ON FRUITS AND SEEDS.

BY SIR JOHN LUBBOCK, F. R. S.

OUR eloquent countryman, Mr. Ruskin, commences his work on "Flowers" by a somewhat severe criticism of his predecessors. He reproduces a page from a valuable but somewhat antiquated work, "Curtis's Magazine," which he alleges to be "characteristic of botanical books and botanical science, not to say all science," and complains bitterly that it is a string of names and technical terms. No doubt that unfortunate page does contain a list of synonyms and long words. But, in order to identify a plant, you must have synonyms and technical terms, just as to learn a language you must have a dictionary. To complain of this would be to resemble the man who said that Johnson's "Dictionary" was dry and disjointed reading. But no one would attempt to judge the literature of a country by reading a dictionary. So also we can not estimate the interest of a science by reading technical descriptions. On the other hand, it is impossible to give a satisfactory description of an animal or plant except in strict technical language. Let me reproduce a description which Mr. Ruskin has given of the swallow, and which, indeed, he says in his lecture on that bird, is the only true description that could be given. His lecture was delivered before the University of Oxford, and is, I need hardly say, most interesting.

Now, how does he describe a swallow? "You can," he says, "only rightly describe the bird by the resemblances and images of what it seems to have changed from, then adding the fantastic and beautiful contrast of the unimaginable change. It is an owl that has been trained by the Graces. It is a bat that loves the morning light. It is the aërial reflection of a dolphin. It is the tender domestication of a trout." That is, no doubt, very poetical, but it would be absolutely useless as a scientific description, and, I must confess, would never have suggested, to me at least, the idea of a swallow.

But, though technical terms are very necessary in science, I shall endeavor, as far as I can, to avoid them here. As, however, it will be impossible for me to do so altogether, I will do my best at the commencement to make them as clear as possible, and I must therefore ask those who have already looked into the subject to pardon me if, for a few moments, I go into very elementary facts. In order to understand the structure of the seed, we must commence with the flower, to which the seed owes its origin. Now, if you take such a flower as, say, a geranium, you will find that it consists of the following parts: firstly, there is a whorl of green leaves, known as the sepals, and together forming the calyx; secondly, a whorl of colored leaves, or petals, generally forming the most conspicuous part of the flower, and called the corolla; thirdly, a whorl of organs, more or less like pins, which are called stamens; and in the heads, or anthers, of which the pollen is produced. These anthers are in reality, as Goethe showed, modified leaves; in the so-called double flowers, as, for instance, in our garden roses, they are developed into colored leaves like those of the corolla, and monstrous flowers are not unfrequently met with in which the stamens are green leaves, more or less resembling the ordinary leaves of the plant. Lastly, in the center of the flower is the pistil, which also is theoretically to be considered as constituted of one or more leaves, each of which is folded on itself and called a carpel. Sometimes there is only one carpel. Generally the carpels have so completely lost the appearance of leaves that this explanation of their true nature requires a considerable amount of faith. The base of the pistil is the ovary, composed, as I have just mentioned, of one or more carpels, in which the seeds are developed. I need hardly say that many so-called seeds are really fruits; that is to say, they are seeds with more or less complex envelopes.

We all know that seeds and fruits differ greatly in different species. Some are large, some small; some are sweet, some bitter; some are brightly colored; some are good to eat, some poisonous, some spherical, some winged, some covered with bristles, some with hairs, some are smooth, some very sticky.

We may be sure that there are good reasons for these differences. In the case of flowers much light has been thrown on their various interesting peculiarities by the researches of Sprengel, Darwin, Müller, and other naturalists. As regards seeds also, besides Gärtner's great work, Hildebrand, Krause, Steinbrinck, Kerner, Grant Allen, Wallace, Darwin, and others, have published valuable researches, especially with reference to the hairs and hooks with which so many seeds are provided, and the other means of dispersion they possess. Nobbe also has contributed an important work on seeds, principally from an agricultural point of view, but the subject as a whole offers a most promising field for investigation. It is rather with a view of suggesting this branch of science to you, than of attempting to supply the want myself, that I now propose to call your attention to it. In doing so I must, in the first place, express my acknowledgments to Mr. Baker, Mr. Carruthers, Mr. Hemsley, and especially to Mr. Thiselton Dyer and Sir Joseph Hooker, for their kind and most valuable assistance.

It is said that one of our best botanists once observed to another that he never could understand what was the use of the teeth on the capsules of mosses. "Oh," replied his friend, "I see no difficulty in that, because, if it were not for the teeth, how could we distinguish the species?"

We may, however, no doubt, safely consider that the peculiarities of seeds have reference to the plant itself, and not to the convenience of botanists.

In the first place, then, during growth, seeds in many cases require protection. This is especially the case with those of an albuminous character. It is curious that so many of those which are luscious when ripe, as the peach, strawberry, cherry, apple, etc., are stringy and almost inedible till ripe. Moreover, in these cases, the fleshy portion is not the seed itself, but only the envelope, so that even if the sweet part is eaten the seed itself remains uninjured.

On the other hand, such seeds as the hazel, beech, Spanish chestnut, and innumerable others, are protected by a thick, impervious shell, which is especially developed in many *Proteaceæ,* the Brazil-nut, the so-called monkey-pot, the cocoanut, and other palms.

In other cases the envelopes protect the seeds, not only by their thickness and toughness, but also by their bitter taste, as, for instance, in the walnut. The genus *Mucuna,* one of the *Leguminosæ,* is remarkable in having the pods covered with stinging hairs.

In many cases the calyx, which is closed when the flower is in bud, opens when the flower expands, and then after the petals have fallen closes again until the seeds are ripe, when it opens for the second time. This is, for instance, the case with the common herb-robert (*Geranium Robertianum*). In *Atractylis cancellata,* a South European plant, allied to the thistles, the outer envelopes form an exquisite little cage. Another case, perhaps, is that of *Nigella,* the "Devil-in-abush," or, as it is sometimes more prettily called, "Love-in-a-mist," of old English gardens.

Again, the protection of the seed is in many cases attained by curious movements of the plant itself. In fact, plants move much more than is generally supposed. So far from being motionless, they may almost be said to be in perpetual movement, though the changes of position are generally so slow that they do not attract attention. This is not, however, always the case. We are all familiar with the sensitive-plant, which droops its leaves when touched. Another species (*Averrhoa bilimbi*) has leaves like those of an acacia, and all day the leaflets go slowly up and down. *Desmodium gyrans*, a sort of pea living in India, has trifoliate leaves, the lateral leaflets being small and narrow; and these leaflets, as was first observed by Lady Monson, are perpetually moving round and round, whence the specific name *gyrans*. In these two cases the object of the movement is quite unknown to us. In *Dionæa*, on the other hand, the leaves form a regular fly-trap. Directly an insect alights on them they shut up with a snap.

In a great many cases leaves are said to sleep; that is to say, at the approach of night they change their position, and sometimes fold themselves up, thus presenting a smaller surface for radiation, and being in consequence less exposed to cold. Mr. Darwin has proved experimentally that leaves which were prevented from moving suffered more from cold than those which were allowed to assume their natural position. He has observed with reference to one plant, *Maranta arundinacea*, the arrow-root, a West Indian species allied to *Canna*, that if the plant has had a severe shock it can not get to sleep for the next two or three nights.

The sleep of flowers is also probably a case of the same kind, though, as I have elsewhere attempted to show, it has now, I believe, special reference to the visits of insects; those flowers which are fertilized by bees, butterflies, and other day insects, sleep by night, if at all; while those which are dependent on moths rouse themselves toward evening, as already mentioned, and sleep by day. These motions, indeed, have but an indirect reference to our present subject. On the other hand, in the dandelion (*Leontodon*), the flower-stalk is upright while the flower is expanded, a period which lasts for three or four days; it then lowers itself and lies close to the ground for about twelve days, while the fruits are ripening, and then rises again when they are mature. In the *Cyclamen* the stalk curls itself up into a beautiful spiral after the flower has faded.

The flower of the little *Linaria* of our walls (*L. cymbalaria*) pushes out into the light and sunshine, but as soon as it is fertilized it turns round and endeavors to find some hole or cranny in which it may remain safely ensconced until the seed is ripe.

In some water-plants the flower expands at the surface, but after it is faded retreats again to the bottom. This is the case, for instance, with the water-lilies, some species of the *Potamogeton (Trapa natans).* In *Valisneria,* again, the female flowers (Fig. 1, *a*) are borne on long stalks, which reach to the surface of the water, on which the flowers float. The male flowers (Fig. 1, *b*), on the contrary, have short, straight stalks, from which, when mature, the pollen (Fig. 1, *c*) detaches itself, rises to the surface, and, floating freely on it, is wafted about, so that it comes in contact with the female flowers. After fertilization, however, the long stalk coils up spirally, and thus carries the ovary down to the bottom, where the seeds can ripen in greater safety.

