Maiden Hair Fern.—The *Garden* says: "Some idea of the extent to which Maiden Hair Fern is used in Covent Garden for bouquet making may be gleaned from the fact that Mr. Rochford, of Tottenham, has several large, span-roofed houses entirely devoted to its culture for furnishing fronds in a cut state. The plants are grown in 12-inch pots, and in order to keep up a regular succession, only a portion of them is cut at a time, those which furnish such fronds being subjected to a lower temperature than the rest, by which means the fronds assume a deeper green color, and last longer after being cut than they otherwise would do."

The kind employed is not specified. In this part of the world the common Maiden Hair, *Adiantum capillus veneris*, is used to some degree, though not to the extent indicated in the above extract, as in England. But it might be more generally employed than it is. By the way, this is one of the best of ferns to use as a window plant.

Falling of Flower Buds in the Camellia.—Among the peculiar experiences of the year in English gardens, is a remarkable dropping of the flower buds of Camellias, and the papers are busy in discussing the cause. Amongst other papers is an interesting one in the *Gardener's Magazine*. After showing that neglect the Summer before will operate injuriously the Winter following, it says: "It does not follow, however, that the case now before us is to be explained in this way, and we incline to the belief that very many of the collections that have of late disappointed their owners had the best possible attention in the Summer of last year. Why, then, should they behave so differently to their wont? Can it be that defect of solar light is the cause of their disaster? We incline to the belief that herein is a sufficient explanation. The later days of the Autumn and the whole of the Winter, thus far, have been characterized by the prevalence of rain clouds; and it is scarcely exaggerating the case to say that in London we have had but three bright days during the past three months. Light is the life of flowers, although all flowers do not require equal degrees of light for their full development. The Camellia, indeed, is a shade-loving tree, and we occasionally meet with surprisingly large, healthy, and productive Camellias in old houses that have by long neglect become grass green above, and ruddy below, and rickety everywhere. The coating of moss and coniferæ on the glass, and even the black bars formed by the absorption of dirt in the laps, may be beneficial to the trees in Summer, as affording a little shade, and giving the light the greenish tinge it has in the shade of large trees, where Camellias grow naturally. We should like to know how Camellias have flowered in dirty old houses during the past season, and probably some of our correspondents can inform us. If deficiency of light is the cause of the failure we now deplore, the old houses should be in the worse plight, and the newer houses should present a marked contrast in favor of large glass and good carpentry. To know the cause of a disease is said to be half a cure; we cannot dispel the rain cloud, we cannot produce artificial sunshine; but we may reasonably inquire if, in the case of Camellias, there is this season any difference in the flowering of those that are in light and airy houses, and those that are "boxed up" in tumble-down houses where the woodwork is heavy, the squares small, and the glass more or less coated with black soot or green vegetation. While we incline to the belief that lack of light is the principal cause of the falling of Camellia buds, we do not claim that we have disposed of the question. We prefer to place it before our readers, asking them to assist in its solution. It is more than a horticultural question, it is one of considerable commercial importance."

New Rose, Queen of Bedders.—A good bedding rose, should above all other good characteristics, bloom freely. Mr. Noble, of England, in the above variety, thinks he has just the thing. He says: "Its inflorescence may be imagined when it is stated that a plant 15 inches high had 84 buds and expanded roses upon it on the 6th of September, 1876, and flowered continuously from June until November, on the 20th of which month (1876) it was still in bloom."

A Double White Bedding Lobelia has originated in Prussia, and is now being offered under the designation of *Lobelia erinus erecta fl. albo plena*. It is said to range from three to four inches in height, to be dense in habit, and to flower abundantly in the open ground; but as yet no opportunity has been offered for determining its value for bedding purposes in English gardens. As all the white flowered lobelias that have been introduced up to the present moment have proved worthless, some amount of caution should be exercised in planting this new comer, until it has been subjected to a careful trial; more especially as the double form with blue flowers is of no value whatever in the flower garden.

Apricots in California.—Apricots have been the special pride of the Golden State, but for some reason are said to be very scarce there this year. It would be interesting to know whether the curculio has found its way there yet. We suppose it will get there one of these days.

