Glimpses of Nature.

XI.—A VERY INTELLIGENT PLANT.

By Grant Allen.

PEOPLE who have never had occasion to observe plants closely often fall into the error of regarding them as practically dead—dead, that is to say, in the sense of never doing or contriving anything active. They know, of course, that herbs and trees grow and increase; that they flower and fruit; that they put forth green leaves in spring and lose them again in autumn. But they picture all this as taking place without the knowledge or co-operation of the plant itself—they think of it as done *for* the tree or shrub rather than *by* it. Those, however, who have kept a close watch upon living green things in their native condition have generally learned by slow degrees to take quite a different view of plant morals and plant economy. They begin to find out in the course of their observations that the life of a herb is pretty much as the life of an animal in almost everything save one small particular. The plant, as a rule, is rooted to a single spot; the animal, as a rule, is free and locomotive.

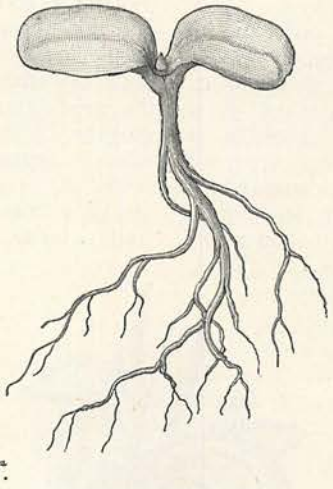
Yet even this difference itself is not quite absolute: for there are on the one hand locomotive plants, such as that quaint microscopic vegetable tumbler, the floating green volvox, which whirls about quickly through the water like a living wheel, by means of its rapid vibratory hairs; and there are, on the other hand, fixed animals, such as the oyster and the sea-anemone, which are far more rigidly attached to one spot for life than, say, the common field-orchid or the yellow crocus. For field-orchids and crocuses do travel very slightly from place to place each season, by putting out fresh bulbs or tubers at the sides of the old ones, and springing up next year in a spot a few inches away from their last year's foothold; whereas the oyster and the sea-anemone settle down early in life on a particular rock, and never stir one step from it during their whole existence. Thus the distinction which seems to most people most fundamental as marking off plants from animals—the distinction of movement—turns out on examination to be purely fallacious. There are sedentary animals and moving plants; there are herbs that catch and eat insects, and there are insects that live a life more uneventful and more stagnant than that of any herb in a summer meadow.

Again, everybody who has studied plants in a broad spirit is well aware that each act of the plant's is just as truly purposive, as full of practical import, as any act of an animal's. If a child sees a cat lying in wait at a mouse's hole, it asks you why she does so; it is told, in reply, and truly told, "Because she wants to catch her prey for dinner." But even imaginative children seldom or never ask of a rose or a narcissus, "Why does it produce this notch on its petals? Why does it make this curious crown inside the cup of its flower?" Those things are thought of as purely ornamental: as parts of the plant, not as organs made by it. Yet the rose and the narcissus have just as much a reason of their own for everything they do and everything they make as the cat or the bird; they are just as much governed by ancestral wisdom, though the wisdom may in one case be conscious, in the other hereditary.

The rose, for example, produces prickles for its own defence, and scented blossoms to attract the fertilizing insects for its own propagation. It does everything in life for some good and sufficient reason of its own, and takes as little heed of other people's convenience as the tiger or the snake does. "Each species for itself," is the rule of nature; no species ever undertakes anything for the sake of any other, except in the expectation of a corresponding advantage. If the wild thyme lays by in its throat abundant honey for the bumble-bee, that is because it counts upon the bumble-bee to carry its pollen from blossom to blossom; if the holly puts forth bright red berries for the robin to eat, that is not because it cares for the

robin's distress, but because it looks upon the bird as a paid disperser of its stony seeds, and gives him in return a pittance of pulp for his pains, as stingy payment for the service rendered. The holly and the thyme are confirmed sweaters. Indeed, you will find that no plant ever wastes one drop more of nectar on its flowers, or one atom more of sweet pulp on its fruit, than is absolutely necessary to secure its own purely selfish object. It offers the bird or the insect the minimum wage for which bird or insect will consent to do the work it contracts for; and it never wastes one farthing's worth of useful material on tips or generosities. The rose, for all that poets have said of it, is strictly utilitarian. "You help me and I will help you," it says to the butterfly; and it keeps the sternest possible debtor-and-creditor account with all its benefactors.

