per for their support, but in these somewhat partial commendations there lurks a fallacy. Any one accustomed to observe the texture of soils, and familiar with the conditions which go to constitute "good tilth," would see at a glance that neither worm-casts, as such, nor the "thin layer of fine dark-colored earth voided by the worms, with which their burrows are lined," can be classed among soils well suited for the growth of plants. "The burrows are not mere excavations, but may rather be compared with tunnels lined with cement." Again, to use Mr. Darwin's words, worms are omnivorous. They swallow an enormous quantity of earth, out of which they extract any digestible matter which it may contain. They also consume a large number of half-decayed leaves of all kinds, excepting a few which have an unpleasant taste, or are too tough for them. They will also consume fresh leaves, as Mr. Darwin has found by repeated trials, as well as raw and roasted meat, fat, and even dead worms. It has been observed, moreover, by naturalists, that worms sometimes drag down into their holes the ends of young, flexible leaves, such as those of grass or grain, in spite of their being firmly attached to the plants.

THEIR ACTION IN THE SOIL.

Mr. Darwin describes the production of worm-casts as follows:

"A worm, after swallowing earth, whether for making its burrow or for food, soon comes to the surface (or to any convenient cavity in the soil) to empty its body. The ejected earth is thoroughly mingled with the intestinal secretions, and is thus rendered viscid. After being dried, it sets hard." "Freshly ejected castings," he says, "often reminded me of the appearance of paint which has just been ground between two flat stones." That is to say, the ejected earth has been so thoroughly "kneaded," "worked," and "puddled" within the bodies of the worms, that it has come to resemble in some sort, as regards its temper and consistence, the prepared clay with which the potter forms his vessels, or that with which the engineer makes the bottoms of reservoirs water-tight. Such puddled earth, so long as it remains in the puddled condition, is manifestly unsuited for the growth of plants, and the more of it that is brought into contact with plant roots, so much the worse for the plant. But if the earth-worms can work so rapidly that, as Mr. Darwin shows, it is no uncommon thing in England for them to bring up fine earth to the surface to the extent that a layer as much as one-fifth of an inch in thickness is formed annually at the surface during long terms of years, it is plain that they can puddle no small amount of soil in a single season. "There is good evidence," Mr. Darwin urges, "that on each acre of land, which is sufficiently damp and not too sandy, gravelly, or rocky for worms to inhabit, a weight of more than ten tons of dry earth annually passes through their bodies, and is brought to the surface. So that the whole superficial bed of vegetable mould passes through their bodies in the course of every few years."

In view of the facts that field crops have to struggle with many adverse circumstances at the best, and that, in the generality of cases, they are less carefully protected, fed, and watered, than potted plants, it is not impossible that each one of the 53,000 worms in the three and a half millions pounds of soil on an acre (taken as one foot deep), may do almost as much harm as the single worm in the single flower-pot of the florist. It is probable, of course, that in the field some particular places and plants will be more hardly beset with worms than others, and that the damage done in these places will be proportionally large. Not only the puddling of the earth which passes through the worm, but the mere compaction of the soil caused by the worm pushing his way through it, like a wedge, as he burrows about, is hurtful to good tilth; and so is the adhesive lining of the burrows already alluded to. The overwhelming excess of mere earth, in the worm-casts, makes it plain, withal, that the minute proportion of useful dung or urine constituents really contained in them cannot be counted upon as likely to help a crop to any appreciable extent.