The next points to which I will direct your attention are the means of dispersion possessed by many seeds. Farmers have found by experience that it is not desirable to grow the same crop in the same field year after year, because the soil becomes more or less exhausted. In this respect, therefore, the powers of dispersion possessed by many seeds are a great advantage to the species. Moreover, they are also advantageous in giving the seed a chance of germinating in new localities suitable to the requirements of the species. Thus a common European species, *Xanthium spinosum,* has rapidly spread over the whole of South Africa, the seeds being carried in the wool of sheep. From various considerations, however, it seems probable that in most cases the provision does not contemplate a dispersion for more than a short distance.

There are a great many cases in which plants possess powers of movement directed to the dissemination of the seed. Thus, in *Geastrum hygrometricum*, a kind of fungus which grows underground, the outer envelope—which is hard, tough, and hygrometric—divides, when mature, in strips from the crown to the base; these strips spread horizontally, raising the plant above its former position in the ground; on rain or damp weather supervening the strips return to their former

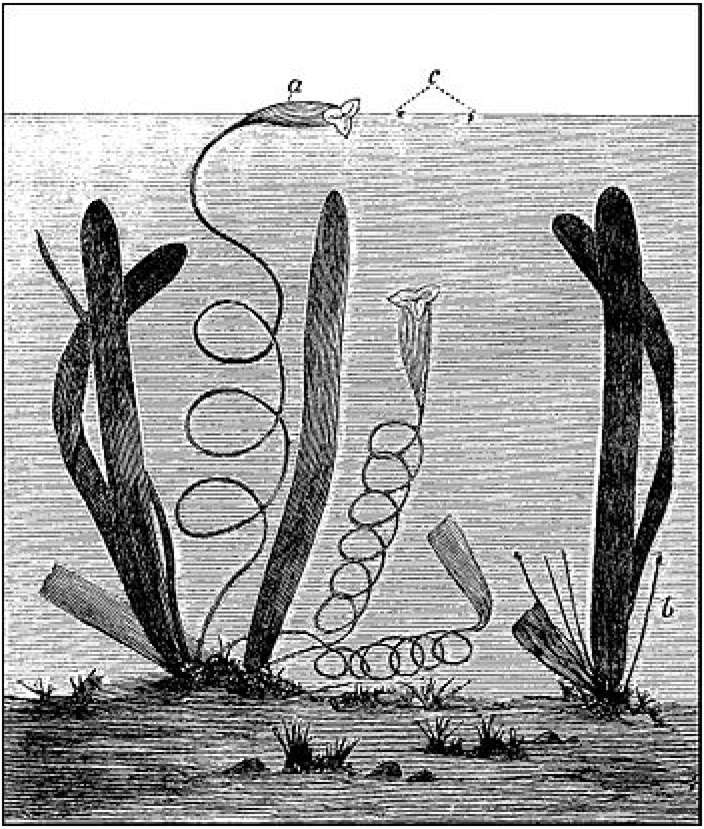


FIG. 1.—VALISNERIA SPIRALIS. *a,* female flower; *b,* male flower; *c,* floating

position; on the return of the drought this process is repeated, until the fungus reaches the surface and spreads out there; then the membrane of the conceptacle opens and emits the spores in the form of dust.

I have already referred to the case of the common dandelion. Here the flower-stalk stands more or less upright while the flower is expanded, a period which generally lasts for three or four days. It then lowers itself, and lies more or less horizontally and concealed during the time the seeds are maturing, which in our summers occupies about twelve days. It then again rises, and, becoming almost erect, facilitates the dispersion of the seeds, or, speaking botanically, the fruits, by the wind. Some plants, as we shall see, even sow their seeds in the ground, but these cases will be referred to later on.

In other cases the plant throws its own seeds to some little distance. This is the case with the common *Cardamine hirsuta*, a little plant, I do not like to call it a weed, six or eight inches high, which comes up of itself abundantly on any vacant spot in our kitchen-gardens or shrubberies, and which much resembles that represented in Fig. 17, but without the subterranean pods *b*. The seeds are contained in a pod which consists of three parts, a central membrane, and two lateral walls. When the pod is ripe the walls are in a state of tension. The seeds are loosely attached to the central piece by short stalks. Now, when the proper moment has arrived, the outer walls are kept in place by a delicate membrane, only just strong enough to resist the tension. The least touch, for instance a puff of wind blowing the plant against a neighbor, detaches the outer wall, which suddenly rolls itself up, generally with such force as to fly from the plant, thus jerking the seeds to a distance of several feet.

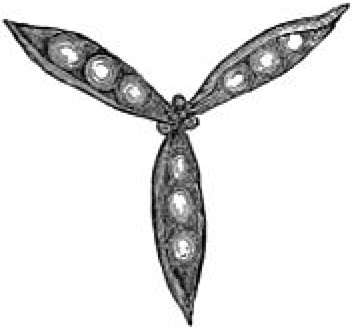
FIG. 2.—VIOLA HIRTA. *a*, young bud; *b*, ripe seed-capsule.

In the common violets, besides the colored flowers, there are others in which the corolla is either absent or imperfectly developed. The stamens also are small, but contain pollen, though less than in the colored flowers. In the autumn large numbers of these curious flowers are produced. When very young they look like an ordinary flower-bud (Figs. 2 and 3, *a*), the central part of the flower being entirely covered by the sepals, and the whole having a triangular form. When older (Figs. 2 and 3, *b*) they look at first sight like an ordinary seed-capsule, so that the bud seems to pass into the capsule without the flower-stage. The pansy violets do not possess these interesting flowers. In the sweet-violet (*Viola odorata* and *Viola hirta*, Fig. 2) they may easily be found by searching among the leaves nestling close to the ground. It is often said, for instance by Vaucher, that the plants actually force these capsules into the ground, and thus sow their own seeds. I have not, however, found this to be the case, though, as the stalk elongates, and the point of the capsule turns downward, if the earth be loose and uneven, it will no doubt sometimes so happen. When the seeds are fully ripe, the capsule opens by three valves and allows them to escape.

In the dog-violet (*Viola canina*, Fig. 3) the case is very different. The capsules are less fleshy, and, though pendent when young, at

FIG. 3.—VIOLA CANINA. *a*, bud; *b*, bud more advanced; *c*, capsule open, some of the seeds are already thrown.

maturity they erect themselves (Fig. 3, *c*), stand up boldly above the rest of the plant, and open by the three equal valves (Fig. 4) resembling an inverted tripod. Each valve contains a row of three, four, or five brown, smooth, pear-shaped seeds, slightly flattened at the upper,



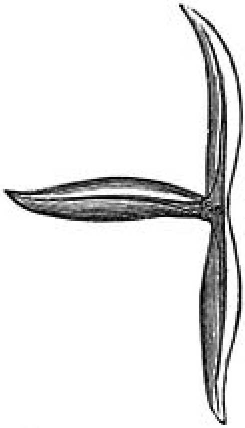


FIG. 4.

FIG. 5.—VIOLA CANINA; SEED-VESSEL AFTER EJECTING THE SEEDS.

wider end. Now the two walls of each valve, as they become drier, contract, and thus approach one another, thus tending to squeeze out the seeds. These resist some time, but at length the attachment of the seed to its base gives way, and it is ejected several feet, this being no doubt much facilitated by its form and smoothness. I have known even a gathered specimen throw a seed nearly ten feet. Fig. 5 represents a capsule after the seeds have been ejected.

Now, we naturally ask ourselves what is the reason for this difference between the species of violets; why do *Viola odorata* and *Viola Hirta* conceal their capsules among the moss and leaves on the ground, while *Viola canina* and others raise theirs boldly above their heads, and throw the seeds to seek their fortune in the world? If this arrangement be best for *Viola canina*, why has not *Viola odorata* also adopted it? The reason is, I believe, to be found in the different mode of growth of these two species. *Viola canina* is a plant with an elongated stalk, and it is easy, therefore, for the capsule to raise itself above the grass and other low herbage among which violets grow.