As a familiar example of this purposive character in all plant life, I am going, in the present article, to take one of our most utilitarian English shrubs — the common gorse—and try to show you why it behaves as it does in the conduct of its affairs; who help it in life and who hinder it, what friends it strives to buy or conciliate, what enemies it repels by what violent acts of armed hostility.

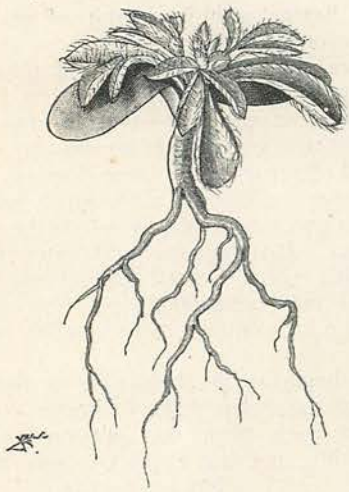


1.—THE BABY GORSE PLANT.

Everybody knows gorse; and everybody also knows that it is almost never out of flower. This last peculiarity, however, is due to a cause that not everybody has noticed. We have in England two distinct kinds of gorse at least—the larger and the smaller. It is the larger sort that one observes most when it is not in blossom, though it is the smaller kind whose golden bloom contrasts so beautifully in autumn with the rich purple of the upland heather. Now, the larger gorse begins to flower in October or November; it goes on opening its buds spasmodically in every fine spell throughout the winter, reaching its fullest glory of blossom in April and May; while the smaller kind begins to flower in summer, as soon as its larger cousin has fixed its attention on setting seed; and it goes on yellowing our heaths with its wealth of gold till October or November, when the bigger sort once more replaces it and takes up the running. In this way there is no bright day throughout the year—that is to say, no day fit for insects to gather honey—on which one kind of gorse or the other does not seek to cater for the friendly allies which help it to set its precious seeds, as we shall see in the sequel. It is the larger and better-known gorse with which I shall deal chiefly here, though I may occasionally refer by way of illustration or contrast to its smaller neighbour.

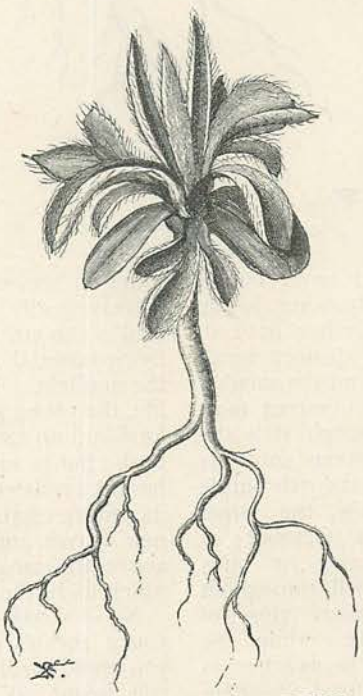
If we begin at the beginning in the life-history of the gorse, it may surprise you to find that each plant sets out on its way through life, not as a prickly gorse-bush, but as a sort of quiet and unarmed little flat trefoil. No. 1 shows you the young furze-bush in its earliest infantine stage, when it is still essentially a two-leaved seedling. This seedling grows from a small bean scattered by the parent plant in a very curious way, which I will explain later. Thousands of the beans lie on the ground on every common, and only a few germinate, under favourable circumstances, into two-leaved seedlings, like those represented in these illustrations. The leaves of the first pair spread out flat on the surface of the unoccupied soil and drink in the sunlight. They also drink in, what is equally important to them, the carbonic acid of the air, and manufacture from it the living material of fresh leaves by the aid of the sunlight. For the first few days of its life, the young gorse plant lives mainly on the food laid up for it in the bean by the parent bush; but as soon as this is exhausted, and it has accumulated a little stock of its own by its private exertions, it begins to manufacture new leaves and branches that it may rise above the tangled mass of competitors by which its birthplace is surrounded.

No. 2 shows us this second stage in the young shrub's development. At first sight you would hardly suppose it was a gorse at all; you might take it for the young of some such allied species as a broom or a genista.



2.—THE GORSE PLANT AT ONE WEEK OLD.