In the case of the flower-pot, it is seen that the washing about of the worm-earth when the plant is watered, converts it into a kind of mud which clogs both the pores of the soil and the pores of the rootlets, to the great detriment of the plant. This fine mud is somewhat similar to that familiarly seen in puddles in roads, and is doubtless almost equally unfit for roots to thrive in. In point of fact, florists, by providing "ample drainage," habitually work to counteract the harmful effects of the puddled earth produced by worms. They are commonly at pains to put so many sherds in a pot, before it is filled with loam, that, within reasonable limits, no matter how much mud may be made by worms, the hole in the bottom of the pot shall not be clogged by it. Were it not for the open subsoil thus provided, it is said that, in case worms are at work in the pot, the hole will often be tightly stopped with the puddled earth, and that, as a consequence, the whole of the earth in the pot will be "drowned," and be made cold and sour. Some greenhouse-men, on noticing worm-casts at the surface of the soil, immediately slip off the pot from the ball of earth and roots within it, and pick out the worms; some of which are apt to be found lying against the ball of earth, *i. e.*, between the earth and the sides of the pot. In case a plant continues to suffer, in spite of these palliative measures, a "sure cure" is effected by repotting it, whereby the worms and their eggs are wholly removed. Other devices for combating earth-worms in flower-pots are to apply lime-water or mustard-water, or to place poisoned bits of potato upon the surface of the earth. Perhaps bits of onion, of cabbage leaves, or celery would be better suited than potato for this service, to judge from Mr. Darwin's remarks on the fondness of worms for these substances. In field practice, it has been reckoned as one advantage of liming land that worms are destroyed by the operation. Salt has also been recommended for destroying worms, and it is probable that heavy dressings of wood ashes would be effective. It is worthy of study whether several of the so-called chemical fertilizers may not be useful in this sense. There is some ground for believing, for example, that many worms might be destroyed by means of high grade superphosphate of lime, especially if it were applied with direct reference to their destruction.

DO THEY EAT THE ROOTS OF PLANTS?

I am myself ignorant as to whether earth-worms ever eat the roots of growing plants, though it is fair to suppose they may do so in some cases. Mr. Darwin finds, for example, that—besides celery, carrots, horseradish, etc., etc.—cabbage leaves and pieces of onion are devoured with much relish by worms; and that even when buried a quarter of an inch deep in common garden soil they were always discovered by the worms upon which he experimented. But if the worms are thus attracted by the odor of pieces of onion, it seems not unreasonable to suppose that they may be attracted in like

manner by the growing bulb (or by the rootlets attached to it), which would assuredly be tender enough for their consumption at some period, at least, in early youth. With respect to bulbs, it so happens that I have myself been asked several times by lady friends, how to make callas grow when there were earth-worms in the pot; and it seems not improbable that, in spite of their bitterness, the softness of the calla rootlets may make them attractive to the worms. Although Mr. Darwin makes no mention of potatoes, it is plain from the general drift of his observations that pieces of potato would be acceptable food to earth-worms, and that, in the field, the tubers must be liable to be eaten when they are planted in cut pieces, as is customary nowadays. The old notion that earth-worms eat potatoes may perhaps be justified by the damage caused by them at the planting season.

In conversation with practical men, I find there is a diversity of opinion among them as to whether earth-worms ever eat live roots in flower-pots. Some florists maintain that the finer, fibrous roots are actually often eaten by earth-worms, while others hold a contrary opinion. I have heard it said that the worms do no harm by removing earth from about the roots; and, again, "the worms give the plant no rest;" and some observers have noticed that roots are occasionally broken in two by the worms, as they force their way through the earth. In general, however, it appears that the puddling and muddying of the soil is a greater and a more palpable grievance to florists than any actual gnawing of any part of the plants. How much harm may be caused by the acidity of the casts, as observed by Mr. Darwin, is a point still to be determined.

CONCLUSION.—THEIR INCREASE IN NEW ENGLAND.

In listening to the complaints of practical men, and looking at the matter from the economical agricultural point of view, it is not easy to escape the conviction that worms must be decidedly hurtful, especially if account be taken of a single crop, or series of crops, or of any other particular year by itself; and this conviction is but strengthened and verified by the evidence adduced by naturalists as to the magnitude of the work done by the worms, and as to its great geological importance in some countries. It is possible, of course, in field practice, that in certain cases the introduction of some puddled earth may be beneficial to such soils, for instance, as are naturally too open and which stand in need of a binding element. But this supposition can rarely, if ever, be true of really fertile soils, the particles of which almost always need to be made loose and open, by appropriate tillage, rather than to be cemented to the condition of clods. Upon arable soils in good tilth, the scattering of the worm earth upon the surface, by the action of rain or wind, can hardly fail to be hurtful; both because the mud which results from it in rainy weather must tend to clog the pores of the soil, and because such mud in drying would naturally help form a crust at the surface of the land.