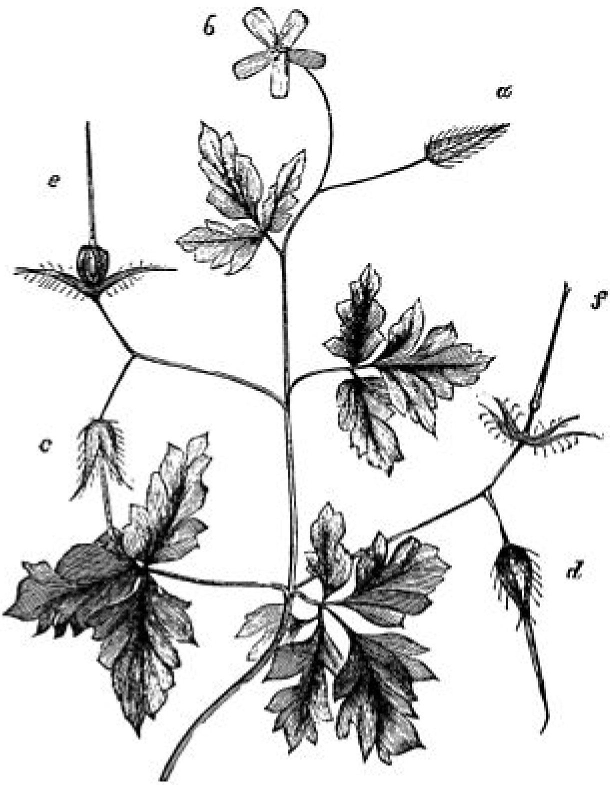


FIG. 6.—THE HERB-ROBERT (Geranium Robertianum,) *a,* bud; *b,* flower; *c,* flower after the petals have fallen; *d,* flower with seeds nearly ripe; *e,* flower with ripe seeds; *f,* flower after throwing seeds.

Viola odorata and *Viola hirta,* on the contrary, have, in ordinary parlance, no stalk, and the leaves are radical, i. e., rising from the root. This is at least the case in appearance, for, botanically speaking, they rise at the end of a short stalk. Now, under these circumstances, if the sweet violet attempted to shoot its seeds, the capsules not being sufficiently elevated, the seeds would merely strike against some neighboring leaf, and immediately fall to the ground. Hence, I think, we see that the arrangement of the capsule in each species is that most suitable to the general habit of the plant.

In the true geraniums again, as for instance in the herb-robert (Fig. 6), after the flower has faded, the central axis gradually elongates (Fig. 6, *c*, *d*). The seeds, five in number, are situated at the base of the column, each being inclosed in a capsule, which terminates upward in a rod-like portion, which at first forms part of the central axis, but gradually detaches itself. When the seeds are ripe the ovary raises itself into an upright position (Fig. 6, *e*); the outer layers of the rod-like termination of the seed-capsule come to be in a state of great tension, and eventually detach the rod with a jerk, and thus throw the seed some little distance. Fig. 6, *f*, represents the central rod after the seeds have been thrown. In some species, as for instance in Geranium dissectum, Fig. 7, the capsule-rod remains attached to the central column, and the seed only is ejected.

It will, however, be remembered that the capsule is, as already observed, a leaf folded on itself, with the edges inward, and in fact in the geranium the seed-chamber opens on its inner side. You

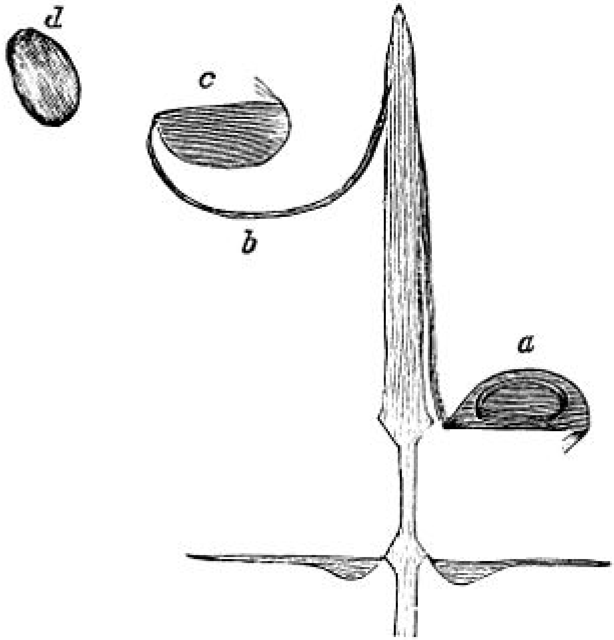


Diagram. FIG. 7.—GERANIUM DISSECTUM. *a,* just before throwing seed; *b,* just after throwing seed; *c,* the capsule still attached to the rod; *d,* the seed.

will, therefore, naturally observe to me that, when the carpel bursts outward, the only effect would be that the seed would be forced against the outer wall of the carpel, and that it would not be ejected, because the opening is not on the outer but on the inner side. Your remark is perfectly just, but the difficulty has been foreseen by our geraniums, and is overcome by them in different ways. In some species, as for instance in *Geranium dissectum*, a short time before the dehiscence, the seed-chamber places itself at right angles to the pillar (Fig. 7, *a*). The edges then separate, but they are provided with a fringe of hairs, just strong enough to retain the seed in its position, yet sufficiently elastic to allow it to escape when the carpels burst away, remaining attached, however, to the central pillar by their upper ends (Fig. 7, *c*).

In the common herb-robert (Fig. 8), and some other species, the arrangement is somewhat different. In the first place, the whole carpel springs away (Fig. 8, *b* and *c*). The seed-chamber (Fig. 8, *c*) detaches itself from the rod of the carpel (Fig. 8, *b*), and when the seed is flung away remains attached to it. Under these circumstances it is unnecessary for the chamber to raise itself from the central pillar, to which accordingly it remains close until the moment of disruption (Fig. 6, *e*). The seed-chamber is, moreover, held in place by a short tongue which projects a little way over its base; while, on the other hand, the lower end of the rod passes for a short distance between the seed-capsule and the central pillar. The seed-capsule has also near its apex a curious tuft of silky hair (Fig. 8, *c*), the use of which I will not here stop to discuss. As the result of all this complex mechanism, the seeds when ripe are flung to a distance which is surprising when we consider how small the spring is. In their natural habitat it is almost impossible to find the seeds when once thrown. I, therefore, brought some into the house and placed them on my billiard-table. They were thrown from one end completely over the other, in some cases more than twenty feet.

Some species of vetch, again, and the common broom, throw their seeds, owing to the elasticity of the pods, which, when ripe, open suddenly with a jerk. Each valve of the pod contains a layer of woody cells, which, however, do not pass straight up the pod, but are more or less inclined to its axis (Fig. 9). Consequently, when the pod bursts it does not, as in the case of *Cardamine*, roll up like a watch-spring, but twists itself more or less like a corkscrew.

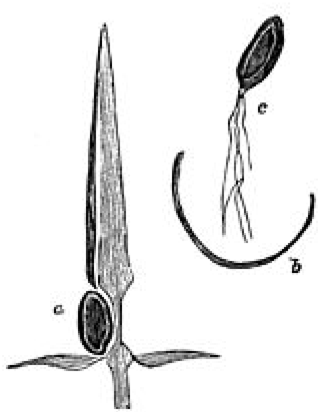


*Diagram.*Fig. 8.—Geranium Robertianum. *a*, just before throwing the seed; *b*, the red; *c*, the seed enclosed in the capsule.

I have mentioned these species because they are some of our commonest wild flowers, so that during the summer and autumn we may, in almost any walk, observe for ourselves this innocent artillery. There are, however, many other more or less similar cases. Thus the squirting cucumber (*Momordica elaterium*), a common plant in the south of Europe, and one grown in some places for medicinal purposes, effects the same object by a totally different mechanism. The

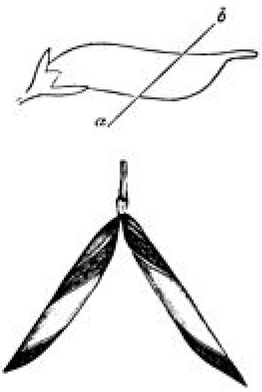


FIG. 9.—VICIA SEPIUM. The line *a b* shows the direction of the woody fibres.

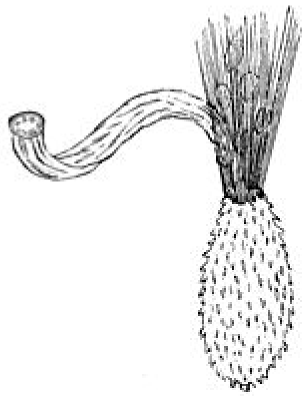


FIG. 10.—THE SQUIRTING CUCUMBER (*Momordica elaterium.*)

fruit is a small cucumber (Fig. 10), and when ripe it becomes so gorged with fluid that it is in a state of great tension. In this condition a very slight touch is sufficient to detach it from the stalk, when the pressure of the walls ejects the contents, throwing the seed some distance. In this case, of course, the contents are ejected at the end by which the cucumber is attached to the stalk. If any one touches one of these ripe fruits, they are often thrown with such force as to strike him in the face. In this the action is said to be due to endosmosis.

