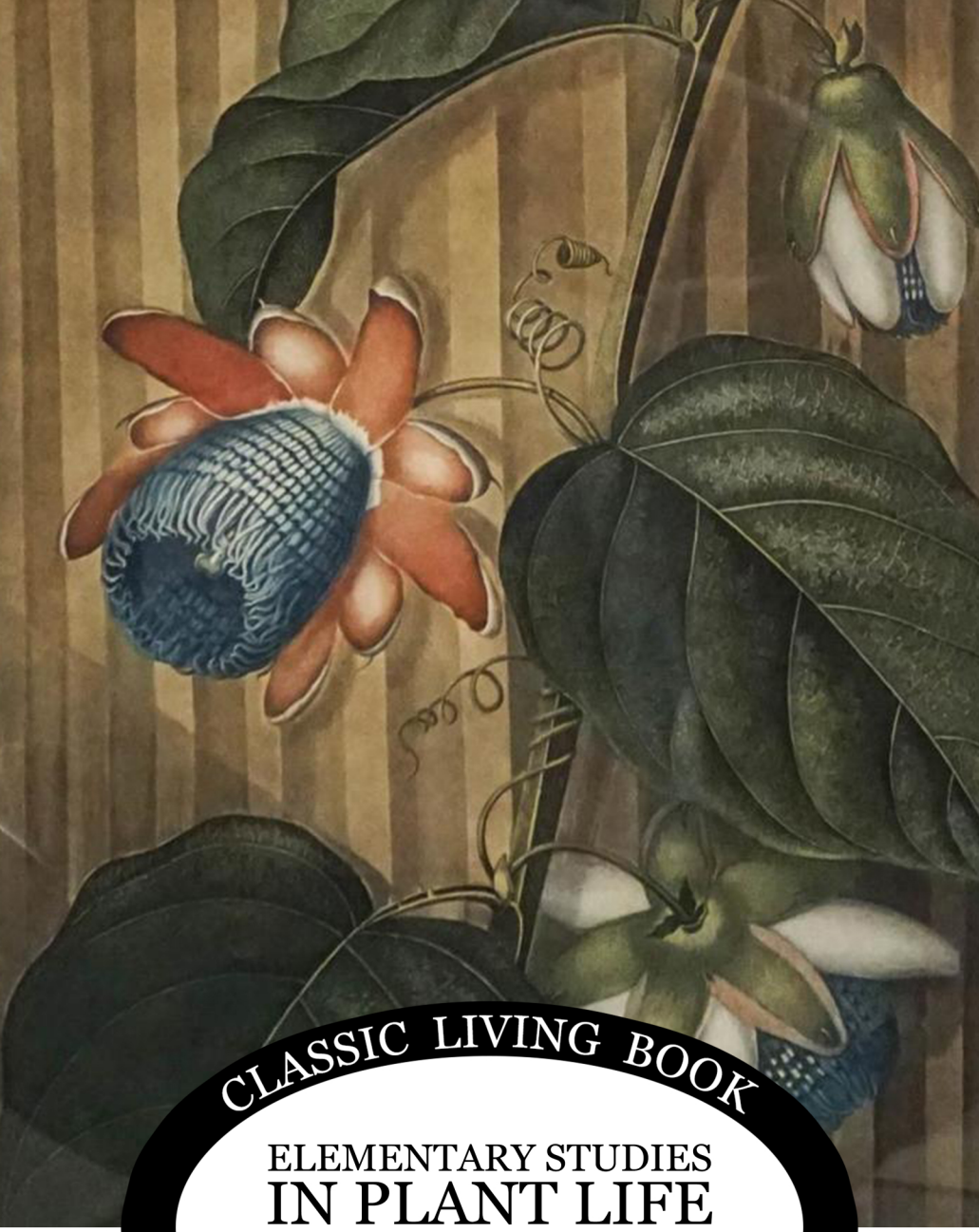

CLASSIC LIVING BOOK

ELEMENTARY STUDIES IN PLANT LIFE

F. E. Fritch

COMPLETE AND UNABRIDGED

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Elementary Studies in Plant Life

by

F. E. Fritch & E. J. Salisbury

Contents

PREFACE

IN writing the present volume, we have hoped to provide a more complete account of the elementary aspects of plant life than is usually given in textbooks for beginners. To this end, we have included brief sections on the soil and different kinds of vegetation, a description of the commoner types of pollination mechanisms, and a considerable number of simple physiological experiments. A glance at the index will show that a large number of common wild or cultivated plants are included as examples. These have also furnished material for the illustrations, which are all original.

The subject matter, for which we are jointly responsible, has been treated, as far as possible, in relation to the seasons of the year. It is hoped that this will facilitate provision by the teacher of material for each lesson and for the practical work.

The first nineteen chapters are suitable for the period between autumn and spring, and many of these could be taken at any time of the year. The remaining chapters are intended for study in the late spring or summer.

Summaries and instructions for practical work are added at the end of each chapter. The practical work is intended to **supplement** the work done in connection with each lesson. A list of material required for the illustration of the lessons themselves is, for the convenience of the teacher, given after the list of contents.

The scope of the book is sufficient to cover all requirements for the Preliminary and Junior Local Examinations of Oxford and Cambridge. It also provides for the greater part of the syllabus of the Northern Universities' Joint Matriculation Board. Questions are included throughout, some of which are taken from the Local Examinations of Oxford and Cambridge. For permission to utilize these, we are indebted to the Oxford Local Examinations Delegates and the Cambridge Local Examinations Syndicate.