It is worthy of remark that the opinion as to the utility of earth-worms advanced by White and others, does not well consist with the familiar fact that these worms were extremely rare, or perhaps altogether absent, in Northern New England, at least, when this country was first settled. As Mr. Marsh, writing in 1863, has well stated, "worms were so scarce forty or fifty years ago in the newer parts of New England, that the rustic fishermen of every village kept secret the few places where they were found in their neighborhood, as a professional mystery." I can myself testify, from personal observation at the northern end of Lake Winipiseogee, in New Hampshire, in the years 1842 and 1846, that, in so far as the boys of that locality knew, there was but one small spot in all the country side where earth-worms could be found. This locality was in the back yard and kitchen garden of one of the houses in the village, to which, as we boys supposed, the worm had been introduced from some other settlement. It hardly needs to be said that the country in question was more fertile when first cleared, and when worms were absent, than it ever has been since. There would seem to be little need, moreover, of urging the self-evident proposition that leaves can decay, and a highly fertile soil be formed, without the intervention of earth-worms. So far from the worms being economically useful in agriculture, it might well be urged that their advent has probably been one cause of the diminution of fertility which is known to have occurred in most places in this country. It seems plain, at all events, that the worms may work to cause sterility, both by destroying dead organic matter (leaves, etc.), which would be valuable if it were left to decay unmolested; by puddling the soil and so impairing its power of supporting vegetation, and as Mr. Darwin himself deems probable, by destroying the low organisms which are essential for the formation of nitrates, and whose presence in good soils is doubtless one prime cause of the fertility. As an extension of this idea, it is not impossible that the absence of the destroying worms may be a necessary condition for the highly interesting and probably useful formation of bicarbonate of lime in dry loams, to which I called attention several years since in one of the numbers of the *Bussey Bulletin*.

Harvard University, Mass.

F. H. STOREY.

ON MANURE PHOSPHATE.

By K. WALTER, Chemical Engineer, Auvclais, Belgium.

WHEN I wrote my last article on this subject in the *Chemical News*, vol. xxxviii, pp. 37-50, I could not have imagined that it would take such a long time before the analysis of those phosphates by the method of citrate of ammonia would be generally adopted. The more, as I know, that the greater number of English agricultural chemists are convinced that the phosphoric acid soluble in the citrate is equal in value to the phosphoric acid soluble in water.

Professor Petermann, in Gembloux, Chief Manager of the Belgian Royal Agricultural Stations, had in 1877 officially announced that from January 1, 1878, all the phosphoric acid soluble in the citrate of ammonia would be counted at the same rate as the former soluble in water. In short, any sample of superphosphate would no more be valued on its contents of phosphoric acid soluble in water, but only on its contents of phosphoric acid soluble in the citrate of ammonia. To this latter process was then given the term determination of *assimilable* phosphoric acid.

Neither manure manufacturers nor agriculturists made the slightest objection to this innovation, because everybody found himself well off by it; and to-day it has so much become the custom, that neither party appears to think that it has ever been otherwise. The more so, as the repeated trials of latter years have clearly shown the superiority of precipitated phosphate (retrograded phosphate) to the superphosphate. All the experiences of Toulie, Grandeau, Petermann, and many others, are, by the trials of late, confirmed to evidence.

As soon as the decision of Dr. Petermann was known; the

German superphosphate manufacturers took up the matter, and tried with all their might to introduce the same system into Germany; but they found it not as easy as they had a right to believe. There were some eminent agricultural chemists who were perfectly of the same opinion as Petermann, and fought by word and writing for the same cause; but the greater number of them, including some of the most influential, were thoroughly against it.

The German Professors never could pardon Petermann, that he had taken, as one of them (Petermann in German), such a measure without first having demanded and obtained the high permission and assent of united sage agricultural Germany.

However, some of them were honest enough to begin to try the matter by experience, and at this period, even the most inveterate opponents of Petermann's system were obliged to come over. It was generally admitted that the phosphoric acid soluble in the citrate has at least the same value as phosphoric acid soluble in water, for those kinds of soils in which the experiments were made. They concluded that further experiments must show if the equality is evident in all kinds of soils.

Anyhow this was a great step forward—by which German superphosphate makers have profited. They have begun to count the phosphoric acid soluble in citrate—*en attendant*—at half the price, as that soluble in water. There can, however, not be the slightest doubt that in a time very near to come, the same system as used in Belgium and in France will be adopted in Germany; at all events, manure makers there do their utmost to bring things to this solution.