In *Cyclanthera*, a plant allied to the cucumber, the fruit is un-symmetrical, one side being round and hairy, the other nearly flat and smooth. The true apex of the fruit, which bears the remains of the flower, is also somewhat eccentric, and, when the seeds are ripe, if it is touched even lightly, the fruit explodes and the seeds are thrown to some distance. The mechanism by which this is effected has been described by Hildebrand. The interior of the fruit is occupied by loose cellular structure. The central column, or placenta, to which the seeds are attached, lies loosely in this tissue. Through the solution of its earlier attachments, when the fruit is ripe, the column adheres only at the apical end, under the withered remains of the flower, and at the swollen side. When the fruit bursts, the placenta unrolls, and thus hurls the seeds to some distance, being even itself sometimes also torn away from its attachment.

Other cases of projected seeds are afforded by *Hura*, one of the *Euphorbiæ*, *Collomia*, *Oxalis*, some species allied to *Acanthus*, and by *Arceuthobium*, a plant allied to the mistletoe, and parasitic on junipers, which ejects its seeds to a distance of several feet, throwing them thus from one tree to another.

Even those species which do not eject their seeds often have them so placed with reference to the capsule that they only leave it if swung or jerked by a high wind. In the case of trees, even seeds with no special adaptation for dispersion must in this manner be often carried to no little distance; and to a certain, though less extent, this must hold good even with herbaceous plants. It throws light on the (at first sight) curious fact that in so many plants with small, heavy seeds, the capsules open not at the bottom, as one might perhaps have been disposed to expect, but at the top. A good illustration is afforded by the well-known case of the common poppy (Fig. 11), in which the upper part of the capsule presents a series of little doors (Fig. 11, *a*), through which, when the plant is swung by the wind, the seeds come out one by one. The little doors are protected from rain by overhanging eaves, and are even said to shut of themselves in wet weather. The genus *Campanula* is also interesting from this point of of view, because some species have the capsules pendent, some upright, and those which are upright open at the top, while those which are pendent do so at the base.

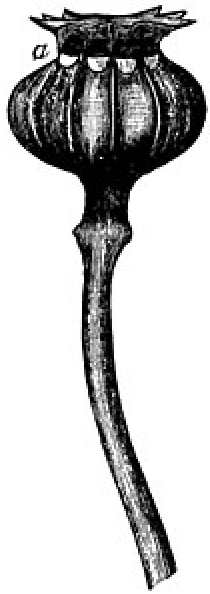


FIG. 11.—SEED-HEAD OF POPPY(*Papver.*)

In other cases the dispersion is mainly the work of the seed itself. In some of the lower plants, as, for instance, in many sea-weeds, and in some allied fresh-water plants, such as *Vaucheria*, the spores[1] are covered by vibratile cilia, and actually swim about in the water, like infusoria, till they have found a suitable spot on which to grow. Nay, so much do the spores of some sea-weeds resemble animals, that they are provided with a red "eye-spot" as it has been called, which, at any rate, seems so far to deserve the name that it appears to be sensitive to light. This mode of progression is, however, only suitable to water-plants. One group of small, low-organized plants (*Marchantia*) develop among the spores a number of cells with spirally thickened walls, which, by their contractility, are supposed to disseminate the spores. In the common horse-tails (*Equisetum*), again, the spores are provided with curious filaments, terminating in expansions, and known as "elaters." They move with great vigor, and probably serve the same purpose.

In much more numerous cases, seeds are carried by the wind. For this, of course, it is desirable that they should be light. Sometimes this object is attained by the character of the tissues themselves, sometimes by the presence of empty spaces. Thus, in *Valerianella auricula*, the fruit contains three cells, each of which would naturally be expected to contain a seed. One seed only, however, is developed, but, as may be seen from the figure given in Mr. Bentham's excellent "Handbook of the British Flora," the two cells which contain no seed actually become larger than the one which alone might, at first sight, appear to be normally developed. We may be sure from this that they must be of some use, and, from their lightness, they probably enable the wind to carry the seed to a greater distance than would otherwise be the case.

In other instances the plants themselves, or parts of them, are rolled along the ground by the wind. An example of this is afforded, for instance, by a kind of grass (*Spinifex squarrosus*), in which the mass of inflorescence, forming a large round head, is thus driven for miles over the dry sands of Australia until it comes to a damp place, when it expands and soon strikes root.

So, again, the *Anastatica hierochuntica*, or "rose of Jericho," a small annual with rounded pods, which frequents sandy places in Egypt, Syria, and Arabia, when dry, curls itself up into a ball or round cushion, and is thus driven about by the wind until it finds a damp place, when it uncurls, the pods open, and sow the seeds.

These cases, however, in which the seeds are rolled by the wind along the ground are comparatively rare. There are many more in which seeds are wafted through the air. If you examine the fruit of a sycamore you will find that it is provided with a wing-like expansion, in consequence of which, if there is any wind when it falls, it is, though rather heavy, blown to some distance from the parent tree. Several cases are shown in Fig. 12; for instance, the maple, *a*, sycamore, *b*, hornbeam, *d*, elm, *e*, birch, *f*, pine, *g*, fir, *h*, and ash, *i*, while in the lime, *c*, the whole bunch of fruits drops together, and the "bract," as it is called, or leaf of the flower-stalk, serves the same purpose.

In a great many other plants the same result is obtained by flattened and expanded edges. A beautiful example is afforded by the genus *Thysanocarpus*, a North American crucifer; *Th. laciniatus* has a distinctly winged pod; in *T. curvipes* the wings are considerably larger; lastly, in *T. elegans* and *T. radians* the pods are still further developed in the same direction, *T. radians* having the wing very broad, while in *T. elegans* it has become thinner and thinner in places, until at length it shows a series of perforations.

Among our common wild plants we find winged fruits in the dock (*Rumex*) and in the common parsnip (*Pastinaca*). But though in these cases the object to be obtained—namely, the dispersion of the seed—is effected in a similar manner, there are differences which might not at first be suspected. Thus in some cases, as, for instance, the pine, it is the seed itself which is winged; in *Thlaspi arvense* it is the pod; in *Entada*, a leguminous plant, the pod breaks up into segments, each of which is

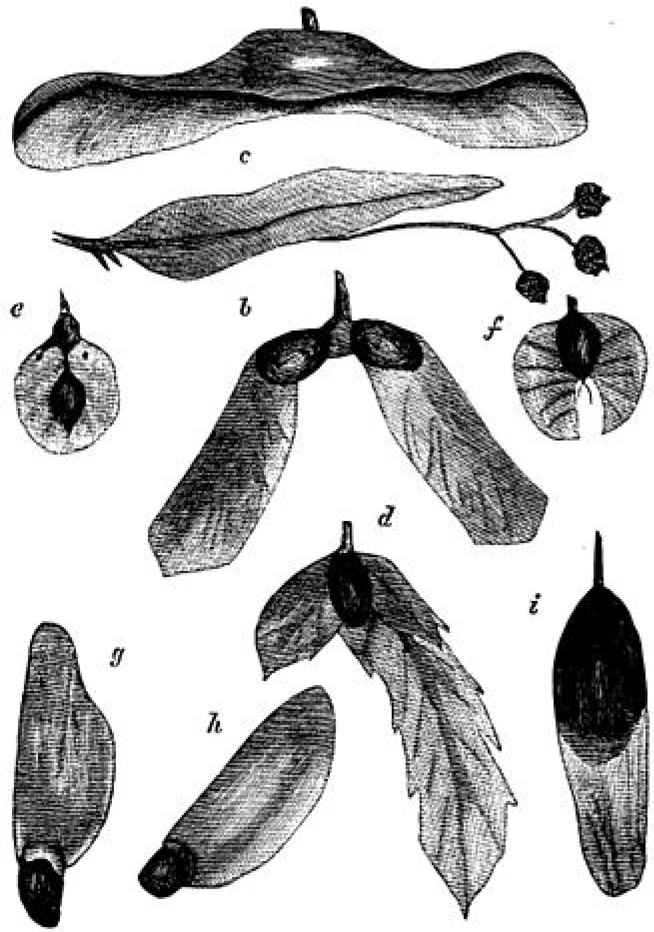


FIG. 12.—*a,* maple; *b,* sycamore; *c,* lime; *d,* hornbeam; *e,* elm; *f,* birch; *g,* pine; *h,* fir; *i,* ash.

winged; in *Nissolia* the extremity of the pod is expanded into a flattened wing; lastly, in the lime, as already mentioned, the fruits drop off in a bunch, and the leaf at the base of the common flower-stalk, or "bract," as it is called, forms the wing.

In *Gouania retinaria* of Rodriguez the same object is effected in another manner; the cellular tissue of the fruit crumbles and breaks away, leaving only the vascular tissue, which thus forms a net inclosing the seed.

