CHAPTER I

INTRODUCTORY

It is to plants that the country-side owes much of its character and charm. While hill and valley, river and plain, give to landscapes their general contour, the vegetation changes their aspect from place to place and gives them greater variety of form and colour. The plants which compose this vegetation differ greatly one from another. Great trees stand out as the most conspicuous objects, while the humble grasses cover wide expanses with their verdure and a variety of herbs and shrubs clothe our banks and form our hedges. Yet all these plants alike are green. They all possess green leaves and have roots underground. Closer examination will show other common features. We shall find, as our study proceeds, that a general similarity underlies their construction and the same principles are involved in the maintenance of their life.

Let us with this end in view compare carefully a few common plants.

A Sunflower. We will begin our study with a common erect plant, the Sunflower. If we dig up carefully a young Sunflower plant, and shake the root free from soil, we shall be able to observe the following points:

The whole plant can be divided into two obviously different parts, that which was above the ground, the *shoot-system*, and that which was below the ground, the

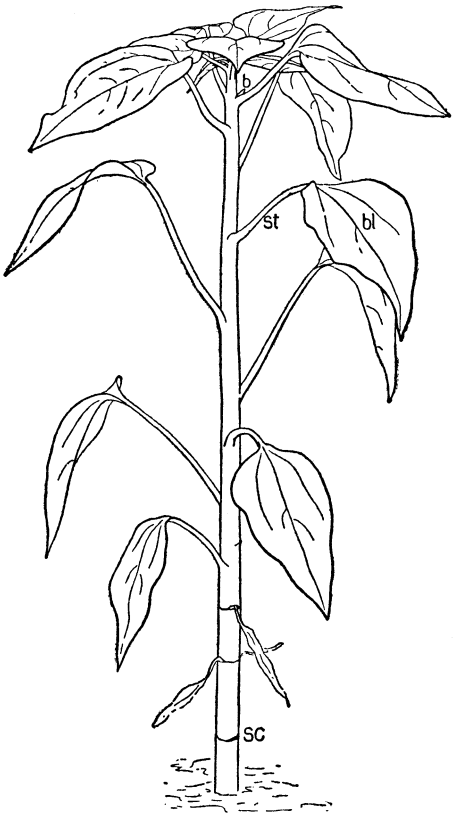

Fig. 1. Shoot-system of young Sunflower plant: *b*, axillary bud; *st*, leaf-stalk; *bl*, leaf-blade; *sc*, leaf-scar. The lower leaves or leaf-scars are in pairs: the other leaves are all arranged spirally.

root-system. The difference between these two parts which strikes us first is that of colour: the shoot-system is *green*, the root-system *whitish*.

There are great differences also in form. The *shoot-system* (Fig. 1) consists of an upright rounded stem along which are borne at intervals flat outgrowths, the leaves. The upper leaves are distributed in such a way that a spiral can be drawn, round the stem, through the points of attachment of successive leaves. Towards the top of the plant (Fig. 2) the leaves are smaller and closer together. The smallest leaves, numerous and

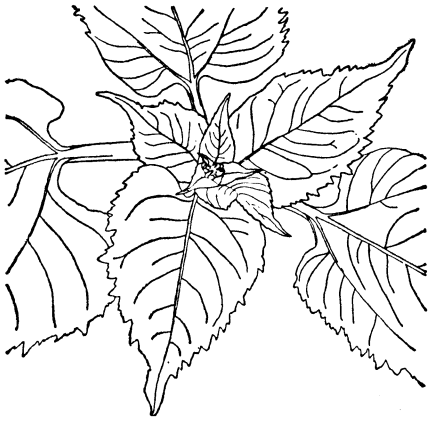

Fig. 2. Apex of a young Sunflower plant seen from above, showing the terminal bud.

crowded, arch over the end of the stem and hide its tip. As we carefully lift the outer overlapping leaves we come to still smaller, softer and more delicate ones and we can see that the tip of the stem itself is very soft and tender. This crowd of tiny overlapping leaves enclosing the stem-tip is called a bud. We infer that its parts, being tender and small, are young; and by a few careful measurements at intervals of a week on a similar plant still in the ground we can readily prove them to be growing.