You will observe that at this point in its history the young gorse has trefoil leaves, not very unlike those of some kinds of clover. Why is this? Well, we have many good reasons for supposing that the ancestors of gorse were originally soft-leaved and unarmed shrubs, like the ornamental genistas which we grow in pots for drawing-room decoration; but as they were much exposed on open moors and commons, where they were liable to be grazed down and browsed upon by rabbits, sheep, and other herbivorous animals, the tenderer and more luscious among them stood little chance of surviving. Indeed, so hard is it for plants to grow in such situations, that one not uncommonly finds tiny trees of Scotch fir, close cropped to the ground, yet with many years' growth exhibited by the annual rings of wood in their underground root-stock. These poor persistent little trees have been nibbled down, year after year, as soon as they appeared, by rabbits or donkeys; yet year after year they have gone on sprouting afresh, as well as they could, and laying by an annual ring of woody tissue in their buried root-stock.



3.—THE PLANT OUTGROWING ITS TREFOIL STAGE.

To some such attacks the ancestral gorses must always have been exposed on the open moors and hillsides of primitive Europe, at first, no doubt, from deer and wild oxen and beavers, but later on from the sheep and cows and goats and donkeys which followed in the wake of aggressive civilization. Under these circumstances, most of the soft-leaved and unprotected plants get eaten down and killed off; but any shrubs which showed a nascent tendency to develop stout spines or prickles on their branches must have been favoured by nature in the struggle for existence. The consequence was that in the end our upland slopes and open spaces all over Western Europe came to be occupied by nothing but strongly-armed plants — brambles, thistles, blackthorns, may-bushes, nettles, butcher's-broom, and the various kinds of furze, all of which can hold their own with ease against the attacks of quadrupeds. Indeed, we have one not uncommon English herb, the little purple-flowered rest-harrow, which very well illustrates this curious connection between the production of thorns and the habit of growing in much-browsed-over spots; for when it settles in inclosed and protected fields, it produces smooth and unarmed creeping branches, but when it happens to find its lot cast in places where donkeys and rabbits abound, it defends itself against the dreaded enemy by covering its shoots with stout woody prickles.

Still, to the end of its days, the developed gorse plant never entirely forgets that it is the remote descendant of trefoil-bearing ancestors: for not only does every young gorse begin life with trefoil foliage, but if frost happens to check the growth of the budding branches in the full-grown bush, or if fire singes them, the shrub at once puts forth a short sprout of trefoil leaves at the injured point, as though reverting in its trouble to its infantile nature.

In No. 3 we see the third stage in the upward evolution of the baby gorse. Here, the seedling begins to outgrow its childish

4.—THE YOUNG SHRUB BEGINS TO ARM ITSELF.

trefoil stage, and to prepare itself for the repellent prickliness of its armed manhood. You will observe in this case that the outer and lower leaves have still three leaflets apiece, but that the upper and inner ones—that is to say, the youngest and latest produced—have the form of single long blades, like those of the broom-bush. As yet, these solitary leaves are also unarmed: they do not end in sharp points like the later foliage, and they cannot pierce or wound the tender noses of sheep or rabbits. But if the gorse were to continue long in this unarmed condition, it would stand a poor chance in life on the open hillsides; so it soon proceeds to the stage exhibited in No. 4. This illustration shows you a plant about a fortnight or three weeks old, with trefoil leaves below, passing gradually into silky and hairy single blades, which in turn grow sharper and thinner as they push upward towards the unoccupied space above their native thicket. Interspersed among these sharp little leaves you will also note a few grooved branches, each ending in a stout prickly point; these prickles are the chief defence of the bush against its watchful enemies. But the leaves and the branches are often so much alike that only a skilled botanist can distinguish the one from the other. Both are sharp and intended for defence; and as the branches of gorse are green like the leaves, both perform the same feeding function.