F. E. F. & E. J. S.
East London College,
June 1915

LIST OF MATERIAL REQUIRED FOR CLASS PURPOSES IN CONNECTION WITH THE DIFFERENT CHAPTERS

(N.B. - The material necessary for the practical work suggested at the end of each chapter is not included here, since what is required can be seen at a glance.)

CHAPTER I. - Young and old plants of the Shepherd's Purse, with roots, flowers, and ripe fruits.

CHAPTER II. - Plants of the Shepherd's Purse, flowers of the Jonquil; salt; two tumblers; oil; stamp paper; red ink; pot with soil; silver paper; pair of scales; white blotting paper; cobalt chloride; small sheets of glass.

CHAPTER III. - Plants of the Shepherd's Purse; pots with soil; methylated spirit; tincture of iodine; starch; lime water; taper; corked jar; glass rod; candle; saucer; glass jam jar.

CHAPTER IV. - Flowers and fruits of the Wallflower; muslin.

CHAPTER V. - Mosses; toadstools; branches of the Scotch Fir and Laurel; plants of Shepherd's Purse and Goosegrass or Stitchwort; branches of Bramble or Dog-rose; stems of Convolvulus or Hop; Ivy; tendrils of White Bryony or Sweet Pea; branches of Old Man's Beard; plants of Creeping Jenny or Ground Ivy (in flower); rhizomes of Dog's Mercury or Iris; first- and second-year plants of Mullein or Turnip; tincture of iodine.

CHAPTER VI. - Leaves of Violet, Lesser Celandine, Pansy, Garden Nasturtium, Shepherd's Purse or St. John's Wort, Grass, Privet, Chickweed, Garden Spurge, Ground Ivy, Convolvulus, Sorrel, Mallow or Garden Geranium, Enchanter's Nightshade, Ivy, False Acacia or Rose, Horse Chestnut, Primrose.

CHAPTER VII. - Cress seedlings (about 5 days old); pea seedlings (about 5 days old); bean seedlings (about 10 days old); pea seeds; roots of Shepherd's Purse or Jack-by-the-Hedge, Carrot, Grass, or Chickweed; cardboard or wooden box; blotting paper; pins; dry soil; flower pot; corks; jam jar.

CHAPTER VIII. - Branches of Horse Chestnut, Ash, Elm, Oak, Beech; Brussels Sprouts or Cabbages.

CHAPTER IX. - Leaves of Mullein; root stocks of Primrose or Violet; rhizomes of Solomon's Seal or Iris; corms and flowering plants of Crocus; bulbs and flowering plants of Tulip or Hyacinth; iodine.

CHAPTER X. - Rhizome of Dog's Mercury; plants of Yarrow, Perennial Sunflower, Jerusalem Artichoke; potato tubers; roots of Carrot, Lesser Celandine, or Dahlia; Beetroot; corm of Crocus; buds of Horse Chestnut; Strawberry or Cinquefoil with runners; iodine.

CHAPTER XI. - Pea and bean seeds; seedlings of Runner and French Beans of various ages; five pots; boiled water; cotton wool; two jam jars; iodine; two large (3 in.) soaked corks; pair of scales; pins and nails; soil; bowl of water. (Remaining chapters would follow in the same format for corrections.)

CHAPTER XII. - Grains of Maize; seeds and seedlings of various ages of Buckwheat and Castor Oil; rhizomes of Solomon's Seal and Dog's Mercury (winter condition); iodine; seedlings of Beech, Holly, etc.

CHAPTER XIII. - Young leaves of Primrose and Barren Strawberry; shoots of Beaked Parsley or Hogweed, Grass, Dock; plants of Daisy or Plantain; shoots of Dead-nettle or Horse Chestnut, Dog-rose; Pea-seeds: fresh and withered shoots of some herb; four pots with soil; plants of Ground Ivy.

CHAPTER XIV. - Opening buds of Flowering Currant, Ash, or Rose, Lilac or Privet, Beech or Elm, Horse Chestnut, Plane Tree; twigs of Apple and Scotch Fir, Horse Chestnut, Lilac.

CHAPTER XV. - Toadstools, Michaelmas Daisy; branches of Horse Chestnut, Ash, and Syringa or Plane Tree, Beech, Elm, or Lime, Lilac; stems of Vegetable Marrow, Buttercup, Maize; thick woody branches of some tree.

CHAPTER XVI. - Maize-seedlings (about 10 days old); Fuchsia plant in pot; soils of different kinds, humus, large bottles, firewood, vessel with water, distilled or rain water, large jam-jars, cardboard, glass tubing, rubber tubing, copper wire, a long stick.

CHAPTER XVII. - Seedlings or herbaceous plants, Canadian Pondweed plants, some plant in a pot; leaves of Variegated Privet; saucer, pair of scales, glass cylinder or jam-jar, glass (4 in.) funnel, copper wire, test-tube, splinters of wood, warm and boiled water, ice, soda water, cardboard, methylated spirit, iodine.

CHAPTER XVIII. - Specimens of Dodder and Broomrape, with hosts; Mistletoe; plants of Yellow Rattle or Red Eye-bright with suckers; Bird's Nest Orchid, Toadstools, Puffballs, Sundew, Butterwort; jam-jar.

