the ovary. The fruit is an achene.

Since the flowers are massed together, they may be very small, and yet form an attractive cluster for insects, especially when there are ray flowers. One insect may visit a great many flowers in a short time. The slender tube and united stamens protect the honey and pollen ; if cross fertilization fails, the divided stigmas may turn back and pollinate themselves. The flowers are so well equipped that they have been distributed, and flourish, in nearly every part of the globe.

Of the 810 genera, 153 are found in South Africa. The genera are grouped according to the style branches, under six tribes.

Disc flowers tubular, regular.

TRIBE I.—Style branches long, slender, pointed, hairy outside. Flowers not yellow, all tubular.

Vernonia.—Involucre of many overlapping scales, not spine-pointed. Pappus of many bristles in two or more rows. Achenes smooth or silky, ribbed. Erect or half-climbing shrubs and herbs with white or purple flowers. Heads single or in corymbs. Eastern.

Corymbium.—Heads 1-flowered, involucre of two opposite scales, with two or three outer bracts at base. Achenes silky. Nearly stemless herbs, with linear parallel-veined leaves. The rootstock clothed with long soft silky hairs. Cape Town to Uitenhage.

TRIBE II.—Stigma long, blunt or flattened at the tip. Flowers all tubular.

Ageratum.—Heads many-flowered, roundish, clustered in corymbs. Pappus 5–10-toothed scales. Herbs with ovate or heart-shaped leaves on long petioles. Flowers mauve. Often cultivated; found in Natal.

TRIBE III.—Style branches long, flattened, often crossing instead of curving backwards. Heads usually with ray flowers.

Aster.—Heads many-flowered. Ray flowers, and usually disc flowers bearing fruit. Involucre of overlapping scales. Achenes flattened. Pappus of many saw-toothed bristles of equal length. Flowers with white, pink, or purple rays and yellow or purple discs. Herbs or shrubs with often small, rarely petioled leaves. A large genus.

Diplopappus.—Flowers as in Aster, except the pappus of two rows, the outer of short, the inner of long bristles. Much-branched shrubs or simple herbs.

TRIBE IV.—Style branches linear, flattened at the top, bristly at the apex, or tipped with a bristly cone.

A. Anthers without tails; pappus of large scales—

Sphenogyne.—Heads radiate, but the disc flowers bear the fruit. The receptacle bearing papery scales **(paleæ)** among the flowers. Involucre of overlapping scales, the inner larger with papery tips. Achenes surrounded at base with long silky hairs. Pappus of five broad scales, spirally rolled before the flower opens; much enlarged in fruit and milk-white.

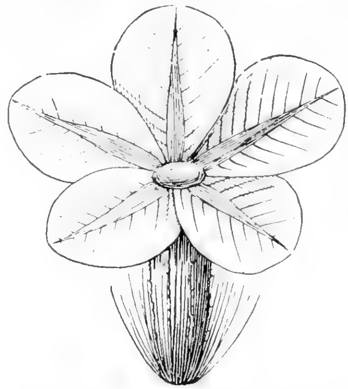


FIG. 270.—*Sphenogyne anthemoides.* Achene with scaly pappus. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

Herbs or shrubs with simple or compound leaves, strongly scented. Flowers yellow, often copper coloured beneath.

AA. Anthers without tails. Pappus none.

Eriocephalus (Woolly head), the "Copock bush."—Heads small, the rays usually broad and heart-shaped, bearing fruit. Disc flowers bearing stamens. Involucre double, the outer of separate scales; the inner scales cohere to form a cup. The achenes are without pappus.

FIG. 271.—*Eriocephalus umbellatus.*

Much-branched rigid shrubs, silky or silvery. The flower heads become very woolly with age.

Athanasia.—Heads many-flowered, without rays. Involucre of dry, overlapping scales. Receptacle-bearing paleæ between the flowers. Achenes sharply five-angled or winged. Pappus of short, flat, unequal scales, or of short, swollen, jointed hairs or none.

Small shrubs or undershrubs. Leaves entire, toothed or pinnate-parted. Heads yellow, mostly in corymbs. Common. In flower nearly throughout the year.

AAA. Anthers tailed. Pappus plume-like. Involucre shining, not withering.

Elyteropappus.—Heads 2–8-flowered. Involucre horny.