In No. 5 I have chosen for illustration and comparison a full-grown shoot of the common scented yellow genista, so often grown in pots as a table decoration. This pretty shrub begins in life so much like a gorse-bush, that if I were to show you very youthful seedlings of both, you could hardly discriminate them. That is to say, in all probability, both are descendants of a common ancestor which had trefoil leaves and bright yellow peaflowers. But the scented genistas happened to find their lot cast in inaccessible places, on cliffs or crags, where defence against browsing animals was practically unnecessary; while our ruder northern gorse had its lines laid on rough upland moors, where every passing beast could take a casual bite at it. The gorse was, therefore, driven perforce into producing thorny branches which would repel its foes, while the genista retained the old soft silky shoots and broad trefoil foliage. Broom, which is a close relation of both these plants, with much the same yellow peaflowers and hairy pods, occupies to some extent an intermediate position between the

5.—ITS FIRST COUSIN, THE GENISTA.

two types. The young shoots have leaves of three leaflets, as shown in No. 6; but the older branches are covered with leaves of a single leaflet apiece, like the second form produced by the gorse plant. The trefoil leaves of the broom also closely resemble those of the laburnum, which is another and more tree-like descendant of the same ancient ancestor, with similar yellow blossoms, and pods and beans of much the same character. It is interesting to observe in a family of this sort how the young seedlings are in every case almost identical, and how, as they approach maturity, they begin to assume the adult differences which mark off each later developed kind from the primitive and central form of its ancestors.

6.—ITS SECOND COUSIN, THE BROOM.

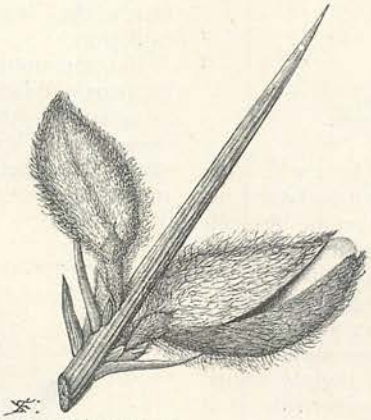
But is gorse really exposed to the attacks of animals? Would any herbivore care to eat such hard food? If you doubt it, you have never lived near a gorse-clad common. From the moment the seedling shows itself above the ground, it is ceaselessly nibbled at by rabbits and other rodents; and even after it has acquired its prickly armour, it makes excellent fodder, if only the sharp tops can be rendered harmless to the sensitive noses of cattle or donkeys. Gipsies know this fact well; and you may often see them on our Surrey hills cutting the succulent young branches and chopping them up fine in a wooden trough till the prickles are destroyed. Their horses then eat the good green food most greedily.

The gorse knows the same thing, too; and it takes particular care to preserve its leaves and flowers against the aggressive quadrupeds. When November comes it begins to blossom. No. 7 shows you how cleverly and cautiously it makes its preparations for this important function. The flower-buds, I need hardly say, are particularly rich and juicy, and, therefore, particularly liable to the assaults of the enemy. Hence, you will observe, they are doubly protected. To guard against large animals, each little knot of buds is carefully placed, for safety, in the angle formed by the main stem with one of its short, stout branches. Stem and branch alike end in a forbidding prickle, and the buds are so set in the axil that it is simply impossible for any browsing creature to get at them without encountering both these serious weapons. Indeed, no illustration can fully bring out the beautiful variety and complexity of arrangement by which each separate group of buds is completely defended; in order to understand it fully, I advise you, after reading this essay, to go out to the nearest common, and examine a flowering gorse-bush for yourself, when you will see how wonderfully and how intelligently the plant provides for the equal security of all its blossoms. I do not wish to be personal, but if for one moment you can imagine yourself a donkey, and try to help yourself with your teeth to some of the juicy buds, you will find that it is practically impossible to do so without receiving a whole array of serried lance-thrusts from several separate prickles.

But large animals are not the only foes against which the gorse has to defend its blossoms. It is almost equally exposed to the unfriendly attentions of flying insects, which desire to lay their eggs near its rich store of pollen and its soft yellow petals.

7.—PROTECTING THE BUDS FROM BROWSING ANIMALS.

To ward off these winged assailants, mere prickles are insufficient. The insect can wriggle in sideways, and so deposit its egg, which would develop in time into a hungry grub; the grub would proceed to eat up the flower, and thus defeat the object which the plant has in view in producing its blossoms. No. 8 shows you how the gorse meets this second difficulty. It covers up the buds with its stout calyx, which, for greater security, is reduced to a pair of sepals only, though in allied types there are five, and traces of the five still exist in the lobed top of the existing calyx. This outer coverlet, or great-coat, is thickly sprinkled with a sort of fur, composed of dark brown hairs, which baffle the insects, and prevent them from laying their eggs upon the surface. Indeed, nothing keeps off insects so well as hairs; they form to these little creeping creatures an impenetrable thicket, like tropical jungle to an invading British army. Ants, you will remember, cannot creep up stems which are thickly set with hairs; and in warm climates people take advantage of this peculiarity by wrapping fur round the legs of meat-safes, so as to keep off those indefatigable pests of the equatorial housekeeper.