CHAPTER XIX. - Bulbs and tubers, some plant in a pot, Bean-seedlings with plumules and radicles (some in pots); Pea-seedlings grown in light and darkness; plants of Violet grown in light and darkness; shoots of White Bryony with tendrils; plants of Convolvulus, Tulip, or Crocus in flower; leaves of Wood Sorrel; growth-lever (this can be simply made from ordinary materials), rulers, Indian ink, jam-jar, garden sticks.

CHAPTER XX. - Plants from a wood or meadow; shoots of Arbor Vitae or Cypress; leaves of Cherry and Cherry Laurel or Holly; shoots of Gorse, Scotch Fir, Horsetail, Butcher's Broom; leaves of Sheep's Fescue or Marram Grass, and Heather; plants of Houseleek, Stonecrop, Mouse-ear Chickweed or Cudweed; twigs of Hawthorn or Sloe, Barberry, Rose, or Bramble; white blotting-paper, cobalt chloride, glass plates (old negatives).

CHAPTER XXI. - Plants of Milkmaid, Rushes, Pondweed, Brooklime, Ragged Robin, Water Plantain, Water Buttercup, Water Milfoil, Canadian Pondweed, Water Lily, Hornwort, Bulrush; land- and water-forms of Water Buttercup or Starwort; Duckweed.

CHAPTER XXII. - Inflorescences of Shepherd's Purse, Currant, or Lupine; Candytuft, Cowslip, or Cherry; Hogweed or Carrot; Plantain or Pondweed; Sunflower or Daisy; Buttercup or Herb Bennett; Campion or Chickweed.

CHAPTER XXIII. - Flowers of Wallflower, Marsh Marigold, or Winter Aconite or Hellebore; Tulip or Hyacinth; Geranium or Stitchwort; Primrose or Convolvulus; Willow-herb, Buttercup, Violet, Mallow, or Hollyhock; Pea or Bean; Campion or Pink; Canterbury Bell, Narcissus, or Apple; Dead-nettle, Honeysuckle, Figwort; pair of compasses.

CHAPTER XXIV. - Fruits of Hazel, Marsh Marigold, or Monkshood; Pea or Vetch; Wallflower or Jack-by-the-Hedge; Snapdragon, Campion, Poppy, Garden Nasturtium, Beaked Parsley or Hogweed; Mallow or Hollyhock; Buttercup, Acorn, Gooseberry or Bittersweet, Plum or Cherry, Blackberry, Strawberry, Mulberry, Fig; seeds of various plants; fruits of Maize and Sunflower.

CHAPTER XXV. - Fruits of Foxglove, Ash, or Elm; Maple or Sycamore; Honesty, Field Spurrey, Dandelion, Thistle, Old Man's Beard, Poplar, Willow-herb, Herb Bennett, Goosegrass or Enchanter's Nightshade, Gorse, or Touch-me-not.

CHAPTER XXVI. - Plants of Lily, Hyacinth, or Orchid; flowers of Tulip or Lily of the Valley; Herb Paris, Onion, Star of Bethlehem; fruits.

CHAPTER XXVII. - Flowers of Daffodil or Narcissus, Snowdrop, Iris, Crocus, Gladiolus, Grasses; plants of Grasses and Sedges.

CHAPTER XXVIII. - Flowers of Buttercup, Wood Anemone, or Winter Aconite; Monkshood, Larkspur, Columbine (the specimens should show the inflorescences and some fruits should also be shown).

CHAPTER XXIX. - Flowers, inflorescences, and fruits of Wallflower, Shepherd's Purse, Honesty, Radish, Charlock, Pink or Campion, Stitchwort or Chickweed, Ragged Robin.

CHAPTER XXX. - Flowers, inflorescences, and fruits of Strawberry, Cinquefoil, Rose, Apple, or Pear; Agrimony, Blackberry, or Raspberry; Cherry or Plum.

CHAPTER XXXI. - Flowers and inflorescences of Gorse or Broom, Sweet Pea or Clover; fruits; flowers and inflorescences of Carrot and Hogweed; also fruits.

CHAPTER XXXII. - Flowers, inflorescences, and fruits of Primrose, Pimpernel, Yellow Loosestrife, Forget-me-not, Viper's Bugloss.

CHAPTER XXXIII. - Flowers, inflorescences, and fruits of Dead-nettle, Bugle, Foxglove, Snapdragon, Mullein, Figwort, or Penstemon; Speedwell.

CHAPTER XXXIV. - Flowers and inflorescences of Sunflower, Cornflower, Dandelion or Sow-thistle, Coltsfoot, or Thistle; fruits of Dandelion, Burr Marigold, Thistle.

CHAPTER XXXV. - The flowers, etc., mentioned in this chapter are best studied in the field.

CHAPTER XXXVI. - The whole subject matter in this chapter should be studied in a number of afternoons in the field.

CHAPTER I

THE LIFE-STORY OF A COMMON FLOWERING PLANT

IN the early spring, we sow seeds in our gardens so that we may have flowers in the summer. Plants that bear flowers usually grow from a seed. This, as you will learn later on, always contains a baby plant. Most weeds produce seeds in large numbers, which is one reason why we find them springing up on every waste piece of ground. One of the commonest of our weeds is the Shepherd's Purse (Fig. I), the story of whose life we shall now briefly follow. We may begin by sowing some seeds of this plant on damp sawdust.

The plant and its enemies.—The seed at first gives rise to a small plant that is quite simple in form. This is called the **seedling** (Fig. I, B). Like many other seedlings, it will be found to possess a short white root (Fig. I, B, r.r.) buried in the earth. Above ground is a little curved or upright **stem** (Fig. I, B, h.) bearing two green **leaves** (Fig. I, B, c.). At the tip of the stem and situated between these two leaves is a tiny bud. As the plant grows up or becomes mature, this bud gradually lengthens into the main stem, bearing leaves, branches, and finally flowers. Meanwhile, the root has also been growing and branching so that it fixes the Shepherd's Purse firmly in the soil.