Three Thousand Varieties of Strawberries.—As showing how easy it is to raise good seedling strawberries, we may say that Mr. Durand, whose name is connected with good varieties, has now in bearing three thousand varieties, which he regards as distinct—but which we should think the "protective committee" at Washington would be hard put to describe explicitly so that any one might know whether he was infringing on a patent right or not—and anyone of which would be good enough for ordinary mortals. Such facts as these make the propriety of going into ecstasies over a new and promising variety, very doubtful. If good kinds can be produced in such numbers, we shall soon be in the condition of the new potato men. They raised new kinds for us by the hundred—all of them so good—that there was no great use in selecting any one, and then they took to advertising the seed, so that every one could raise his own best variety. Will it soon be thus with the strawberry?

Apples for England.—So late as the 4th of May, the "Indiana," of the American Line of Steamers, from Philadelphia to Liverpool, took out 1,500 barrels of apples. Some of these were of the celebrated Pennsylvania variety, "Smoke House," which is said to be highly appreciated in England. In past times they seem to have known nothing of American apples except "Newtown Pippin," and seemed to be astonished at the superiority of other kinds.

The Northern Spy Apple in the West.—It is said that the Northern Spy is fast outrunning all other kinds in popularity in Iowa and Michigan. It is longer coming into bearing than most kinds, but generally brings more in market than the others, and this, perhaps, may help balance accounts.

The Gros Colman Grape.—This variety has never achieved great popularity with American hot-house grape growers,

but we note that in the December reports of Covent Garden (London) Market, it seems to be the general favorite, and to bring higher prices than all the varieties of that season. What say Mr. Huidekoper and our other friends who are interested in experimental vinery culture?

Size of Pot-raised Pears.—In England the Dwarf Pear is not uncommon as an orchard fruit. Of some remarkable fruit the *London Journal of Horticulture* has this to say: "Mr. Hawkins, gardener, Eweny Abbey, Bridgend, Glamorganshire, tells us that he grew last year in pots Pit-maston Duchesse Pears weighing 27 ozs., Durandau, 21 ozs., and Doyenne du Comice, 17 and 18 ozs., that fruit being of excellent flavor. He wishes to know if other gardeners have obtained fruits as fine or finer."

Sending Peaches to Ireland.—Mr. J. H. Parnell, of Alabama, who did himself so much credit in the exhibition of the very large peaches of the Early Beatrice variety, at the Centennial last year, has astonished the residents in "Great Britain and Ireland" by sending peaches from Alabama to Ireland in a first-rate condition. The *Irish Farmers' Gazette* says they were in just as good condition as if pulled fresh from the tree. Mr. Parnell brought them in a box, which is thus described: "The contrivance consisted of a large, square bin or deep wooden chest, strongly put together, and lined with zinc; within this was another large chest similarly lined, a space of some 8 or 9 inches intervening between the inner and outer chest, which was filled with ice. In the inner chest the peaches were stored, not in separate trays, layers, or anything of the kind, but heaped as you would stow potatoes in a pit; and there they lay, a rosy and happy looking mass, in the best possible condition."

Forcing Asparagus.—The poor stuff called canned vegetables, will never compete with nice fresh ones, just cut fresh from the plant, and particularly is this so with Asparagus; and then it forces so easily. A correspondent of the *Garden* gives his experience, which we give on the principle that what a man says he has done, is worth a whole chapter of "how you may do it." "Asparagus may be obtained a month before it is ready out of doors as follows: About the middle of February place some movable wooden frames over a permanent bed of it, and with a few barrow loads of warm manure and leaves, make up a lining all round the bed, and cover its surface with dry hay. Then put on the lights and keep them closed for three weeks, when the heads will begin to appear. The hay should then be cleared off; and a little air given on every favorable opportunity. Under this treatment I cut my first Asparagus on March 20, and since that date I have cut several hundreds of beautiful heads, and still they promise to be sufficiently abundant to keep up a good supply until the outdoor crop is ready. By this plan the bed, which does not experience any disturbance, will last a great number of years, provided its produce is not cut too late. Cutting should cease and the glass be removed directly the out-door crop is ready."

[COUNTRY GENTLEMAN.] THE LIRODENDRON.

THE tulip tree, or poplar, as it is generally termed here, is one of our most common as well as most useful trees for ornament, shade, and lumber. Within the last decade, millions of fine specimens of this grand tree have been ruthlessly destroyed and cut into the lumber which constitutes the major part of many a cosy home. Timber is no object, and the destruction still goes on; portable mills are plentiful, and in a score or two of years this beautiful specimen of Nature's handiwork will have disappeared from our forest.