It is altogether inexplicable that the English manure manufacturers—by far the most interested in this question—did not take serious steps to follow the same road. The quantities of superphosphate made by the English works is so very important that those manufactured on the Continent are a mere nothing against it. The English superphosphate manufactory loses annually hundreds of thousands of pounds by persisting in their present system—and this in times in which the chemical trade cannot afford to make any superfluous losses which easily might be avoided.

Every experienced superphosphate maker knows that even the purest raw phosphates (containing only traces of iron and alumina) give superphosphates, which contain three-quarters to 1 per cent. of phosphoric acid not soluble in water but easily in the citrate of ammonia. Most phosphates, however, used for the trade in question, give superphosphates containing in a fresh state $1\frac{1}{2}$ per cent. of phosphoric acid not soluble in water but in the citrate. After storing of three to four months' duration, this latter amounts to 2 to 3 per cent., and sometimes even more—of course to the detriment of the phosphoric acid soluble in water.

If we take superphosphate, on an average, as containing 14.5 per cent. phosphoric acid soluble in citrate, or 13 per cent. phosphoric acid soluble in water, $1\frac{1}{2}$ per cent. are lost for the English manufacturer. That is to say for the whole quantity of phosphoric acid rendered soluble for sale and available for agricultural purposes, 10 per cent. A manufacturer making per year 3,000 tons of superphosphate actually loses about £1,200 annually.

It is certainly no advantage for the agricultural chemists to exchange the handy analysis of phosphoric acid soluble in water, against the more complicated and tedious one of phosphoric acid soluble in the citrate.

They were, however, obliged to do it on the Continent, and the English chemists will have to follow, sooner or later. This mode of analysis has now arrived at such a perfection that the results of the different chemists, when they follow the same method, are most satisfactory, and just of the same accordance as the analysis of phosphoric acid soluble in water. In the International Congress of Agricultural Chemists, held at Paris last summer, the manner of analysis was fixed for the rest.

I will now narrate in as few words as possible the comparative results, given by a great series of trials in different parts of Belgium, Germany, and France, between the superphosphate monobasic phosphoric acid and the precipitated (retrograded, gone-back) phosphoric acid, considered to be bibasic; the first soluble in water, the second soluble in citrate of ammonia.

1. In heavy clay soils, the phosphoric acid soluble in water has the same effect as phosphoric acid soluble in the citrate, sometimes even a trifle better.

2. In soils rich in humus, limestone soils, slaty soils, the effect of the second is at least the same as that of the first.

3. In light, sandy soils, the effect of phosphoric acid soluble in water is surprisingly inferior to that of phosphoric acid soluble in the citrate.

In short terms, the one is worth as much as the other as a general rule, but the intelligent farmer will take his choice in consequence of the soils he has to deal with. In the latter years experience has shown that in light, sandy soils, even precipitated phosphate dried at a very high temperature, and in consequence only containing traces of phosphoric acid soluble in the citrate, is by far superior in its action to superphosphate. I have likewise to remark that repeated trials have shown that phosphoric acid as precipitate is a little superior to phosphoric acid as it is in a retrograded state in the superphosphates, though both are soluble in the citrate. I attribute this difference in action to the different mechanical state of them, the precipitate permitting a finer division in the soil. The reason why monobasic phosphoric acid has in the most kinds of soils an action inferior to that of one of bibasic phosphoric acid is easy to explain. In heavy clay soils, the first one, the monobasic phosphoric acid, is put into solution by the water contained in the ground rather quickly, but is fixed immediately through the propensity of such soils to retain all kinds of salt solutions mechanically, and this in a very powerful manner. By and by it is transformed by the limestone, iron, or alumina in the ground into bibasic phosphate of lime, iron, or alumina; and as such it is by slow degrees, according to the want of the plants, again put into solution by the carbonic acid, certain salt solutions, and even by the secretion of the roots themselves. The bibasic phosphate has not to be transformed and is ready for action.

In light and sandy soils, the superphosphate is more or less lost; those soils, not having a very strong fining power, the rain washes its solution right through into the subsoil, before it has time to transform itself into bibasic phosphate. This latter, however, put into the ground as such is only—being slowly soluble—put to profit by and by, just as the plants wanted it during their growth.

The consequence of those observations has been that phosphoric acid in the precipitate of lime is already paid at a little higher rate than phosphoric acid in the superphosphate in Belgium and the north of France. The demand far exceeds the production of the former.