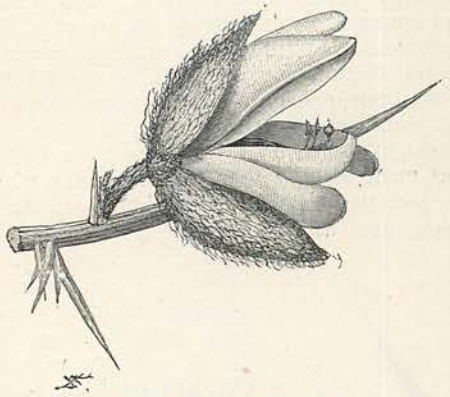
8.—THE GREAT-COAT, PROTECTING THE BUDS FROM COLD AND FROM EGG-LAYING INSECTS.

Nor is this the only use of the short brown hairs. I spoke of the calyx above as a great-coat, for warmth is really one of its chief objects. It keeps off the cold as well as the insects. You must remember that the greater gorse is a winter-flowering plant: it lays itself out to attract the few stray bees which flit out in search of food on sunny mornings in December and January. A bush with this habit needs protection for its buds from the cold: just as you see the crocus does, when it wraps up its flowers in a papery spathe, and as the willow does when it incloses its catkins in soft silky coverings. The hairy coat of the gorse-bud has just the same function: it is there for warmth as well as for protection against egg-laying insects. That, I think, is the reason why the hairs are coloured brown; because brown is a good absorber of heat; the fur collects and retains whatever warmth it can get from the winter sun in his friendlier moments.

You will further observe in the illustrations, and still better on the living gorse-bush, that all the buds are not at the same stage of development together. The plant does that intentionally. It is a slow and gradual flowerer. The reason is plain. Our winter and spring are proverbially uncertain. The bush does not want to put all its eggs into one basket. Sometimes, in doubtful weather, a few of the buds develop up to the stage shown in No. 8, and are just ready to open. Then comes a frost, a killing frost, and nips them in the bud, more literally than we often mean when we use that familiar metaphor. In such cases, you will sometimes find the more advanced flowers are killed off and never develop further. But look behind them, in No. 8, and you will see that the bush holds in reserve a number of younger buds, against this very contingency. They are wrapped up tight in their warm brown overcoats, and they keep one another warm as they nestle against the stem; so that, however sharp the frost, they seldom suffer, in England at any rate. Beyond the Rhine, where the winters are severer, both buds and foliage would be nipped by the east wind; and so the smaller gorse is confined to the portion of Europe west of the Rhineland, while even the greater kind cannot live in Russia. To eastward its place is taken by hardier shrubs, which have still more special methods of protection against the severe weather. In Western Europe, on the other hand, the buds are so arranged that in spite of frost we get a constant succession of gorse-blossoms from November to May or June, when the running is taken up by the smaller summer species. Thus the bees are never deprived of gorse-blossom, and kissing, as the old saw says, is never out of fashion.

I have said above that gorse protects itself against flying insects. But not indiscriminately. It is a respecter of persons. While it wishes to keep off the egg-laying

and flower-gnawing types, it wishes to attract and allure the honey-suckers and fertilizers. For this object alone it produces its bright yellow petals and its delicious nutty perfume, which hangs so sweetly on the air in warm April weather. And I know few things in plant life more instructive and interesting to

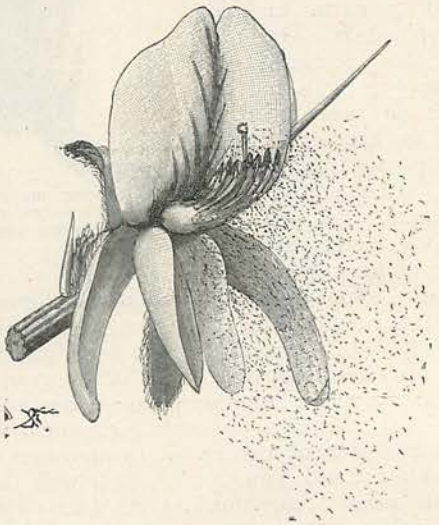


9.—THE FLOWER, HALF OPENED.