Another mode, which is frequently adopted, is the development of long hairs. Sometimes, as in Clematis, Anemone, Dryas, these hairs take the form of a long, feathery awn. In others the hairs form a tuft or crown, which botanists term a pappus. Of this the dandelion and John Go-to-bed-at-noon, so called from its habit of shutting its flowers about mid-day, are well-known examples. Tufts of hairs, which are themselves sometimes feathered, are developed in a great many Composites, though some, as, for instance, the daisy and lapsana, are without them: in some very interesting species, of which the common *Thrincia hirta* of our lawns and meadows is one, there are two kinds of fruits, as shown in Fig. 13, *b*, one with a pappus and one without. The former are adapted to seek "fresh woods and pastures new," while the latter stay and perpetuate the race at home.

A more or less similar pappus is found among various English plants—in the Epilobium (Fig. 13, *a*), Thrincia (Fig. 13, *b*), Tamarix

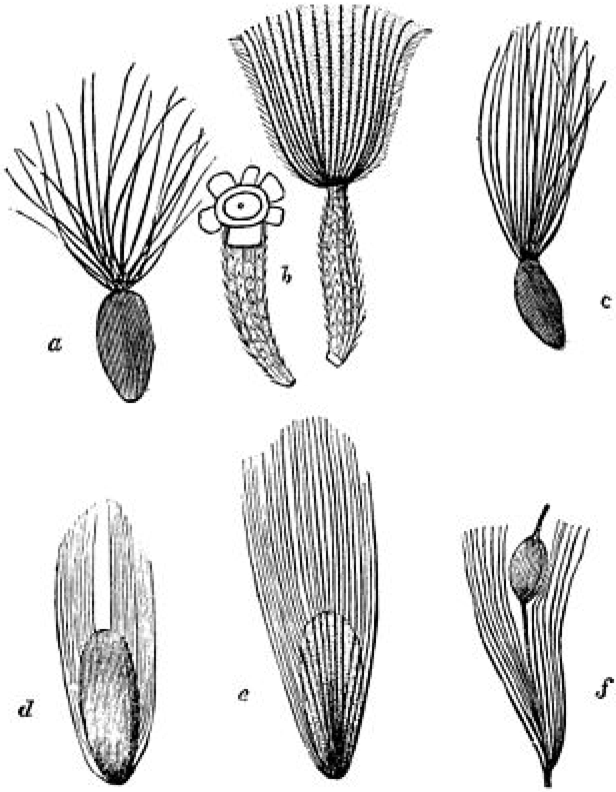


FIG. 13.—*a,* willow herb (*Epilobium*); *b,* two forms of seed of *Thrincia hirta*; *c,* Tamarix; *d,* willow (*Salix*); *e,* cotton grass (*Eriophorum*); *f,* bulrush (*Typha*).

(Fig. 13, *c*), willow (Fig. 13, *d*), cotton-grass (Fig. 13, *e*), and bulrush (Fig. 13, *f*); while in exotic species there are many other cases—as, for instance, the beautiful oleander. As in the wings, so also in that of the pappus, it is by no means always the same part of the plant which develops into the crown of hairs. Thus in the Valerians and composites it is the calyx; in the bulrush the perianth; in

Epilobium the crown of the seed; in the cotton-grass it is supposed to represent the perianth; while in some, as, for instance, in the cotton-plant, the whole outer surface of the seed is clothed with long hairs. Sometimes, on the contrary, the hairs are very much reduced in number, as, for instance, in some species of *Æschynanthus*, where there are only three, one on one side and two on the other. In this case, moreover, the hairs are very flexible, and wrap round the wool of any animal with which they may come in contact, so that they form a double means of dispersion.

In other cases seeds are wafted by water. Of this the cocoanut is one of the most striking examples. The seeds retain their vitality for a considerable time, and the loose texture of the husk protects them and makes them float. Every one knows that the cocoanut is one of the first plants to make its appearance on coral islands, and it is, I believe, the only palm which is common to both hemispheres.

The seeds of the common duckweeds (*Lemna*) sink to the bottom of the water in autumn, and remain there throughout the winter; but in the spring they rise up to the surface again, and begin to grow.—*Fortnightly Review.*

[*To be continued.*]

1. ↑ I need hardly observe that, botanically, these are not true seeds, but rather motile buds.

ON FRUITS AND SEEDS. [1]

By Sir JOHN LUBBOCK, F. R. S.

IN a very large number of cases the diffusion of seeds is effected by animals. To this class belong the fruits and berries. In them an outer fleshy portion becomes pulpy, and generally sweet, inclosing the seeds. It is remarkable that such fruits, in order, doubtless, to attract animals, are, like flowers, brightly colored—as, for instance, the cherry, currant, apple, peach, plum, strawberry, raspberry, and many others. This color, moreover, is not present in the unripe fruit, but is rapidly developed at maturity. In such cases the actual seed is generally protected by a dense, sometimes almost stony, covering, so that it escapes digestion, while its germination is perhaps hastened by the heat of the animal's body. It may be said that the skin of apple and pear pips is comparatively soft; but then they are imbedded in a stringy core, which is seldom eaten.

These colored fruits form a considerable part of the food of monkeys in the tropical regions of the earth, and we can, I think, hardly doubt that these animals are guided by the colors, just as we are, in selecting the ripe fruit. This has a curious bearing on an interesting question as to the power of distinguishing color possessed by our ancestors in bygone times. Magnus and Geiger, relying on the well known fact that the ancient languages are poor in words for color, and that in the oldest books—as, for instance, in the Vedas, the Zend-Avesta, the Old Testament, and the writings of Homer and Hesiod—though, of course, the heavens are referred to over and over again, its blue color is never dwelt on, have argued that the ancients were very deficient in the power of distinguishing colors, and especially blue. In our own country Mr. Gladstone has lent the weight of his great authority to the same conclusion. For my part I can not accept this view. There are, it seems to me, very strong reasons against it, into which I can not, of course, now enter; and, though I should rely mainly on other considerations, the colors of fruits are not, I think, without significance. If monkeys and apes could distinguish them, surely we may infer that even the most savage of men could do so too. Zeuxis would never have deceived the birds if he had not had a fair perception of color.

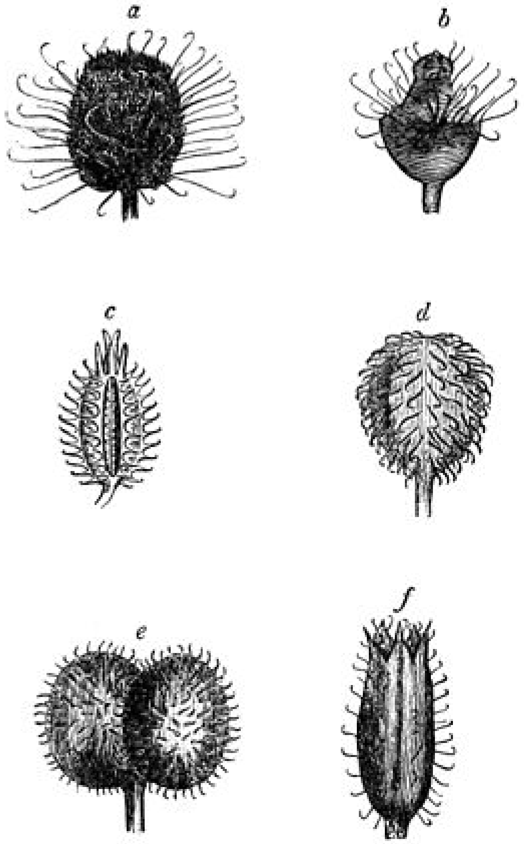


FIG. 14.—*a,* burdock (*Lappa*); *b,* agrimony (*agrinmonia*); *c,* bur parsley (*Caucalis*); *d,* enchanter's nightshade (*Circæa*); *e,* cleavers (*Galium*); *f,* forget-me-nots (*Myosotis*).

In these instances of colored fruits, the fleshy edible part more or less surrounds the true seeds; in others the actual seeds themselves become edible. In the former the edible part serves as a temptation to animals; in the latter it is stored up for the use of the plant itself. When, therefore, the seeds themselves are edible they are generally protected by more or less hard or bitter envelopes, for instance the horse-chestnut, beech, Spanish chestnut, walnut, etc. That these seeds are used as food by squirrels and other animals is, however, by no means necessarily an evil to the plant, for the result is that they are often carried some distance and then dropped, or stored up and forgotten, so that in this way they get carried away from the parent tree.