It seems most congenial to hilly, broken land, where it attains its greatest size. The valleys and hills of the Ohio and Mississippi seem to be its native home. Wood, in his botanical works, gives an account of a tree 23 feet in circumference four feet from the ground, and 125 feet high, growing in Indiana. Fifteen years ago, when thousands of acres that are to-day in grass and grain were in all their primeval woodland glory, broken only here and there by a small farm, there was a tree a mile or so from my father's house in this county, 10 feet in diameter and 140 or 150 feet high. Alas, the woodman spared not that tree, and this king of all its race has gone the way of all things earthly! Trees four and five feet in diameter are abundant. The kind known as white or blue poplar is very tough and will not split; the yellow kind makes good rails, shingles, etc., and above ground compares favorably with our best lasting woods, but will soon rot in the ground.

Another feature your correspondent failed to note—and a very important one too for shade and ornamental trees—is that it is one of the earliest to put forth leaves, which quickly grow to their full size. They are now (April 21st) about one-third grown, and already make quite a shade. The leaves are very graceful, dark green, smooth, truncate at the end with two lateral lobes, on long, drooping petioles; are from 3 to 5 inches in length and breadth, and when held in the sun have the appearance of being bronzed, something like the southern magnolia. The flowers in dry weather accumulate several drops of honey on the petals and sepals, and are generally sought after by the average small boy, bees, and animals that have a sweet tooth. Young trees 10 or 12 feet high are often replanted, after trimming the tops, and few die. They grow rapidly from the seeds, and, when left alone, soon make beautiful shade trees.

Henderson County, Ky.

WILL A. SISSON.

THE PHOSPHATES.

PHOSPHATIC manures are made from several crude substances; yet all depending, first, upon their content of phosphoric acid. This acid, so important as a plant food, is almost always found in combination with lime, forming a phosphate of lime. And just here it will be well to consider these several forms of phosphate of lime. Phosphoric acid unites with lime in three proportions, viz.: one part acid to three parts of lime, called the *tricalcic* phosphate; one part acid to two parts of lime, called the *bicalcic* phosphate; and one part acid to one part lime, called the *monocalcic* phosphate. The tricalcic form contains the "insoluble" phosphoric acid; the bicalcic form, the "reduced" phosphoric acid; and the monocalcic form, the "soluble" phosphoric acid. These different forms have different values as plant food, owing to the degree of solubility and consequent availability to the roots of the plant. These values are commercially expressed at 12½ cents per pound for the soluble phosphoric acid; 9 cents for the reduced; and 6 cents for the insoluble. The tricalcic or insoluble phosphate is soluble in 100,000 parts of water. It is therefore probable that a portion is available to plants in this form.

The value of a phosphatic manure depends, therefore, not

only on the percentage, but also on the form in which the phosphoric acid contained in it exists. And the aim of the manufacturer should be to have the larger portion of this ingredient in the soluble form, as it is for the interest of the buyer to have it in a condition to be readily taken up by the plant.

SOURCE OF PHOSPHATES.

The usual sources of phosphate of lime are bones, mineral phosphates and guanos: in all of which, and in barnyard manure, it is present mostly in the insoluble form. But it should be remarked here that this so-called insoluble phosphoric acid is gradually changed to the soluble and available form, when applied to the soil, through the agency of the carbonic acid of decomposing organic matter. In the case of finely ground bones, for example, it is estimated that about 50 per cent. of its phosphoric acid is used by the crop the first year, 25 per cent. the second year, 15 per cent. the third, etc. For general use, however, the "soluble" form is the most economical; unless the farmer has an unlimited capital, those boughten manures which contain this plant food in an immediately available form are the only ones he can afford to purchase. A manure which only makes a partial return the first year, is like an investment of money making similarly slow returns—safe, perhaps, but less profitable than that which makes a quick return.

MANUFACTURE.