During this gradual development, the plant is exposed to many dangers. Birds may pick up the seeds before they can sprout, and the leaves of the growing plant may be eaten by snails and caterpillars. Seedlings, like children, are often the victims of diseases. You can easily recognize one of the commonest diseases of the Shepherd's Purse, since the parts attacked look swollen and as though they had been whitewashed. At any time, too, a spell of dry weather may make it difficult for the plant to obtain the large amount of water it must continually suck up from the soil.

The mature plant.—When you pull up a full-grown Shepherd's Purse, you can clearly distinguish the buried part, or root, from the overground part, or shoot (Fig. I). The root is white and bears many branches that are all alike (Fig. 2).

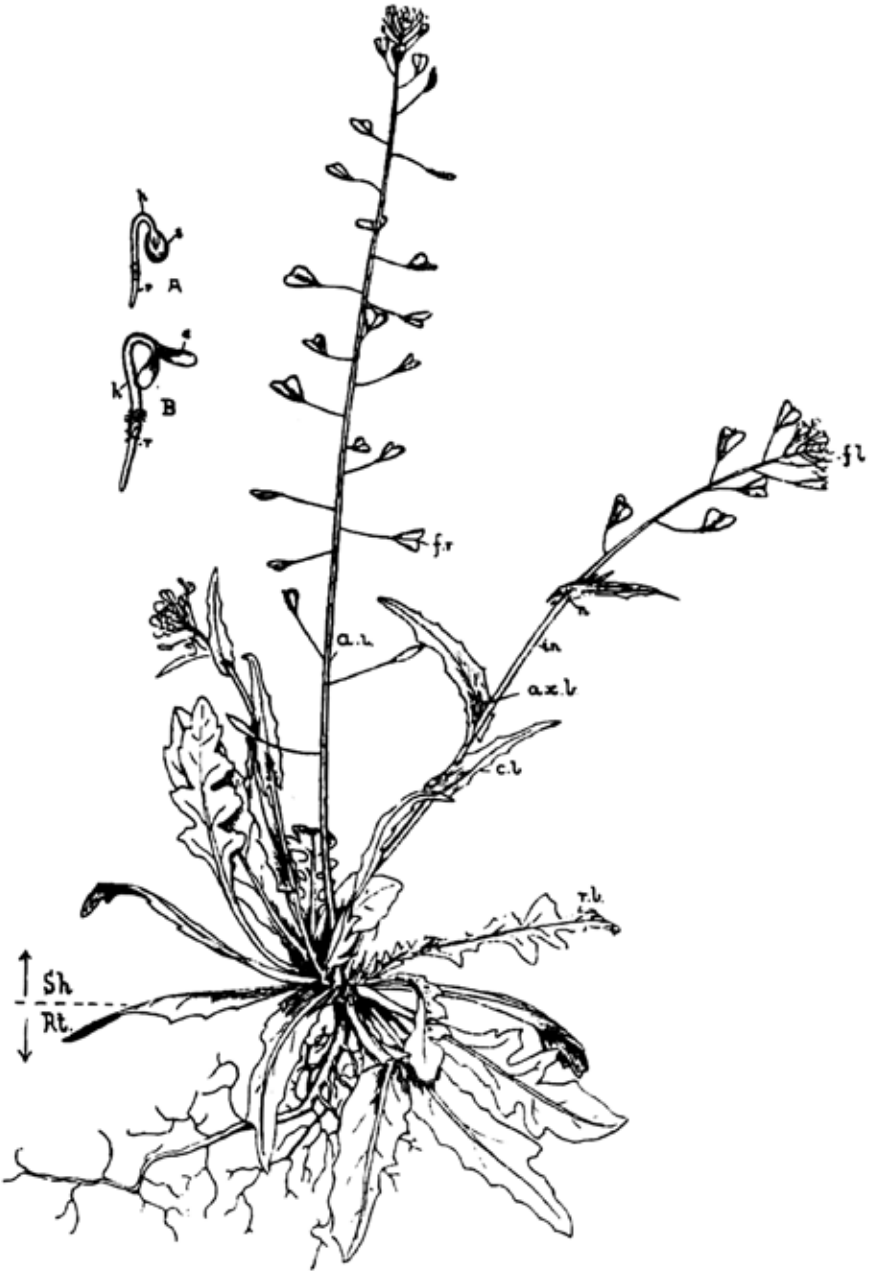

FIG. 1. — Complete plant of Shepherd's Purse (slightly reduced). The surface of the soil is shown by the dotted line on the left.
a.i., main stem of the inflorescence; a.r.b., axillary bud; c.h., upper leaf; A., flowers; fr., fruit; in., internode; n., node; r.l., leaf of rosette; Rt., root; Sh., shoot; A and B, two stages in the sprouting of the seed (somewhat enlarged); C., cotyledon; h., hypocotyl (p. 57); r., radicle; S., seed-coat.

The **shoot** is green and bears leaves and flowers in addition to branches (Fig. I). You will also notice that the branches of the shoot always join onto the stem just above a leaf.

The angle between a leaf and the stem upon which it is borne is called the **axil** of the leaf (Fig. 3, E). Since all the branches arise in these angles, they are said to be **axillary**.