observe than the way of a bee with this common English flower. Go out and watch it, and verify my statements. When the blossom first opens, it looks somewhat as in No. 9, only that the keel, as we call the lower part of the flower, is not half open, as there, but firmly locked together above the stamens on its upper edges. This keel, as you may note in No. 10, consists of two petals slightly joined together at the margin. On either side of it come two other petals, which we call the wings, and which are fitted with a funny little protuberance at their base so arranged that it locks the whole lower part of the blossom together. This mechanism cannot be seen in the illustrations, nor indeed can it be properly understood except in action; but gorse is so universal a plant in Britain, that most of my readers can observe it and examine it for themselves at leisure. The upper petal of all, known as the standard, has no special duty to perform save that of advertisement. It attracts the insects, and shows them in which direction to approach the flower.

Now comes the strangest part of the whole process of flowering. When the bee settles on the blossom, she alights on the keel and wings, to which she clings by her fore-legs, and so weighs down the entire lower portion of the mechanism with her weight. As she does so, the clasps or knobs on the wings come undone, and the whole flower springs open elastically, as you see it in No. 10, exposing the stamens and the young pod which form its central organs. At the same moment, the pollen, which is specially arranged for this contingency, bursts forth in a little explosive cloud, covering the body and legs of the visiting insect. She takes no notice of this queer manœuvre on the part of the plant, being quite familiar with it, but goes on helping herself to the store of honey. As soon as she has rifled it all, she flies away, and visits a second flower of the same kind. In the act of doing so, she rubs off on its sensitive surface the pollen with which the last blossom dusted her, each part being so contrived that what she takes from one flower she hands on to another. You can see the little tufted stigma standing up in the centre of No. 10, and can understand how it must catch on its tip the fertilizing yellow grains which the bee collected in a previous explosion.

But now notice a curious thing that next happens. When once the flower is "sprung," as we call it—that is to say, thus elastically opened—the keel and wings never go back again into their original position. They remain permanently open. You will thus



10.—THE FLOWER, SPRUNG, AND DISCHARGING POLLEN-SHOWERS.

comprehend that there is a great difference between the virgin flower, in which the keel and wings are locked over the stamens, and the "sprung" one, in which the keel and wings have descended from their first position so that the entire centre of the blossom is exposed to view. Moreover, after the

flower is once fertilized, it produces no more bribes for the bee; it has got all it wants out of her, and it is certainly not going to find her in food and pay her wages for nothing. The consequence is, that a "sprung" flower becomes, as it were, an advertisement to the bee of "Nothing to eat here." If you watch a bee paying her visits to a gorse-bush, you will find that she passes by the "sprung" flowers without the slightest notice—seems, in fact, oblivious of their existence; but she fastens at once on each virgin flower, and promptly — though, of course, unconsciously—fertilizes it. Such a device for showing the visiting insects automatically which flowers are fertilized and which are not is, naturally, a great saving of time; and plants which develop such devices gain such an advantage thereby as neither they nor the bees are slow to appreciate. In some cases, indeed, as soon as the blossom has begun to set its seeds, it changes colour as a sign to the bees and butterflies that it is no longer open to receive their visits; in others, the petals fall the moment fertilization is effected, and so the flower ceases to be at all conspicuous.

In the gorse-bush, however, the petals do not fall at all. They remain to inclose the young pod as it swells and develops. The reason for this divergence from the usual habit of plants is, I think, because the gorse-bush flowers and ripens its fruit in such very cold weather, that the young and tender pods need all the cover they can get at the moment when they begin to swell and to go through the important process of fructification. The calyx and the petals help to keep things warm for them, and so they persist till the pods are ready to open and discharge their beans.