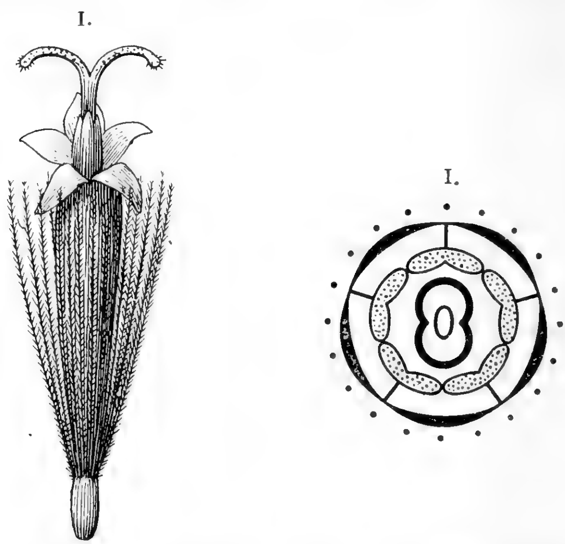


FIG. 272.—*Helipterum canescens*. I. Flower. II. Diagram of disc-flower. (From Edmonds and Marloth's "Elementary Botany for South Africa.")

Much-branched shrubs with heath-like, spirally twisted leaves. The Rhenoster bosch is the despair of farmers; it is chiefly Western, but has spread as far as Grahamstown, crowding out other flowers as it advances. Introduced from the Congo.

Helichrysum.—Heads many- or few-flowered, either all tubular or with ray flowers. Pappus of slender bristles. Involucre showy, rosy, yellow, or white. These and the next genus are the beautiful Everlastings, the Cape Flower.

Herbs and shrubs, mostly with woolly leaves and stems.

Helipterum differs form Helichrysum in having feather-like pappus.

AAAA. Anthers without tails. Pappus bristles abundant. Involucre in one row—

Senecio.—Heads with or without rays, purple or yellow. The genus may be known by the involucre of one row of scales with a few small bracts at the base. Shrubs or small trees.

Othonna.—Rays yellow or purple. Involucre as in Senecio, without bracts. Shrubs or herbs with smooth shiny leaves. The herbs often have tuberous roots.

FIG. 273.—*Osteospermum monitiferum* fruits; the ray flowers produce large achenes with bony seeds; the disc-flowers are sterile.

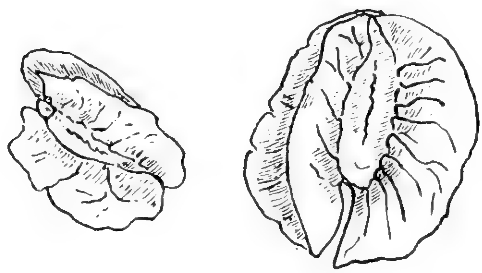


FIG. 274.—Three-winged fruits of *Tripteris*.

AAAAA. Anthers with short tails. Pappus none—

Dimorphotheca.—Heads with rays. Involucre in one row. The genus may be readily recognized by the two kinds of fruit. Those of the ray flowers are slender, three-cornered; of the disc flowers, flattened, heart-shaped, with thick, wide wings.

Herbs or half shrubs, often sticky, with yellow or purple flowers, or white with purple underneath.

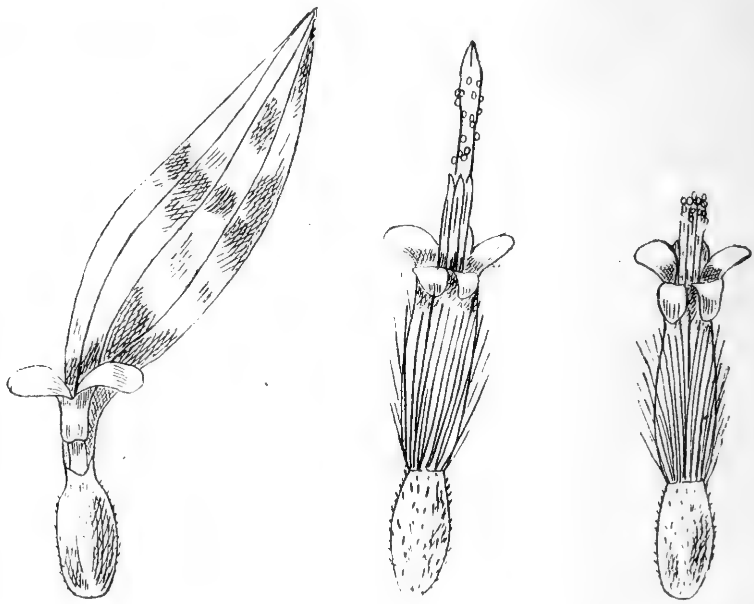
Osteospermum.—Heads yellow, many flowers with rays. Only the ray flowers bear fruits, which contain white, bony seeds. Shrubs, rarely herbs, with alternate leaves, which may be cobwebby, or rough with sticky hairs, or smooth.

Tripteris.—Heads with ray flowers, which bear the fruit.

Flowers yellow, white, or purplish. Fruits three-winged. Herbs or shrubs, mostly sticky, strongly scented.

TRIBE V.—Heads with rays (rarely all tubular). Anthers with short tails. Achenes swollen, with a flat disc at the top, often woolly. Pappus none, or of scales or bristles.