If a number of specimens of the Shepherd's Purse are examined,

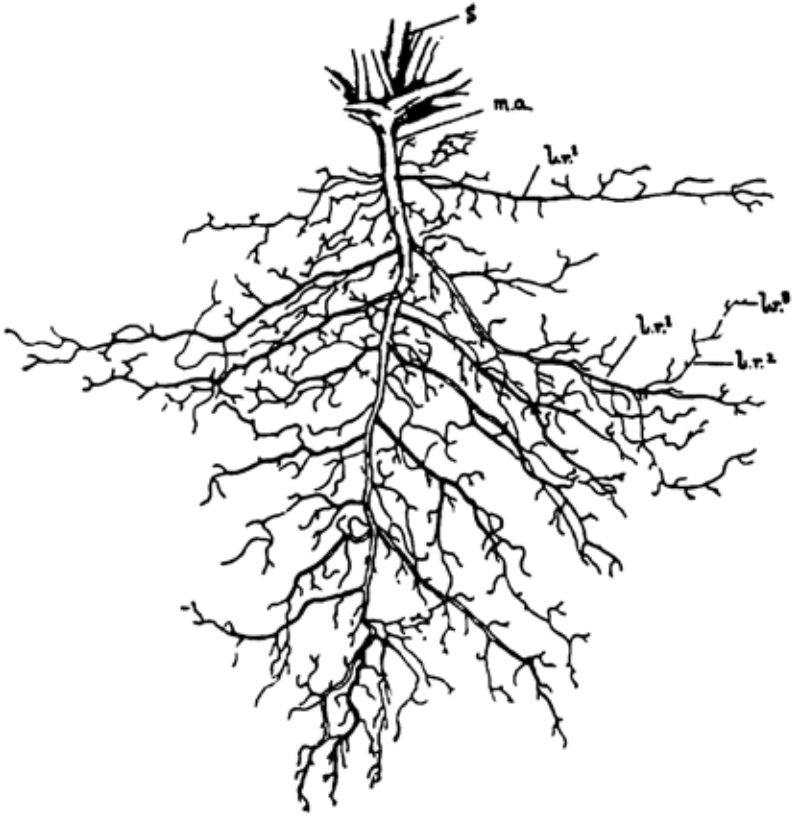

FIG. 2. — Root-system of the Shepherd's Purse (about natural size). s., lower end of the stem; m.a., main axis of root; Lr.1, Lr.2, Lr.3, successive branches of the root.

you will find that the lower leaves generally form a **rosette**, close to the surface of the ground (Fig. I). The others are far less crowded and situated at intervals up the stem. The part of the stem to which each leaf is attached is called a **node** (Fig. I, n.), whilst the bare length of stem between one leaf and the next is termed an **internode** (Fig. I, in.). Between the leaves at the base of the stem, the internodes are very short,

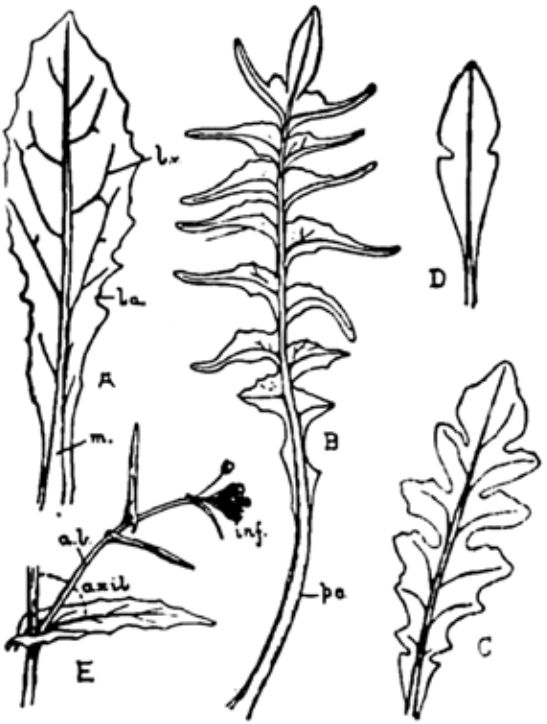

FIG. 3. A.D. — Leaves from the rosette at the base of the stem of the Shepherd's Purse (about half the natural size). m., midrib; l.a., blade; l.v., vein; pe., petiole; E., node with leaf and axillary branch bearing inflorescence (inf.) (about half the natural size); a.b., axillary branch.

so that the leaves are closely crowded.

The leaves. — The lower leaves are flat green structures with a varying outline. Each is borne at the end of a short green stalk, the **leaf-stalk** or **petiole** (Fig. 3, B, pe.). This is continued into the flat part of the leaf or **leaf-blade** as a thick **midrib** (Fig. 3, A, m.), which runs right up to the tip.

If you hold the leaf-blade up to the light, thinner ribs, the **veins**, are seen branching off on either side of the midrib (Fig. 3, A, l.v.). The midrib and veins together form a framework, between which the thin green substance or **tissue** of the leaf-blade is spread out. You will soon learn, however, that they also serve as channels for the passage of water.

The upper leaves of the Shepherd's Purse (Fig. I), unlike the lower ones, have no petioles. The base of their blade is enlarged in such a way as to clasp the stem (Fig. 3, E). In all the leaves, the blade is placed so that one surface is directed towards the ground, whilst the other turns away from it. You can therefore speak of an **upper** and a **lower surface**. The former is of a deeper green than the latter.