In another class of instances animals, unconsciously or unwillingly, serve in the dispersion of seeds. These cases may be divided into two classes, those in which the fruits are provided with hooks, and those in which they are sticky. To the first class belong, among our common English plants, the burdock (*Lappa*, Fig. 14 *a*), agrimony (*Agrimonia*, Fig. 14 *b*); the bur parsley (*Caucalis*, Fig. 14 *c*); enchanter's nightshade (*Cicræa*, Fig. 14 *d*); goose-grass or cleavers (*Galium*, Fig. 14 *e*), and some of the forget-me-nots (*Myosotis*, Fig. 14 *f*). The hooks, moreover, are so arranged as to promote the removal of the fruits. In all these species the hooks, though beautifully formed, are small; but in some foreign species they become truly formidable. Two of the most remarkable are represented on page 357—*Martynia proboscidea* (Fig. 15 *b*) and *Harpagophyton procumbens* (Fig. 15 *a*). Martynia is a plant of Louisiana, and if its fruits once get hold of an animal it is most difficult to remove them. Harpagophytum is a South African genus. The fruits are most formidable, and are said sometimes even to kill lions. They roll about over the dry plains, and, if they attach themselves to the skin, the wretched animal tries to tear them out, and sometimes getting them into his mouth perishes miserably.

The cases in which the diffusion of fruits and seeds is affected by their being sticky are less numerous, and we have no well-marked instance among our native plants. The common plumbago of South Europe is a case which many of you no doubt have observed. Other genera with the same mode of dispersion are *Pittosporum*, *Pisonia*, *Boerhavia Siegesbeckia*, *Grindelia*, *Drymaria*, etc. There are comparatively few cases in which the same plant uses more than one of these modes of promoting the dispersion of its seeds, still there are some such instances. Thus in the common burdock the seeds have a pappus, while the whole flower-head is provided with hooks which readily attach themselves to any passing animal. *Asterothrix*, as Hildebrand has pointed out, has three provisions for dispersion; it has a hollow appendage, a pappus, and a rough surface.

But perhaps it will be said that I have picked out special cases; that others could have been selected, which would not bear out, or perhaps would even negative, the inferences which have been indicated; that I have put the cart before the horse; that the ash-fruit has not a wing in order that it may be carried by the wind, or the burdock hooks that the heads may be transported by animals, but that, happening to have wings and hooks, these seeds are thus transported. Now, doubtless there are many points connected with seeds which are still unexplained; in fact, it is because this is so that I was anxious to direct attention to the subject. Still I believe the general explanations which have been given by botanists will stand any test.

Let us take, for instance, seeds formed on the same type as that of the ash—heavy fruits, with a long wing, known to botanists as a *samara*.

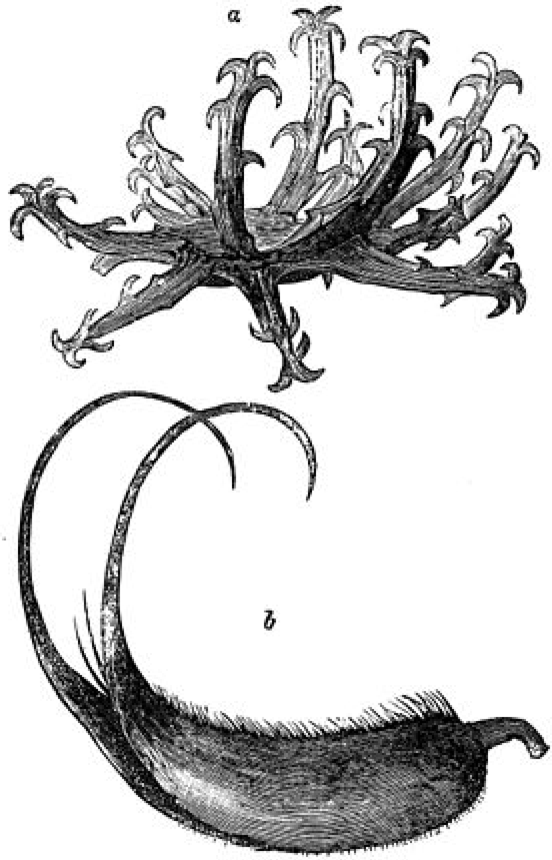


FIG. 15.—*a*. HARPAGOPHYTON PROCUMBENS (natural size); *b*, MARTYNIA

PROBOSCIDEA (natural size).

Now, such a fruit would be of little use to low herbs, which, however, are so numerous. If the wing was accidental, if it was not developed to serve as a means of dispersion, it would be as likely to occur on low plants and shrubs as on trees. Let us, then, consider on what kind of plants these fruits are found. They occur on the ash, maple, sycamore, hornbeam, pines, firs, and elm; while the lime, as we have seen, has also a leaf attached to the fruits, which answers the same purposes. Seeds of this character therefore occur on a large proportion of our forest-trees, and on them alone. But more than this: I have taken one or two of the most accessible works in which seeds are figured, for instance, Gärtner's "De Fructibus et Seminibus," Le Maout and Decaisne's (Hooker's translation) "Descriptive and Analytical Botany," and Baillon's "Histoire des Plantes." I find thirty genera, belonging to twenty-one different natural orders, figured as having seeds or fruits of this form. They are all trees or climbing shrubs, not one being a low herb.

Let us take another case, that of the plants in which the dispersion of the seeds is effected by means of hooks. Now, if the presence of these hooks was, so to say, accidental, and the dispersion merely a result, we should naturally expect to find some species with hooks in all classes of plants. They would occur, for instance, among trees and on water-plants. On the other hand, if they are developed that they might adhere to the skin of quadrupeds, then, having reference to the habits and size of our British mammals, it would be no advantage for a tree or for a water-plant to bear hooked seeds. Now, what are the facts? There are about thirty English species in which the dispersion of the seeds is effected by means of hooks, but not one of these is aquatic, nor is one of them more than four feet high. Nay, I might carry the thing further. We have a number of minute plants, which lie below the level at which seeds would be likely to be entangled in fur. Now, none of these, again, have hooked seeds or fruits. It would also seem, as Hildebrand has suggested, that in point of time, also, the appearance of the families of plants in which the fruits or seeds are provided with hooks coincided with that of the land mammalia.

Again, let us look at it from another point of view. Let us take our common forest-trees, shrubs, and tall, climbing—plants not, of course, a natural or botanical group, for they belong to a number of different orders, but a group characterized by attaining to a height of say over eight feet. We will in some cases only count genera; that is to say, we will count all the willows, for instance, as one. These trees and shrubs are plants with which you are all familiar, and are about thirty-three in number. Now, of these thirty-three no less than eighteen have edible fruits or seeds, such as the plum, apple, arbutus, holly, hazel, beech, and rose. Three have seeds which are provided with feathery hairs; and all the rest, namely, the lime, maple, ash, sycamore, elm, hop, birch, hornbeam, pine, and fir, are provided with a wing.

Moreover, as will be seen by the following table, the lower trees and shrubs, such as the cornel, Guelder rose, rose, thorn, privet, elder, yew, and holly, have generally edible berries, much eaten by birds. The winged seeds or fruits characterize the great forest trees.

TREES, SHRUBS, AND CLIMBING SHRUBS NATIVE OR NATURALIZED IN BRITAIN.

	Seed or Fruit.			
	Edible.	Hairy.	Winged.	Hooked.
Clematis vitalba		X		
Berberis vulgaris				
Lime (*Tilia Europæa*)			X	
Maple (*Acer*)			X	
Spindle-tree (*Euonymus*)	X			
Buckthorn (*Rhamnus*)				
Sloe (*Prunus*)	X			
Rose (*Rosa*)	X			
Apple (*Pyrus*)	X			
Hawthorn (*Cratægus*)	X			
Medlar (*Mespilus*)	X			
Ivy (*Hedera*)	X			
Cornel (*Cornus*)	X			
Elder (*Sambucus*)	X			
Guelder rose (*Viburnum*)	X			
Honeysuckle (*Lonicera*)				
Arbutus (*Arbutus*)	X			
Holly (*Ilex*)	X			
Ash (*Fraxinus*)			X	
Privet (*Ligustrum*)	X			
Elm (*Ulmus*)			X	
Hop (*Humulus*)			X	
Alder (*Alnus*)				
Birch (*Betula*)			X	
Hornbeam (*Carpinus*)			X	
Nut (*Corylus*)	X			
Beech (*Fagus*)	X			
Oak (*Quercus*)	X			
Willow (*Salix*)		X		
Poplar (*Populus*)		X		
Pine (*Pinus*)			X	

Fir (*Abies*)			X	
Yew (*Taxus*)	X			

Or let us take one natural order. That of the roses is particularly interesting. In the genus *Geum* the fruit is provided with hooks; in *Dryas* it terminates in a long feathered awn, like that of Clematis. On the other hand, several genera have edible fruits; but it is curious that the part of a plant which becomes fleshy, and thus tempting to animals, differs considerably in the different genera. In the blackberry, for instance, and in the raspberry, the carpels constitute the edible portion. When we eat a raspberry we strip them off and leave the receptacle behind; while in the strawberry the receptacle constitutes the edible portion; the carpels are small, hard, and closely surround the seeds. In these genera the sepals are situated below the fruit. In the rose, on the contrary, it is the peduncle that is swollen and inverted, so as to form a hollow cup, in the interior of which the carpels are situated. Here you will remember that the sepals are situated above, not below, the fruit. Again, in the pear and apple, it is

the ovary which constitutes the edible part of the fruit, and in which the pips are imbedded. At first sight, the fruit of the mulberry—which, however, belongs to a different family—closely resembles that of the blackberry. In the mulberry, however, it is the sepals which becomes fleshy and sweet.