For this purpose a few of the outer leaves of the bud should be numbered with water-proof ink and their lengths carefully recorded. At the same time the lengths and breadths of the other older leaves may also be recorded, together with the distances between them on the stem. At the end of a week or a fortnight the outermost leaves of the bud will have expanded and turned back, their place being taken by younger leaves which they formerly enclosed; while the leaves just below will also have grown in length and breadth and will have been carried farther apart by the upward growth of the stem between them. Farther down, however, neither stem nor leaves will have grown: here are the old full-grown leaves on the oldest and toughest part of the stem. Some of the oldest leaves may have died and fallen off, leaving scars which mark the positions they once occupied.

Thus it is in the *apical* or *terminal* bud, at the tip or apex of the shoot, that new parts are added to the shoot. Such *apical growth* is in strong contrast with the general growth of all parts alike which we observe in animals.

If we now look in the angle between the base of any leaf and the stem (we call this angle the *axil* of the leaf) we see a small outgrowth (see Fig. 1, *b*) which on close examination we find to be composed of tiny closely overlapping delicate leaves like those of the terminal bud. This is in fact also a bud, and because it is at the side of the stem and not at the tip it is called a lateral bud. As it is in the axil of the leaf it is also called an axillary bud, and a careful search will prove that all the lateral buds are axillary. No lateral bud occurs except in the axil of a leaf. Often in vigorous old plants some of the buds grow out into branches, which, like the main stem, bear leaves with buds in their axils and end in the bud from which they have grown.

Let us now examine the *root-system*. Continuous with the main stem of the plant is the main or primary root. Like the stem, its tip is soft and delicate and, as we shall prove for ourselves later, is the part which is young and growing. The harder part farther up has ceased to grow in length. From the main root there come off, usually in a more or less horizontal position, side roots which, being branches of the primary root, are called secondary roots. These are of various sizes, the oldest and largest being at the top and the smallest and youngest nearer the tip of the primary root. From the secondary roots grow other roots in all directions, and these branch again and again; all these finer rootlets are called tertiary roots.

Except for their size and position there is nothing to distinguish these various roots in appearance one from another. They are all cylindrical; and in colour are whitish, at any rate towards the tip where the more delicate younger parts are situated.

In an older plant the root-system has grown. The main root has become thicker and tougher and is dark brown in colour. It has not grown far in a downward direction, but the root-system has developed on all sides by the further growth of some of the principal secondary roots and the tertiary roots arising from them, thus keeping in the upper layers of the soil.

A time comes in the life of the Sunflower plant when the apical bud of the stem no longer produces new leaves but opens out into the well-known golden 'flower,' the Sun-flower itself. This fades at last, leaving a mass of 'seeds,' which when sown produce new plants like the old one. We shall leave till later the study of the flower, merely noting here that the production of flowers and seeds is a very important point of agreement between most of our common plants.

A grass plant.

Let us now take a grass plant and examine that. A plant of the common wayside grass, *Poa annua*, growing as a weed in the garden will serve well; it can easily be taken up from the soft