If you look carefully at the stem or at one of the leaves, you will notice numerous white branched **hairs** (Fig. 119, C, p. 151) scattered over the surface.

Cells. — Such a plant as the Shepherd's Purse is composed of innumerable tiny units, or **cells**, which are of many different kinds. They are so small that you cannot see them without using a micro-

scope. Near the tips of all the branches of the stem and root, there are special groups of cells. These form the **growing points**, which carry on the growth of the particular branch.

The flowers. — In the mature plant, the main stem and some of its larger branches end in groups of small white **flowers** (Fig. I). At the very top, they appear as tiny green buds, which gradually open out and expose the white **petals**. Still further from the tip, you will find that the petals have fallen off and that the flower-stalk ends in a little flat green triangle — the young **fruit** (Fig. I, fr.). At the same time, the internodes between the flower-stalks lengthen out, so that the enlarging fruits become widely separated (Fig. I). The whole of this part of the plant which bears the flowers and fruits is called the **inflorescence**.

The fruits and seeds. — At the bottom of the inflorescence, the triangular fruits have reached their full size. In an old plant, some of them will have **split into two halves**, leaving a small white membrane at the end of the flower-stalk. If you squeeze a slightly younger fruit, before it has opened in this way, a number of little oval bodies will be pressed out. These, which are green or yellowish in color according to their age, are the **seeds**. They are usually shed when the fruit splits open.

The seeds fall onto the surface of the ground and gradually get washed by the rain into the soil. There they sprout or **germinate** to form new plants. Since each Shepherd's Purse forms numerous seeds, one plant may produce many seedlings. Soon after the seeds are shed, the parent itself dies away.

Summary.—The ordinary plant consists, then, of a green overground part or shoot and a white underground part or root. Both are branched. The shoot bears leaves at its nodes and axillary branches. Some of the branches bear groups of flowers or inflorescences at their ends. The flowers form fruits within which are the seeds.

PRACTICAL WORK

1. Examine a number of seedlings, such as the Sunflower, the Cress, the Marrow, the Beech, the Nettle, the Buckwheat, etc. Make drawings of several and name the different parts.

2. Examine full-grown plants of the Shepherd's Purse, Groundsel, Chickweed, and Red Dead-nettle. Notice root and shoot and how the leaves and branches are attached in the different cases.

3. Look at any plants that have been flowering for some time. Notice that as the flowers wither, their places are taken by fruits. Examine the latter and see that they contain seeds.

QUESTIONS

1. Describe and name the different parts of some common plant.
2. Enumerate the differences between the shoot and root of a Flowering Plant.

CHAPTER II

HOW PLANTS GET WATER

The taking up of water (absorption). — You have already been told that the plant is continually sucking up the moisture present in the soil. You know also that unless a plant grown in a pot is watered, it soon droops and dies. The water is taken up by the root and is passed through the stem into the leaves.

If a substance like salt is placed in water, it rapidly becomes dissolved. In the same way, the water in the soil dissolves some of the salts present, so that the root really **takes up** a weak **solution of substances in the earth**. In this manner, the plant obtains an important part of its food.

The large amount of moisture which is sucked up is shown by a simple experiment (Fig. 4). Place a plant of the Shepherd's Purse with its roots in a tumbler of water. Pour oil (Fig. 4, o.) on the surface so as to form a thin film, and mark its level on the outside with a strip of stamp-paper (Fig. 4, p.). Fill another tumbler with about the same quantity of water, covering it with a layer of oil as before, and again mark the level of the liquid. Each day the level of the water in the tumbler containing the plant will be found to have dropped slightly (Fig. 4, p'.), whilst there is no change in the other tumbler. This is because the oil prevents evaporation, and so the water lost in the first tumbler must have been taken up by the plant.

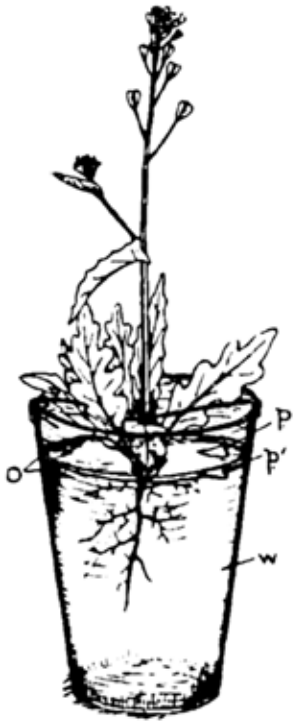

FIG. 4 - Experiment to show the absorption of water by the roots of a plant. o., oil; P., p successive levels of the liquid in the tumbler; w., water

The course of the water. — You can easily follow the course of the water through the plant by placing a Shepherd's Purse with its roots (whose tips must be cut off) in red ink diluted with water. After a few days, the midribs of the leaves will appear red when held up to the light. The red solution must therefore have travelled **through the root and stem** into the leaves. You will get a more striking result by putting the cut stalk of a white flower, such as a Jonquil, in the colored liquid. In a few hours, the petals appear streaked with red. You will sometimes see flowers which have been treated in this way in a florist's window.