The next point is that seeds should be in a spot suitable for their growth. In most cases the seed lies on the ground, into which it then pushes its little rootlet. In plants, however, which live on trees, the case is not so simple, and we meet some curious contrivances. Thus, the mistletoe, as we all know, is parasitic on trees. The fruits are eaten by birds, and the droppings often, therefore, fall on the boughs; but if the seed were like that of most other plants it would soon fall to the ground and consequently perish. Almost alone among English plants it is extremely sticky and thus adheres to the bark.

FIG. 16.—MYZODENDRON. (After Hooker.)

I have already alluded to an allied genus, *Arceuthobium*, parasitic on junipers, which throws its seeds to a distance of several feet. These also are very viscid, or, to speak more correctly, are imbedded in a very viscid mucilage, so that if they come in contact with the bark of a neighboring tree they stick to it.

Another interesting genus, again of the same family, is *Myzodendron* (Fig. 16), a Fuegian species, described by Sir Joseph Hooker, and parasitic on the beech. Here the seed is not sticky, but is provided with four flattened, flexible appendages. These catch the wind, and thus carry the seed from one tree to another. As soon, however, as they touch any little bough, the arms twist round it and there anchor the seed.

In many epiphytes the seeds are extremely numerous and minute. Their great numbers increase the chance that the wind may waft some of them to the trees on which they grow; and as they are then fully supplied with nourishment they do not require to carry any store with them. Moreover, their minute size is an advantage, as they are carried into any little chink or cranny in the bark, while a larger or heavier seed, even if borne against a suitable tree, would be more

FIG. 17.—CARDAMINE CHENOPODIFOLIA. *a a*, ordinary pods; *b*, subterranean pods.

likely to drop off. In the genus *Neumannia*, the small seed is produced at each end into a long filament which must materially increase its chances of adhering to a suitable tree

Even among terrestrial species there are not a few cases in which plants are not contented simply to leave their seeds on the surface of the soil, but actually sow them in the ground.

Thus in *Trifolium subterraneum*, one of our rarer English clovers, only a few of the florets become perfect flowers, the others form a rigid, pointed head, which at first is turned upward, and, as their ends are close together, constitute a sort of spike. At first, I say, the flower-heads point upward like those of other clovers, but, as soon as the florets are fertilized, the flower-stalks bend over and grow downward, forcing the flower-head into the ground, an operation much facilitated by the peculiar construction and arrangement of the imperfect florets. The florets are, as Darwin has shown, no mere passive instruments. So soon as the flower-head is in the ground they begin, commencing from the outside, to bend themselves toward the peduncle, the result of which, of course, is to drag the flower-head farther and farther into the ground. In most clovers each floret produces a little pod. This

FIG. 18.—VICIA AMPHICARPA. *a a,* ordinary pods; *b b,* subterranean pods.

would in the present species be useless, or even injurious; many young plants growing in one place would jostle and starve one another. Hence we see another obvious advantage in the fact that only a few florets perfect their seeds.

I have already alluded to our cardamines, the pods of which open elastically and throw their seed some distance. A Brazilian species, C. chenopodifolia (Fig. 17), besides the usual long pods (Fig. 17, *a a*), produces also short, pointed ones (Fig. 17, *b b*), which it buries in the ground.

Arachis hypogæa is the ground-nut of the West Indies. The flower is yellow and resembles that of a pea, but has an elongated calyx, at the base of which, close to the stem, is the ovary. After the flower has faded, the young pod, which is oval, pointed, and very minute, is carried forward by the growth of the stalk, which becomes two or three inches long and curves downward, so as generally to force the pod into the ground. If it fails in this, the pod does not develop, but soon perishes; on the other hand, as soon as it is underground, the pod begins to grow and develops two large seeds.

In *Vicia amphicarpa* (Fig. 18), a south European species of vetch.

FIG. 19.—LATHYRUS AMPHICARPOS. (After Sowerby.) *a,* ordinary pods; *b,* subterranean pods.

there are two kinds of pods. One of the ordinary form and habit (*a*), the other (*b*) oval, pale, containing only two seeds, borne on underground stems, and produced by flowers which have no corolla.

Again, a species of the allied genus *Lathyrus* (Fig. 19), *L. amphicarpos* affords us another case of the same phenomenon.

Other species possessing the same faculty of burying their seeds are *Okenla hypogæa* several species of *Commelyna*, and of *Amphicarpæa*, *Voandzeia subterranea*, *Scrophularia arguta*, etc.; and it is very remarkable that these species are by no means nearly related, but belong to distinct families, namely, the *Cruciferæ*, *Leguminosæ*, *Commelynaceæ Violaceæ*, and *Scrophulariaceæ*.

Moreover, it is interesting that in *L. amphicarpos* as in *Vicia amphicarpa* and *Cardamine chenopodifolium*, the subterranean pods differ from the usual and aërial form in being shorter and containing fewer seeds. The reason of this is, I think, obvious. In the ordinary pods the number of seeds of course increases the chance that some will find a suitable place. On the other hand, the subterranean ones are carefully sown, as it were, by the plant itself. Several seeds together would only jostle one another, and it is therefore better that one or two only should be produced.

In the *Erodiums*, or cranesbills, the fruit is a capsule which open elastically, in some species throwing the seeds to some little distance. The seeds themselves are more or less spindle-shaped, hairy, and produced into a twisted hairy awn as shown in Fig. 20, representing a seed of *E. glaucophyllum*. The number of spiral turns in the awn depends upon the amount of moisture; and the seed may thus be made into a very delicate hygrometer, for, if it be fixed in an upright position, the awn twists or un-twists according to the degree of moisture, and its extremity thus may be so arranged as to move up) and down like a needle on a register. It is also affected by heat. Now, if the awn were fixed instead of the seed, it is obvious that, during the process of untwisting, the seed itself would be pressed downward, and, as M. Roux has shown, this mechanism thus serves actually to bury the seed. His observations were made on an allied species, *Erodium ciconium*, which he chose on account of its size. He found that, if a seed of this plant is laid on the ground, it remains quiet as long as it is dry; but as soon as it is moistened—i. e., as soon as the earth becomes in a condition to permit growth—the outer side of the awn contracts, and the hairs surrounding the seed commence to move outward, the result of which is gradually to raise the seed into an upright position with its point on the soil. The awn then commences to unroll, and consequently to elongate itself upward, and it is obvious that, as it is covered with reversed hairs, it will probably press against some blade of grass or other obstacle, which will prevent its moving up, and will therefore tend to drive the seed into the ground. If, then, the air becomes drier, the awn will again roll up, in which

FIG. 20.—ERODIUM GLAUCOPHYLLUM .(after Sweet).

action M. Roux thought it would tend to draw up the seed, but from the position of the hairs the feathery awn can easily slip downward, and would therefore not affect

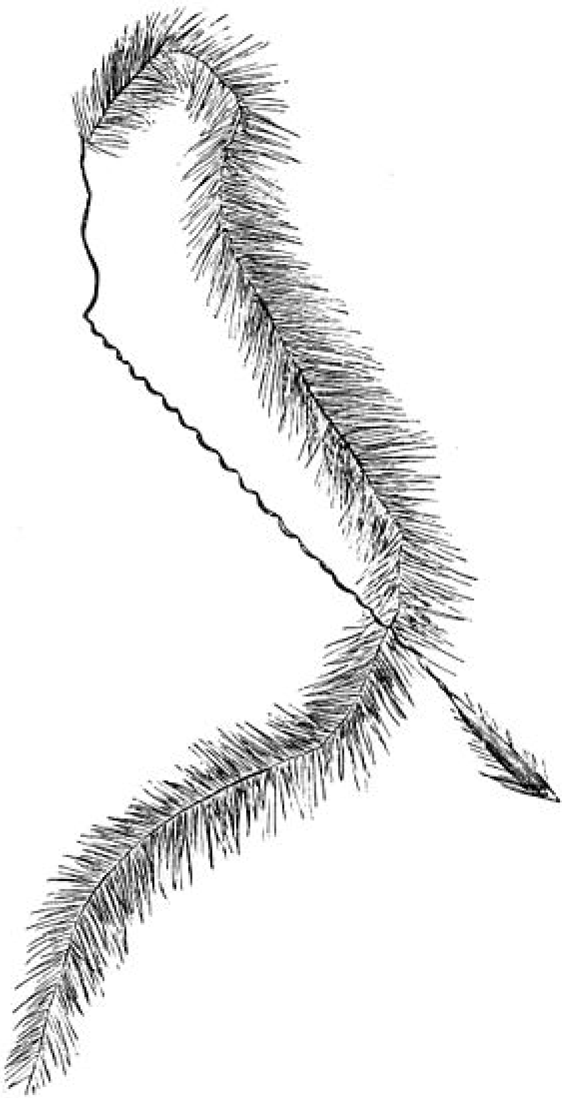


FIG. 21.—SEED OF STIPA PENNATA. (Natural size.)

the seed. When moistened once more, it would again force the seed farther downward, and so on until the proper depth was obtained. A species of anemone (*A. montana*) again, has essentially the same arrangement, though belonging to a widely separated order.