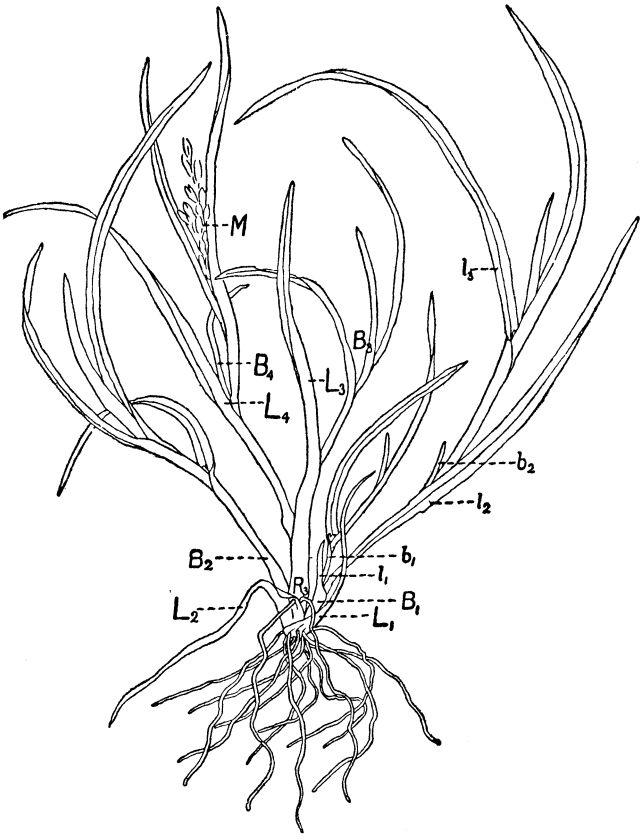

Fig. 3. Grass plant (*Poa annua*). L_1, L_2, L_3, etc., successive leaves of main stem, which ends in the inflorescence M; B_1, B_2, B_3, etc., the shoots in the axils of these leaves. l_1, l_2, l_3, leaves of axillary shoot B_1; b_1, b_2, the shoots in their axils. R_3, the adventitious roots springing from the node at which the leaf L_3 is attached. (M. G. T.)

garden soil without damaging its roots. Here again we find a green shoot-system, and a bunch of whitish roots below it. This plant is not, however, tall and erect like the Sunflower, but low and tufted (Fig. 3): let us see how it is built up.

The shoot-system consists of a number of shoots which come together at the base. Each of these shoots has a few bright green leaves, which are very narrow in comparison with their length and are called linear leaves. If we trace one of these leaves downwards, we find the blade attached, not to a stalk like that of the Sunflower, but to a sheath (Fig. 4, *sh*) which enwraps the sheath of another leaf, within which still other leaves may be visible. The innermost leaf is the smallest and most delicate; its sheath is hidden and its blade is folded. At the top of the sheath of each leaf, at the point where it joins the leaf-blade, is a small membranous or skin-like outgrowth, called a *ligule* (Fig. 4, *lig*), which fits closely against the leaf next within, and prevents rain that runs down the blade from getting into the sheath.

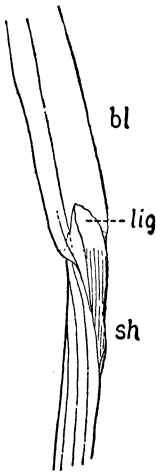

Fig. 4. Lower part of grass leaf: *sh*, sheath; *lig*, ligule; *bl*, blade.

Low down on a shoot, we may find a leaf of which the sheath has been forced back by another smaller shoot arising within it (e.g. Fig. 3, l_1, with b_1). When this leaf is pulled down, we discover that the sheath is attached at the bottom around a swollen place (a *node*) on a whitish stem. From this same node, on the same side as the leaf-blade—in the axil of the leaf—arises the small lateral shoot. The lowest leaf of this axillary shoot is a very thin transparent sheath without any blade.

A very short way above this node is another similar node, and here arises the next leaf, with its blade on the opposite side of the stem. Pulling down this leaf we shall find another younger axillary shoot (b_2), consisting of very young and delicate leaves, nearly enclosed in the lowest leaf, which as before is a thin transparent sheath.

The part of the stem which comes between this node and the next (called an *internode*) is very short and tender. Each successive internode is shorter and more delicate. Thus we have here a terminal or apical bud, just as in the Sunflower, and also axillary shoots and axillary buds in the axils of the leaves.

This whole shoot is joined below to another similar shoot. Careful search at the point where they join may reveal a dead or dying leaf with a torn sheath, surrounding them both (Fig. 3, L_1). This is the leaf in the axil of which our shoot started as a bud. In fact, a comparison of old and young grass plants will prove to us that the whole tuft of shoots has been formed from a single shoot by the production of lateral shoots from axillary buds.