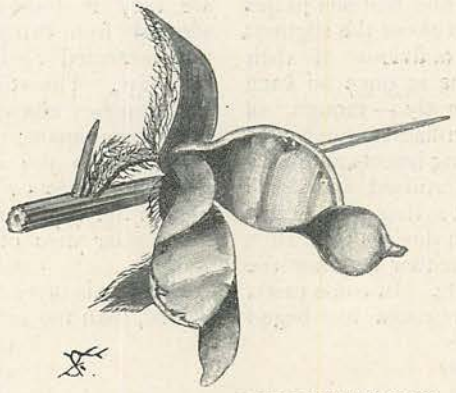
Each pod contains as a rule four beans, and these are fat and well stored with nutriment for the baby seedling. The young plant subsists for its first few days on the nourishment thus laid by for it; for gorse is not one of those improvident plants which turn their young ones loose upon a cold and unsympathetic world without a penny in their pockets, so to speak, to fall back upon. Plants in this respect differ, like human beings. Some send their offspring out, mere street Arabs of the vegetable world, without any capital to live upon; others provide them with a good stock or reserve of foodstuff, which suffices them till they are of an age to earn their own living. You can judge by the fatness and distention of the pod in No. 11 that the young beans of the gorse are fairly provided for in this respect. Indeed, so rich are they in food, that they would suffer seriously from two sets of enemies, were they not protected against both exactly as the buds are. The stout prickles at the ends of the branches efficiently repel the assaults of browsing animals; the close hairs on the pods (not seen in the sketch) just as efficiently repel the insects which would fain lay their eggs in the beans, as one knows they do in the similar case of the edible peas in our garden.

Nothing is more beautiful about the gorse, indeed, than the soft, close covering of fur in the young pods, which gives them almost the appearance of miniature ducklings. No insect can penetrate it; and if only the first few days pass by without serious mishap, the gorse may count upon maturing its seeds in peace and quietness.

11.—THE POD, WITH THE BEANS WITHIN IT.

They ripen in the first basking warmth of July, or often earlier. As soon as they are ready for dispersal, the bush has a device for scattering them and sowing them in proper places for their due germination, which is quite in accordance with its other proceedings. Gorse, indeed, is a very explosive species. It knows the full value of the propulsive habit. The valves of the pods remain straight and rigid after the beans have ripened; but the sides contract, only the ribs or thickened edges keeping them extended in their places. At last, on some very sunny morning, the baking heat dries them up to such a point that they can no longer hold together. They curl up suddenly and violently, as you see in No. 12, and expel the beans, shooting them out like little bullets all over the common. If you happen to sun yourself on a gorse-clad moor on such a warm summer morning, you will hear, from time to time, little abrupt discharges as if a succession of toy pistols were being continually fired off in the thicket all round you. These noises are due to the bursting pods of gorse, which go

off one ofter another, and shed their seeds piecemeal over a considerable area. Should you look in early spring on the bare spots around a moor or common, you will find gorse seedlings by the thousand, all fighting it out among themselves, and all trying their best to occupy the uncovered spaces in the neighburhood of their parents.



12.—THE POD, AFTER DISCHARGING THE BEANS ELASTICALLY.

And here the wonder of their life begins all over again. For while the gorse was old and woody, it grew like gorse, all stern and prickly. But as soon as the young seedlings start afresh in life, they seem to forget their parents: they revert once more to the old trefoil condition. All young plants and animals, at least in their embryonic stages, show this strange tendency to throw back at first to the ancestral form; and it is fortunate for us that they do so, for it often enables us to perceive underlying relationships which in the adult form escape our notice. Nobody who looked at a furze-bush in its stiff and prickly old age would ever suspect it at first sight of a cousinship with clover. Yet when we consider the trefoil leaves of the seedling, and the shape of the separate peaflowers in the adult form, we can see for ourselves that the two plants are far closer together than we might be tempted to imagine. Indeed, between the little creeping yellow clovers and the aggressive furze or the tall and beautiful laburnum, we can find even now a regular series of connecting links which show clearly that all alike are slightly divergent descendants of a single common ancestor.

We may conclude, then, that gorse in every particular lays itself out in life to fight its own battle, and to meet the peculiarities of its special situation by its own exertions. Born a trefoil-bearing plant, unarmed and undefended, it produces spines instead of leaves as soon as its growth exposes it to the attacks of enemies. It defends its buds alike from the attacks of cattle and the assaults of insects: it wraps them up from the cold in efficient overcoats. It cares for its young and lays up food in its beans on their account; it scatters its seed upon unoccupied spots where they may stand the best chance of picking up a living. All these acts are analogous to those produced by intelligence in animals; and though the intelligence is here no doubt unconscious and inherited, I think we are justified in applying the same word in both cases to operations whose effects are so closely similar. Gorse, in short, may fairly be called a clever and successful plant, just as the bee may be called a clever and successful insect, because it works out its own way through life with such conspicuous wisdom.