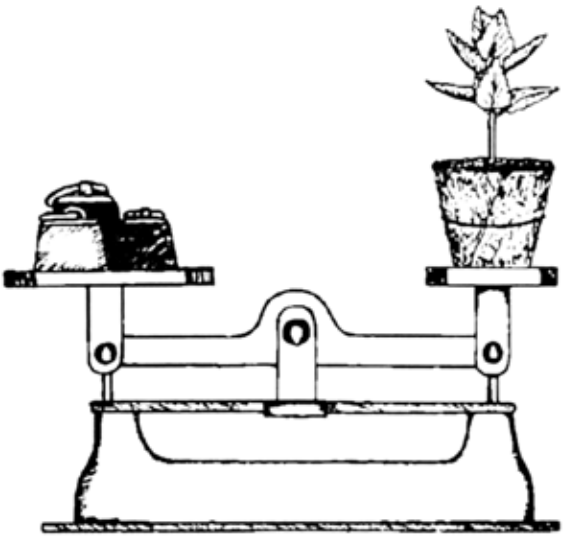

FIG. 5. - Experiment to show loss of weight due to the giving off of water-vapour by a plant. Description in the text.

What happens to the water. — What becomes of all the water which the plant takes up? A few simple experiments will answer this question for you. Plant a few healthy specimens of the Shepherd's Purse in some garden soil in a pot and give them plenty of water. Allow all the water which the soil will not hold to drain away. Then cover the whole pot and the bare soil between the plants with "silver paper." You thus prevent any moisture being lost by evaporation from the surface of the soil or pot.

Now place the pot on one pan of a pair of scales and put sufficient weights in the other pan to counterbalance it (Fig. 5). After a day or two, you will find that the pan bearing the pot has risen; it has become lighter. This can only be due to **loss of weight by the plant**. The next experiment shows that this is a result of the escape of water-vapor.

Dip some white blotting paper in the pink solution of a substance called cobalt chloride, and then dry it in front of a fire. The color of the paper gradually changes to bright blue. If you breathe on the paper, it will become damp and again turn pink. Now place small

pieces of the blue paper on either surface of a leaf of the Shepherd's Purse, with a small sheet of glass on both sides to keep off the moisture of the air.

After a few minutes, you will find that the blue color is disappearing, and that the paper against the lower surface of the leaf fades more rapidly than that against the upper. This shows that the leaves are **giving off water-vapor**, a process known as **transpiration**. The loss of weight noticed in the previous experiment was due to this cause. The water-vapor passes out through innumerable minute holes or **pores** in the surface skin. Since these are mostly situated on the lower side of the leaf, transpiration is most active from this surface.

The substances in the soil-water. — When a solution of salt is exposed to the air, the water gradually evaporates, and the salt is left behind as white crystals. In the same way, the substances dissolved in the water absorbed from the soil remain in the plant and accumulate as the water evaporates. The soil-water is a very weak solution of these substances, so that, unless large quantities of water pass through the plant, it does not obtain enough of them. You will learn later that a constant supply of these salts is necessary for the growth of the plant.

Summary. — We have thus seen that there is a constant stream of water through the plant, bringing with it mineral substances obtained from the soil. Only a small amount of this water is kept in the plant, whilst most of it evaporates from the foliage (transpiration). In fact, the larger part merely serves to carry food substances from the soil to the leaves.

PRACTICAL WORK

1. Perform the experiment described on p. 7 with a number of different plants, and compare the rates at which they take up water.

2. Take leaves of these same plants and compare the rates of transpiration from their under surfaces by means of the cobalt method described on p. 9.

QUESTIONS

1. What experiments would you perform to prove that roots absorb water from the soil?

2. Describe carefully two experiments to show that water is given off from the leaves of a plant.

3. Plants use a large amount of water. Why is such a large quantity taken up?

CHAPTER III

HOW PLANTS GET FOOD FROM THE AIR

YOU have learnt that the roots take nourishment for the plant from the soil. But this is not the only source of the plant's food supply, since an important part is obtained from the air. Air consists mainly of a mixture of the gases oxygen and nitrogen, with a small quantity of carbonic acid gas.

The necessity of light. — If you grow some plants in the light and others in the dark for a few weeks, you will find that those in the light remain quite healthy, whilst those in the dark become sickly, yellowish, and eventually die. Evidently, then, **light is necessary** for the well-being of the plant.

In order to find out why this is so, we may see whether the plant grown in the light contains any substance which is not present in that grown in the dark. As a matter of fact, **starch**, which is an important plant food, is only found in the leaves of plants which have been exposed to the light. You can prove this for yourself as follows.

Light and starch-formation. — Take some leaves from the plant grown in the light and some from the plant grown in the dark, and put them separately into boiling water. When they have become limp, pour off the water and add a little methylated spirit. After a short time, the green color passes into the spirit, and the leaves become colorless.

Now paint a leaf from each set with tincture of iodine. The one from the plant exposed to light becomes darkly colored, whilst that from the plant grown in the dark remains unchanged. Next, add some of the iodine to a piece of starch, such as you get from the grocer's, and you will find that it also turns a dark color. This is a certain means of recognizing starch, i.e., it is a test for that substance.

The above experiment has therefore shown you that **starch is only formed when the plant is exposed to light.** You will learn later that the green substance in the leaves is also necessary for its production. The starch is manufactured from **carbonic acid gas** taken in from the air and **water** sucked up from the soil. The processes leading to starch-formation are spoken of as assimilation.

The breathing of plants (respiration). — Like all animals, you breathe so long as you live. At every breath, you **take in oxygen** from the air and **give out carbonic acid gas**. This you can easily recognize by blowing down a tube whose end dips into lime-water and noticing how the latter turns milky. This is because the carbonic acid gas from your lungs unites with the lime to form a white insoluble powder (carbonate of lime). All **plants breathe** in just the same way as animals, and they too die if deprived of oxygen for any length of time. The breathing process, both of animals and plants, is termed **respiration**.