As each shoot grows older its terminal bud, like that of the Sunflower, stops producing leaves, and grows up rapidly into a long stem ending in a plume of flowers (like the main shoot in Fig. 3, M); this finally bears seed, and from this seed, when scattered on the ground, arise new plants like the old one.

The shoot-system of the grass plant is thus built up in a similar way to the shoot-system of the Sunflower; but in the grass the many lateral branches develop early from the axils of the lower leaves, and as the leaves are close together near the ground a tufted habit is produced. The branches grow at first in a horizontal direction, so that with each lateral shoot the plant spreads a little farther over the surface of the soil.

If we now examine the lower nodes of the outer

shoots of our plant we find tiny roots beginning to grow from them, or longer roots already well grown. A close comparison of plants of different ages will prove that the whole mass of roots is formed in this way from the nodes of the stems: there is no large main root continuous with the central shoot as in the Sunflower. But the difference is not so great as appears at first sight, for nearly all plants have the power to produce roots directly from the stem; gardeners take advantage of this when they plant cuttings (i.e. cut branches) in the ground to produce new plants. Moreover, we shall see later that even a grass plant begins life with a main root but soon gives up the single root-system in favour of these separate small root-systems produced direct from its branches wherever required (*adventitious* roots). By the formation of such roots each new shoot is fixed firmly and closely to the ground. From each root grow fine, hair-like, secondary roots, and from these still finer tertiary roots; so the surface soil is penetrated as far as the plant extends and, as the many roots soon grow tough and fibrous, is converted into springy turf.

As we have seen, the stem is short until the time of flowering, and its tender tip is low down within the protecting sheaths of the outer leaves. In this position it stands some chance of escaping the mouth of a grazing animal. If, however, this terminal bud should be removed it is readily replaced by the growth of younger lateral buds. Of such buds there are always many which are not actively growing, and are therefore described as dormant (i.e. sleeping) buds. If need or opportunity arise they awake into activity and grow out into branches. Dormant buds are also found in the Sunflower: even in the oldest plant there are many buds which have not grown out into branches and as the Sunflower does not

survive the winter these buds never grow out. In the grass, too, many buds remain always dormant.

A Dandelion. The Dandelion is a plant which grows abundantly in meadows amongst the grass, and in many places besides. As this looks very different from either Sunflower or grass, let us examine it (Fig. 5).

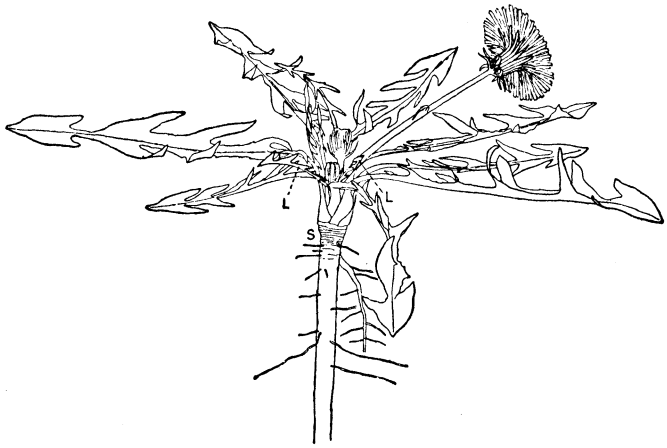

Fig. 5. Dandelion, showing 'rosette' habit, and part of the long tap-root. *S*, scars of fallen leaves. *L*, *L*, leaves of an axillary shoot.

When we try to dig it up we find a stout tapering main root, which pierces the ground to such a depth that it would be very troublesome and difficult to remove the whole of it. We may be satisfied if we obtain six or eight inches of it. Compared with the root-system of the Sunflower, that of the Dandelion has few lateral roots, though these increase in number lower down. In contrast with the main root, all the secondary and tertiary roots are thin and fibrous.

Thus whereas the grass plant and the Sunflower are surface-rooted, the Dandelion is deep-rooted. Its long main root, straight and stout, piercing the ground so