Arctotis.—Ray flowers bearing fruit. Pappus of two rows of scales. Achenes very silky near the base. Receptacle



I. II. III.

FIG. 275.—*Printzia*. I. Ray flower. II. The stigma, pushing out, brushes the pollen from the stamens. III. The following day it draws back and leaves the pollen in a ring at the top of the stamens.

honeycombed, with bristles. Involucre of small outer scales, the inner with large, thin, papery tips.

Herbs, often stemless. Flowers large, handsome, white, yellow, or orange, the rays usually purplish beneath.

Gazania.—Heads radiate, the disc flowers bearing the fruit. Involucre in several rows, forming a cup at the base. Receptacle honeycombed. Pappus in two rows of toothed scales, often hidden in the wool of the achenes.

Herbs with or without stems. Leaves all radical or scattered, often white woolly beneath. Heads large, showy rays, yellow or orange, dark at base, reflecting peacock colours.

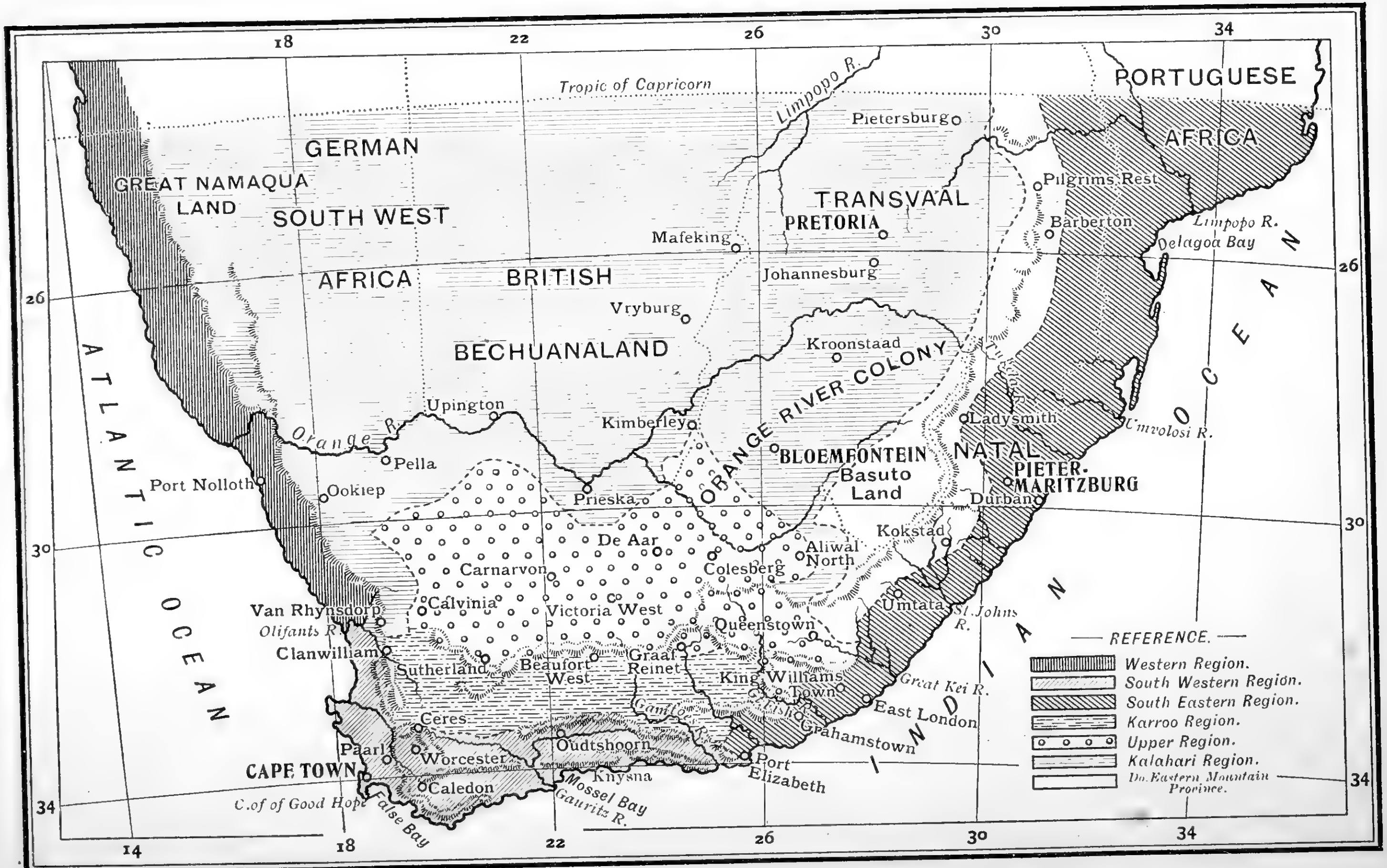
** All the flowers strap-shaped and perfect.