The taking in of oxygen. — Place a number of plants of the Shepherd's Purse in a securely corked jar and a similar number of dead ones in a second jar. Keep both in the dark for about two days. Then quickly place the end of a lighted taper in each jar. You will find that it immediately goes out in that containing the living plants, whilst in the other, it continues to burn. Since burning can only take place in the presence of oxygen, the living plants must have used up all of this gas. In the jar containing the dead ones, on the other hand, there is nearly as much oxygen as at the beginning of the experiment.

The giving out of carbonic acid gas. — Next, instead of the taper, hold a glass rod that has been dipped in lime-water in each jar. In that containing the living plants, the lime-water rapidly becomes milky, whilst in the other, there is scarcely any change. You must, of course, be careful not to breathe on the rod whilst performing this experiment. You have thus learnt that the living plants have not only **used up the oxygen** but have given out and so **increased the amount of carbonic acid gas** in the jar.

FIG. 6. - Experiment to show that living plants give off oxygen during assimilation. Description in the text.

If both jars are left in the light, you will obtain no such result. This is because, in the daytime, the plant uses up the carbonic acid gas produced in breathing to form starch from it in the way described above. There would consequently be no increase in the amount of carbonic acid gas in the jar. During the formation of starch, moreover, plants give out a large quantity of oxygen. Part of this is used for breathing, whilst the

remainder escapes into the air. In the light, therefore, enough of this gas will be formed to enable the taper to go on burning.

The giving off of oxygen. — You can show that oxygen escapes during starch-formation in the following way. Heap up some living plants around a short length of burning candle placed in the middle of a saucer containing a little water (Fig. 6). Cover the whole with a glass jam-jar placed mouth downwards. Soon the candle goes out, having used up all the oxygen. Keep your experiment in bright sunlight for a few hours, and then, rapidly lifting up the jar, push into it a lighted taper. You will find that the latter goes on burning, so that the plants in the jar must have **given off a new supply of oxygen**.

Summary. — You have now learnt that plants obtain oxygen and carbonic acid gas from the air by way of their leaves, water and various dissolved substances from the soil by means of their roots. Also, that the important plant-food starch is only formed by the green parts and in the presence of light. When plants breathe, oxygen is taken in and carbonic acid gas is given out (**respiration**). When starch is formed, on the other hand, carbonic acid gas is taken in and oxygen is given out (**assimilation**). Since the amount of gas taken in and given out during assimilation is much greater than in breathing, the latter process is hidden unless the plant is in darkness.

Plants thus use much more carbonic acid gas than oxygen, whilst animals inhale large quantities of oxygen and give out a constant supply of carbonic acid gas. The latter does not, however, accumulate, as it is used by plants in assimilation and replaced by the oxygen which they give out.

PRACTICAL WORK

1. Perform the different experiments described above.

2. Collect leaves of a number of different plants in the afternoon. Decolourise them as described on p. 11, and test for starch.

QUESTIONS

1. Give a short account of the different kinds of work done for the plant by a leaf. Describe an experiment which shows the existence of *one* of the activities you mention.

2. If you want a plant to live, why must you let it have (a) light, (b) fresh air, (c) water?

3. Describe, as far as you can, how plants and animals resemble and differ from one another in the way in which they live.

4. How will the plants in a closed greenhouse alter the composition of the air (a) in the daytime, and (b) at night?

CHAPTER IV

THE PARTS OF A FLOWER

SOONER or later, plants, like the Shepherd's Purse, always form flowers, and we will now study them a little more fully than we did in the first chapter. The flowers of the Shepherd's Purse are so small, however, that we will substitute for them the similar, but larger, flowers of the Wallflower.

The floral leaves. — All the different parts of such a flower arise from the top of the **flower-stalk** or **peduncle** (Fig. 7, p.). Outside, you will find four small pale green leaves (the **sepals**), which come off at almost the same level, and together form what is called the **calyx** (Fig. 7, i.s.). Two of the sepals are enlarged into small pouches at their base.

Within the calyx are four coloured **petals** situated opposite the gaps between the sepals (Fig. 8, A, p.), in other words, the two kinds of floral leaves **alternate** with one another. The petals together form the **corolla**. Pull off a petal and notice that it consists of two parts: the broad blade and a narrow tapering portion, the claw. The four upright sepals and the claws of the petals form a tube, at the top of which the blades of the petals spread out (Fig. 116, p. 149).

The stamens. — If you remove all the sepals and petals, there remains a green central body surrounded by six green stalks, each ending in a little oval swelling (Fig. 8, A). Each of these six structures is called a **stamen**, the stalk being known as the **filament** (Fig. 8, C, f.) and the yellow swelling as the **anther** (Fig. 8, C, a.). By squeezing one of the anthers, you will press out a yellow powder, the **pollen**. In some flowers, the anthers will have split open of themselves (Fig. 8, C), thus shedding their pollen, a little of which still remains clinging to them.

The ovary. — The green body or **ovary** (Fig. 8, O.) in the centre of the flower is oblong in form and ends in two little sticky swellings, the **stigmas** (Fig. 8, B, st.). If you examine the latter carefully, you will probably find some of the yellow pollen adhering to them. Now cut open the ovary and notice the small greenish bodies which it contains. These are the unripe seeds or **ovules** (Fig. 7, O.; Fig. 8, D, Ov.).

When you have pulled off all the parts of the flower, you will see that the end of the peduncle to which they were attached is slightly