A still more remarkable instance is afforded by a beautiful South European grass, *Stipa pennata* (Fig. 21), the structure of which has been described by Vaucher, and more recently, as well as more completely, by Frank Darwin. The actual seed is small, with a sharp point, and stiff, short hairs pointing backward. The posterior end of the seed is produced into a fine twisted corkscrew-like rod, which is followed by a plain cylindrical portion, attached at an angle to the corkscrew, and ending in a long and beautiful feather, the whole being more than a foot in length. The long feather, no doubt, facilitates the dispersion of the seeds by wind; eventually, however, they sink to the ground, which they tend to reach; the seeds being the heaviest portion, point downward. So the seed remains as long as it is dry, but if a shower comes on, or when the dew falls, the spiral unwinds, and if, as is most probable, the surrounding herbage or any other obstacle prevents the feathers from rising, the seed itself is forced down and so driven by degrees into the ground.

I have already mentioned several cases in which plants produce two kinds of seeds, or at least of pods, the one being adapted to burying itself in the ground. Heterocarpism, if I may term it so, or the power of producing two kinds of reproductive bodies, is not confined to these species. There is, for instance, a North African species of corydalis (*C. heterocarpa* of Durieu) which produces two kinds of seed (Fig. 22), one somewhat flattened, short, and broad, with rounded angles; the other elongated, hooked, and shaped like a shepherd's crook with a thickened staff. In this case the hook in the latter form perhaps serves for dispersion.

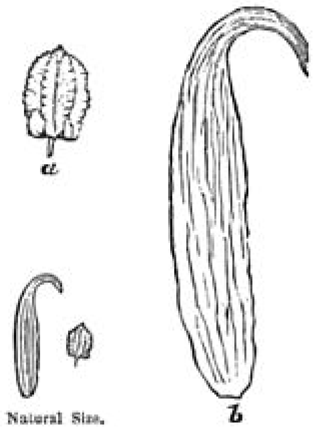


FIG. 22.—SEEDS OF CORYDALIS HETEROCARPA.

Our common *Thrincia hirta* (Fig. 13, *b*) also possesses, besides the fruits with the well-known feathery crown, others which are destitute of such a provision, and which probably, therefore, are intended to take root at home.

Mr. Drummond, in the volume of "Hooker's Journal of Botany" for 1842, has described a species of *Alisimaceæ* which has two sorts of seed-vessels; the one produced from large, floating flowers, the other at the end of short, submerged stalks. He does not, however, describe either the seeds or seed-vessels in detail.

Before concluding, I will say a few words as to the very curious forms presented by certain seeds and fruits. The pods of Lotus, for instance, quaintly resemble a bird's foot, even to the toes; whence the specific name of one species, *Ornithopodioides;* those of *Hippocrepis* remind one of a horseshoe; those of *Trapa bicornis* have an absurd resemblance to the skeleton of a bull's head. These likenesses appear to be accidental, but there are some which probably are of use to the plant. For instance, there are two species of Scorpiurus (Fig. 23), the pods of which lie on the ground, and so curiously resemble the one (*S. subvillosa*, Fig. 23, *a*) a centiped, the other (*S. vermiculata*, Fig. 23, *b*) a worm or caterpillar, that it is almost impossible not to suppose that the likeness must be of some use to the plant.

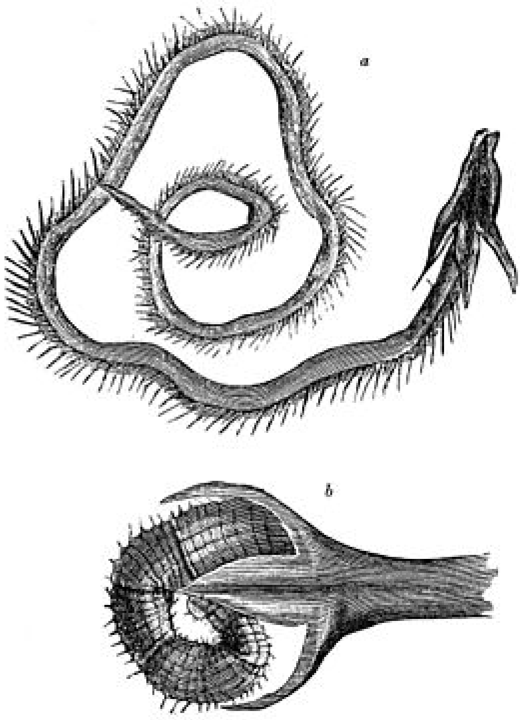


FIG. 23,— *a*, POD OF SCORPIURUS SUBVILLOSA; *b*, POD OF SCORPIURUS VERMICULATA.

The pod of *Biserrula pelecinus* (Fig. 24, a) also has a striking resemblance to a flattened centiped; while the seeds of *Abrus precatorius*, both in size and in their very striking color, mimic a small beetle, *Artemis circumusta*.

Mr. Moore has recently called attention to other cases of this kind. Thus the seed of *Martynia diandra* much resembles a beetle with long antenna: several species of Lupins have seeds much like spiders, and those of

Dimorphochlamys, a gourd-like plant, mimic a piece of dry twig. In the common castor-oil plants (Fig. 24, *b*), though the resemblance is not so close, still at first glance the seeds might readily be taken for beetles or ticks. In many Euphorbiaceous plants, as, for instance, in Jatropha (Fig. 24, c), the resemblance is even more striking. The seeds have a central line resembling the space between the elytra, diverging and slightly diverging at the end, while between them the end of the abdomen seems to peep; at the anterior end the seeds possess a small lobe, or caruncle, which mimics the head or thorax of

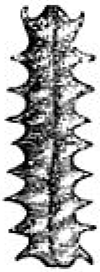


FIG. 24 *a.*—POD OF BISERRULA.

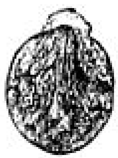


FIG. 24 *b.*—SEED OF CASTOR-OIL (Ricinus).

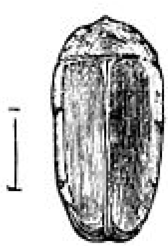


FIG. 24 *c.*—SEED OF JATROPHA.

the insect, and which even seems specially arranged for this purpose; at least it would seem from experiments made at Kew that the caruncle exercises no appreciable effect during germination.

These resemblances might benefit the plant in one of two ways. If it be an advantage to the plant that the seeds should be swallowed by birds, their resemblance to insects might lead to this result. On the other hand, if it be desirable to escape from graminivorous birds, then the resemblance to insects would serve as a protection. We do not, however, yet know enough about the habits of these plants to solve this question.

Indeed, as we have gone on, many other questions will, I doubt not, have occurred to you, which we are not yet in a position to answer. Seeds, for instance, differ almost infinitely in the sculpturing of their surface. But I shall woefully have failed in my object to-night if you go away with the impression that we know all about seeds. On the contrary, there is not a fruit or a seed, even of one of our commonest plants, which would not amply justify and richly reward the most careful study.

In this, as in other branches of science, we have but made a beginning. We have learned just enough to perceive how little we know. Our great masters in natural history have immortalized themselves by their discoveries, but they have not exhausted the field; and, if seeds and fruits can not vie with flowers in the brilliance and color with which they decorate our gardens and our fields, still they surely rival—it would be impossible to excel them—in the almost infinite variety of the problems they present to us, the ingenuity, the interest, and the charm of the beautiful contrivances which they offer for our study and our admiration.—*Forthnightly Review.*

1. ↑ Continued from page 171.

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