TRIBE VI.—Styles long. Plants with milky juice.

Urospermum.—Heads many-flowered. Involucre in one row. Pappus one-rowed and feathery. Receptacle bristly. Achenes with long sharp beaks, bladdery at base and rough with sharp points. Herbs with stem-clasping leaves.

Sonchus.—Heads many-flowered. Involucre in several rows. Pappus soft, very white slender hairs. Achenes not beaked.

Common weeds with yellow flowers. Leaves with a wavy margin, or pinnatisect.



Index map of floral regions of South Africa, with approximate boundaries by H. Bolus, 1905.

(By the courtesy of Dr. H. Bolus.)

THE BOTANICAL REGIONS OF SOUTH AFRICA

It is difficult in a small book for small children in South Africa to give a satisfactory list of plants. A group of plants familiar in one district will be quite strange on the opposite side of a mountain range. The "South-Easter" that parches one part of the country brings needed rains to another. Rainy winters of the Western Province produce a different flora from that of the dry winters and rainy summers of the East. Plants in a sandy soil will differ from those in a clayey soil. Dr. Bolus, in his "Sketch of the South African Flora," has given a vivid picture of the five botanical regions he has defined as follows :—

1. **The South-Western Region** is a strip from 40 to 80 miles wide, extending along the coast from near the mouth of Oliphant's River to the region of Port Elizabeth. It is bordered on the landward side by a range of mountains from 4000 to 8000 feet high. It is characterized by low-growing scattered shrubs, with small leaves of a sombre greyish green, due to their waxy covering. Trees are chiefly confined to the seaward mountain slopes, and seldom exceed 50 feet in height. To the east, however, beautiful forests exist in this region. They are composed of *Podocarpus* (Yellow-wood), *Ptæroxylon* (Sneezewood), *Grewia*, *Sideroxylon* (Milkwood), Olives, and others, some of which furnish good timber.

Few flowers are found in summer except in the mountains. *Disa uniflora* can be found in January, and in March the flowers are at their best along the mountain streams of the Peninsula and about Wellington.

The Amaryllideæ have so much stored food that they need not wait for the rains, and Buphane and Brunsvigia fruits, chasing each other over the veld, remind us to be on guard. May is the beginning of the fall season. In a few weeks after the first rains the veld is aglow with Irideæ, Proteaceæ, Oxalis, Leguminoseæ, and Ericaceæ.

2. **South-Eastern Region.**—From the Zitzikamma forests around the east coast, a broader strip of country than that on the south-east coast passes up to the Tropics. The vegetation changes. Trees are conspicuous with handsome green foliage. Palms and *Encephalartos* (Kaffir Bread) begin to appear, and the vegetation becomes tropical. Euphorbias and Aloes are typical ; epiphytic orchids festoon the trees and tree ferns become more frequent.

3. **The Karroo Region.**—North of the South-West region, and extending somewhat further east, there is a similarly curved region with the Nieuwveld mountains as a northern boundary. It is a large shallow basin surrounded by mountains. Violent rains have carried off the soil. Grazing flocks, by destroying vegetation and thereby loosening the soil, aid in the process, and year by year the rivers have carried away "the dust of continents yet to be." The climate is marked by dryness and extremes of heat and cold; the desert of the dry season becomes a garden after rain. Its plants are thorny and succulent, with underground storage systems. *Acacia horrida* (Karroo thorn), *Portulacaria afra* (Spekboom) *Sarcocaulon* (Candlebush), *Testudinaria* (Elephant's foot), serve as examples.

4. The **Upper Karroo,** or **Region of Compositæ,** a mountainous region lying north of the Karroo region, but not extending to the Orange River except at the extreme east and west, has a flora in some respects similar to that of the Lower Karoo region, but Composites abound, some of which furnish excellent food for stock.

5. **The Kalahari Region** is the name which Dr. Bolus gives to the large tract of land lying to the north of the Composite Region, west of the Natal Region and south of the Tropic of Capricorn. The western coast strip is a weird desert producing the curious *Welwitschia* on stony ground among the sand dunes, and the Naras, or *Acanthosicyos horrida.* The latter is one of the Calabas family. It has roots as large as a man's arm and 50 feet or more in length. They push down until they find water below the sand of the desert. The rigid green stems have opposite thorns in the axils of reduced leaves. Growing in sandy places, the winds sweep over and often completely bury the stems. The stems push quickly up, and the sandhills are often built upon the plants, in the centre. A bitter juice protects all parts but the sweet juicy fruits, which are eaten by jackals and Hottentots.

To the east and north the region is largely a grass country. The tufts of grass grow to a great height. Between the months of November and February large tracts of grass look like fields of corn. Maize reaches a height of 8 to 13 feet, and it becomes necessary to cut down the stalks in order to get at the grain.

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THE END

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