The enormous loss of the English superphosphate makers is not the only drawback in this important question; a great

resource of the English chemical manufacturing industry is likewise cut off by maintaining the present system. In England are actually great quantities of *muratic acid* runing to waste, not to count those enormous quantities which are employed for bleach making. This latter article stands at present at a price which makes it hardly worth while to manufacture it, and many works use hydrochloric acid only for that purpose, because they are not allowed to let the acid run away.

England has equally great layers of natural phosphates, too poor to be employed for superphosphate making, but they are just the thing to serve as raw material for the manufacturing of precipitated phosphate, by means of the now useless quantities of *muratic acid*. With the progress this kind of manufacture has made in the latter years, it would be an exceedingly profitable one in England.

Of course, as long as precipitated phosphate has to be exported to bring its real value, no manufacturer will find it inviting enough to go in for it, though even for export it would very well be worth while to manufacture it; and once tried in England by some farmers it would make its way in no time, even if chemists and superphosphate makers cannot as yet make up their minds to introduce officially the citrate of ammonia analysis.

May these few lines tend to direct the attention of the leading chemical men and manufacturers in England to the important question before named, and cause them to take serious and united steps for the welfare of the English chemical trade by following a system now in application for the past four years on the Continent.

CULTIVATION OF THE RAMIE PLANT.

The ramie plant possesses qualities and merits of the highest value for textile industries, and in the whole of Europe, Consul Stanton states that France alone has attempted the industrial development of this Chinese plant, and the attempt has met with such success as to give that country a decided advantage over other European manufacturing countries. At the present time the cultivation makes great progress in Southern France, Corsica, and Algiers, and a practical process has lately been discovered for separating the fibers from the stems. The plant belongs to the nettle family, and although stinging, is similar to the stinging nettle in the form both of its leaves and branches, having, however, a much more luxuriant growth. The branches grow straight and in bunches, and are composed of a brittle woody substance, filled with pith, and surrounded with a fibrous covering, which, in its turn, is covered with a thin skin or rind. The fibers are bound together by a resinous substance, which is more difficult to dissolve than that contained in flax and hemp, and from this circumstance the setting of the ramie plant is more laborious than hemp and flax, though the hackling of the stems is less arduous. The propagation of the plant may be affected by seeds, layers, or cuttings; but as the reproduction from seeds is generally slow and uncertain, slips and layers are more often used. The ramie is a perennial, and not like flax or hemp, an annual, and its strength and fertility increases with its age. It withstands both drought and damp, but is very susceptible to frost. Even after frost, however, it is only the first crop which is lost, since the roots, which penetrate the ground to a depth of about a foot, are seldom affected, and soon put forth new shoots. Its growth is unusually rapid, and even in France it attains annually a height of from six feet to eight feet. In its home, however (China and Bengal), it attains the height of fifteen feet. By cutting the stems when they have attained a height of three feet, several crops and finer fibers are obtained, the plant renewing its shoots continually. The leaves, when dried, are valuable for the manufacture of the tough paper which is so extensively used in China, while the green ones afford excellent cattle fodder. On account of its luxuriant growth, extensive manuring is requisite; and, with the exception of this manuring, and the careful manner in which it must be done, the cultivation of the ramie is of the simplest kind, and with due care for frost, it may be planted at any season. The planting is generally in furrows ten inches deep, and a yard apart, the plants being set out at intervals of a yard. Hoeing and digging are only necessary the first year, the plant growing afterwards with such luxuriance as to smother all weeds. In the spring, and after each cutting, hoeing is generally resorted to; and if at the approach of winter, the earth is heaped round the roots, to protect them from frost, the branches increase rapidly in number, the first growth yielding from three to four, the second from six to eight, the third from ten to twelve, and the fourth (this, however, is only in warm climates), from sixteen to twenty branches. The pecuniary results so far obtained are most satisfactory. It is maintained that the ramie plant will yield a crop worth from £56 to £80 per hectare (2.47 acres); and assuming that three cuttings are annually obtained, there would be a yield of from 4,000 to 5,000 kilos of leaves alone, which would cover all the expenses of cultivation. In addition to this, there would be from 1,500 to 2,200 kilos of fibers, from which 1,200 to 1,500 kilos of white linen could be spun. The tenacity of the ramie fiber is 30 per cent. greater than that of flax, and in consequence of this tenacity it has for many years been used in China, in the manufacture of many articles in which solidity is absolutely necessary. In China, from fibers of this plant the coarsest nets are woven, and fabrics which surpass in gloss and delicacy the finest battiste. As with flax and hemp, the first operation is to separate the fibers from the resinous substance which unites them. This is effected by steeping in water. The Belgians have recently substituted for the old plan a new, more rapid, and healthier process, which produces an excellent commercial result. Large square cemented vats are used. In these the branches are laid, then water is poured on, and kept for flax and hemp, for one or two days, and for ramie from five to six days. To the water one-half per cent. of the weight of the branches of pulverized charcoal is added, and the same quantity of carbonate of soda of potash, and throughout the process the vats are kept carefully closed. In this manner decomposition takes place slowly, and the fibers are protected from the injurious effects of the exhalations of sulphureted hydrogen. After the gluten is dissolved from the fibers they have only to be separated from the woody tissue. This is effected by hackling, which was formerly slowly and arduously done by hand, but is now performed by machinery in a very simple manner. The branches are passed successively through four pairs of rollers, which destroy the woody tissue; then the hackling is done by two pairs of grooved cylinders, which, by a movement backwards and forwards, rub and cleanse the fibers from all impurities. A third machine, which consists of a hollow cylinder inclosing an axle, does the combing. This axle is provided with a number of whips, which beat the fibers continually. The fibers enter the cylinder at an opening in the side, the dust

is removed by a ventilator, and the branches, reduced to the finest fiber, leave the machine perfectly cleansed, and after bleaching are ready for spinning. In consequence of the silky character of the fiber it is necessary to fasten the warp securely, to prevent its being pulled out when weaving. Special attention is also paid to the dyeing, to insure fast colors. In France, measures have been taken for the manufacture of elegant ramie stuffs on a large scale, either from ramie for tablecloths and furniture coverings, or mixed for wool and silk for draperies; and it is the opinion of those engaged in the manufacture of textile fabrics that the time has arrived when this material will play a great role in textile industries.—*Textile Manufacturer*.

HYACINTH BULBS.

By GRANT ALLEN.

If we were not so familiar with the fact, we would think there were few queerer things in nature than the mode of growth followed by this sprouting hyacinth bulb on my mantelpiece here. It is simply stuck in a glass stand, filled with water, and there, with little aid from light or sunshine, it goes through its whole development like a piece of organic clockwork, as it is, running down slowly in its own appointed course. For a bulb does not grow as an ordinary plant grows, solely by means of carbon derived from the air under the influence of sunlight. What we call its growth we ought rather to call its unfolding. It contains within itself everything that is necessary for its own vital processes. Even if I were to cover it up entirely, or put it in a warm, dark room, it would sprout and unfold itself in exactly the same way as it does here in the diffused light of my study. The leaves, it is true, would be blanched and almost colorless, but the flowers would be just as brilliantly blue as these which are now scenting the whole room with their delicious fragrance. The question is, then, how can the hyacinth thus live and grow without the apparent aid of sunlight, on which all vegetation is ultimately based?

Of course, an ordinary plant, as everybody knows, derives all its energy or motive power from the sun. The green leaf is the organ upon which the rays act. In its cells the waves of light propagated from the sun fall upon the carbonic acid which the leaves drink in from the air, and by their disintegrating power liberate the oxygen while setting free the carbon, to form the fuel and food-stuff of the plant. Side by side with this operation the plant performs another, by building up the carbon thus obtained into new combinations with the hydrogen obtained from its watery sap. From these two elements the chief constituents of the vegetable tissues are made up. Now the fact that they have been freed from the oxygen with which they are generally combined gives them energy, as the physicists call it, and when they re-combine with oxygen, this energy is again given out as heat, or motion. In burning a piece of wood or a lump of coal, we are simply causing the oxygen to re-combine with these energetic vegetable substances, and the result is that we get once more the carbonic acid and water with which we started. But we all know that such burning yields not only heat, but also visible motion. This motion is clearly seen even in the draught of an ordinary chimney, and may be much more distinctly recognized in such a machine as the steam-engine.

At first sight, all this seems to have very little connection with hyacinth bulbs. Yet, if we look a little deeper into the question, we shall see that a bulb and an engine have really a great many points in common. Let us glance first at a somewhat simpler case, that of a seed, such as a pea or a grain of wheat. Here we have a little sack of starches and albumen laid as nutriment for a sprouting plantlet. These rich food stuffs were elaborated in the leaves of the parent pea, or in the tall haulms of the growing corn. They were carried by the sap into the ripening fruit, and there, through one of those bits of vital mechanism which we do not yet completely understand, they were selected and laid by in the young seed. When the pea or the grain of wheat begins to germinate, under the influence of warmth and moisture, a very slow combustion really takes place. Oxygen from the air combines gradually with the food stuffs or fuels—call them which you will—contained in the seed. Thus heat is evolved, which in some cases can be easily measured with the thermometer, and felt by the naked hand—as, for example, in the malting of barley. At the same time motion is produced; and this motion, taking place in certain regular directions, results in what we call the growth of a young plant. In different seeds this growth takes different forms, but in all alike the central mechanical principle is the same: certain cells are raised visibly above the surface of the earth, and the motive power which so raised them is the energy set free by the combination of oxygen with their starches and albumens. Of course, here, too, carbonic acid and water are the final products of the slow combustion. The whole process is closely akin to the hatching of an egg into a living chicken. But, as soon as the young plant has used up all the material laid by for it by its mother, it is compelled to feed itself just as much as the chicken when it emerges from the shell. The plant does this by unfolding its leaves to the sunlight, and so begins to assimilate fresh compounds of hydrogen and carbon on its own account.

Now it makes a great deal of difference to a sprouting seed whether it is well or ill provided with such stored-up food-stuffs. Some very small seeds have hardly any provisions to go on upon; and the seedlings of these, of course, must wither up and die if they do not catch the sunlight as soon as they have first unfolded their tiny leaflets; but other wiser plants have learnt by experience to lay by plenty of starches, oils, or other useful materials in their seeds; and wherever such a tendency has once faintly appeared, it has given such an advantage to the species where it occurred, that it has been increased and developed from generation to generation through natural selection. Now what such plants do for their offspring, the hyacinth, and many others, like it, do for themselves. The lily family, at least in the temperate regions, seldom grows into a tree-like form; but many of them have acquired a habit which enables them to live on almost as well as trees from season to season, though their leaves die down completely with each recurring winter. If you cut open a hyacinth bulb, or, what is simpler to experiment upon, an onion, you will find that it consists of several short abortive leaves, or thick fleshy scales. In these subterranean leaves the plant stores up the food-stuffs elaborated by its green portions during the summer; and there they lie the whole winter through, ready to send up a flowering stem early in the succeeding spring. The material in the old bulb is used in thus producing leaves and blossoms at the beginning of the second or third season; but fresh bulbs grow out anew from its side, and in these the plant once more stores up fresh material for the succeeding year's growth.

The hyacinths which we keep in glasses on our mantelpieces represent such a reserve of three or four years' accumulation. They have purposely been prevented from flowering, in order to make them produce finer trusses of bloom when they are at length permitted to follow their own free will. Thus the bulb contains material enough to send up leaves and blossoms from its own resources; and it will do so even if grown entirely in the dark. In that case the leaves will be pale yellow or faintly greenish, because the true green pigment, which is the active agent of digestion; can only be produced under the influence of light; whereas the flowers will retain their proper color, because their pigment is always due to oxidation alone, and is but little dependent upon the ways of sunshine. Even if grown in an ordinary room, away from the window, the leaves seldom assume their proper deep tone of full green; they are mainly dependent on the food-stuffs laid by in the bulb, and do but little active work on their own account. After the hyacinth has flowered, the bulb is reduced to an empty and flaccid mass of watery brown scales.

Among all the lily kind, such devices for storing up useful material, either in bulbs or in the very similar organs known as corms, are extremely common. As a consequence, many of them produce unusually large and showy flowers. Even among our native English lilies we can boast of such beautiful blossoms as the fritillary, the wild hyacinth, the meadow-saffron, and the two pretty squills; while in our gardens the tiger lilies, tulips, tuberose, and many others belong to the same handsome bulbous group. Closely allied families give us the bulb-bearing narcissus, daffodil, snow-drop, amaryllis, and Guernsey lily; the crocus, gladiolus, iris, and corn-flag; while the neighboring tribe of orchids, most of which have tubers, probably produce more ornamental flowers than any other family of plants in the whole world. Among a widely-different group we get other herbs which lay by rich stores of starch, or similar nutritious substances, in thickened underground branches, known as tubers; such, for example, are the potato and the Jerusalem artichoke. Sometimes the root itself is the storehouse for the accumulated food-stuffs, as in the dahlia, the carrot, the radish, and the turnip. In all these cases, the plant obviously derives benefit from the habit which it has acquired of hiding away its reserve fund beneath the ground, where it is much less likely to be discovered and eaten by its animal foes. For it is obvious that these special reservoirs of energetic material, which the plant intends as food for its own flower or for its future offspring, are exactly those parts which animals will be likely unfairly to appropriate to their personal use. What feeds a plant will feed a squirrel, a mouse, a pig, or a man, just as well. Each requires just the same free elements, whose combination with oxygen may yield it heat and movement. Thus it happens that the parts of plants which we human beings mainly use as food stuffs are just the organs where starch has been laid by for the plant's own domestic economy—seeds, as in the pea, bean, wheat, maize, barley, rice, or millet; tubers, as in the potato and Jerusalem artichoke; corms, as in the yam or taro; and roots, as in arrowroot, turnip, parsnip, and carrot. In all these, and in many other cases, the habit first set up by nature has been sedulously encouraged and increased by man's deliberate selection. What man thus consciously effects in a few generations, the survival of the fittest has unconsciously effected through many long previous ages of native development.—*Knowledge*.

A SHEEP-EATING PARROT.

A SINGULAR bird has recently been added to the collection in the Zoological Gardens, London. This is none other than a carnivorous parrot, whose love of animal flesh manifests itself in a very decided predilection for mutton. There are two things which to the naturalist are remarkable in connection with this bird. First, it is, in respect of this flesh eating propensity, an exception to the whole family of parrots, which are frugivorous, living on fruits, seeds, leaves, buds, and the like; and second, this carnivorous taste is not a natural but an acquired possession, the species of parrot in question having been till a few years since frugivorous, like others of its family.

This curious bird is the kea (*Neslor notabilis*) or mountain parrot, and comes from New Zealand. The general color of its plumage is green; its length from point of bill to extremity of tail is twenty-one inches; its bill is about two inches long, the upper mandible being curved, and very strong. It inhabits the higher wooded glens and recesses of the mountainous districts of New Zealand, and, like the owl, is generally nocturnal in its habits. The kea was first made known to science in 1856. In the time of Maori rule, the bird was as innocent and harmless in its habits, as respects its food, as any others of the parrot family; and it was not till the higher tracts of country were utilized by the early settlers as runs for sheep, that the kea was tempted to desert its fruit-eating habits, and to join the destructive army of the carnivora.

About 1868, it was noticed at the sheep-shearing season on the upland runs that many sheep were suffering from sores or scars, more or less recent, on the back, immediately in front of the hips. Curiously enough, it was observed that in all the animals so injured the wound was in precisely the same place in each—fairly above the kidneys. In some cases (says Mr. Potts, who has contributed an article to the *Zoologist* on the subject), the part affected had a hard dry scab or merely a patch of wool stripped off; others showed a severe wound, in some instances so deep that the entrails protruded. The animals so injured were invariably those that were in the best condition; and many discussions ensued as to what could be the cause of this singular state of things. At last a shepherd gave it as his opinion that the injury was inflicted by a kind of parrot, rather a tame sort of bird, that was to be met with in the higher ranges; but the shepherd's opinion was only laughed at. Yet the shepherd, after all, was found to be right. In connection with the stations on sheep-runs in New Zealand, there is a meat-gallows, where the carcasses of sheep killed for food are kept; and it was observed by the shepherds that the keas were in the habit of visiting the gallows and breaking off bits of mutton-fat with their strong beaks. Soon afterward, one or more hands actually saw a parrot on the back of a sheep plucking and tearing the wool and flesh on a precisely similar spot to that where so many had been found to be fatally wounded.

There was no doubt about the keas being the offenders, and means were at once taken to have their numbers reduced. Since then, a mortal enmity has existed against them on the part of the shepherds; and justly so, as it is found that from three to five per cent. of every flock is so wounded or killed. In some individual instances, the ratio of destruction has been much higher. On one station on the Matatapu, out of a flock of twenty Lincoln rams, nineteen were within