The most prolific source of phosphate of lime is bones, and the country has been scoured, from the backdoor and swill-tub of the humblest cot, to rendering establishments, battle-fields, and the great western prairies, for a supply of the raw material. Bone fertilizers are found in the market in several forms, ground bone being the simplest. Fresh, raw bones contain an average of 22.50 per cent. of phosphoric acid, or about 50 per cent. of phosphate of lime, and from 3 to 5 per cent. of nitrogen. Bone-black is also largely used as a supply of phosphate of lime. It is the refuse of the bone charcoal used in the refining process at refineries, and contains from 32 to 34 per cent. of phosphoric acid, the nitrogenous portion having been driven off by the burning.

All manures, to be most efficient, must have a fine mechanical condition. This is always obtained in well manufactured fertilizers. Bones have other value than for manure, however, and before being used for this are usually subjected to a steaming and reducing process to remove the fat, etc., for other purposes. This also helps to render part of the phosphoric acid soluble. The residue—and the same for bone-black—is treated with sulphuric acid, in the proportion of 63 parts of the latter to 100 parts of the tricalcic phosphate contained in the bone. These are the theoretically proper proportions, but in practice less sulphuric acid is used—about one-half—on account of the expense; which accounts for the fact that only a portion of the phosphoric acid in the fertilizer is found in the "soluble" form. The sulphuric acid unites with a portion of the lime of the tricalcic phosphate, leaving the remainder in combination with the phosphoric acid, "soluble" and readily available for plant food. We shall speak hereafter of the home manufacture of superphosphates. The term "superphosphate" of lime means the same, chemically, as "monocalcic phosphate," above described, but is applied indiscriminately to any fertilizer, the principal ingredient of which, in value, is phosphoric acid.

MINERAL SUPERPHOSPHATES.

Bones, though at first the main source, now furnish but little of the phosphoric acid of fertilizers, so great has been the demand for phosphatic manures. To supply the deficiency, the vast beds of mineral phosphates, so called, prove to be deposits of great aggregate value. The chief of them are located in Central Russia, Western Germany, Southern France, Canada, South Carolina, and in the Navassa, Sombrero, Jarvis, and Baker Islands. The Navassa and South Carolina deposits are now the main sources of supply. It has been estimated that four-fifths of the superphosphates manufactured in this country are now produced from the two last-named sources. The Navassa contains from 32 to 36 per cent. of phosphoric acid, the South Carolina from 24 to 27 per cent. Though so rich in this ingredient, it is all in the insoluble form, and owing also to the extreme hardness of the substance, it is manipulated with difficulty. Though ever so fine, sulphuric acid acts but slowly upon it; due to its hardness, and also to the presence of carbonates of lime, magnesia, alumina, and oxide of iron. The entire absence of nitrogen and potash from this class of superphosphates, makes them of value chiefly to use in connection with barnyard or other manure containing these indispensable ingredients of an effective manure. Some superphosphates are manufactured from the real mineral phosphates, Apatite—the above being the mineral remains of the deposits of sea birds, etc. The insoluble phosphoric acid of the superphosphate made from Apatite is held by Professor Goessmann to possess little if any appreciable value, because of the compact nature of the rock containing it, though the soluble portion is as good as any.—*Scientific Farmer*.

ON EXTIRPATION OF INJURIOUS INSECTS.

By ANDREW MURRAY, F.L.S.*

I PRESUME it is unnecessary for me to inform any one present that this meeting has arisen out of a letter addressed by the President of the Privy Council to the different agricultural societies throughout the kingdom, covering a copy of a communication that I had made to my Lords, recommending steps to be taken for the extirpation of insects injurious to agriculture, etc. That communication was simply a letter drawing attention to the amount of damage done by insects; to the fact that isolated action was powerless against them; while in many cases their extirpation, or, at least, a great reduction in their numbers, might be effected with ease by combined action; and recommending that my Lords (as the department more especially connected with agriculture) should make a tentative experiment with that object. Anxious not to injure my proposition by making too bold or radical suggestions, I timidly limited it to one or two garden pests peculiarly open to attack, and to three counties—Lancashire, Derbyshire, and Cheshire—that had something of a peninsular or semi-isolated character. The reply of my Lords was, that though they were of opinion that it did not fall within the province of the Science and Art Department (to which my communication had been officially addressed) to take action in the manner suggested by me, yet they felt that the subject was one which well deserved the consideration of agricultural societies in the United Kingdom, and that to them copies of my letters would be sent.

* Read before the Society of Arts.

The reply is somewhat Delphian in its utterance, and may be read in more ways than one. To some it may seem to be merely a civil way of shelving a difficult question, and others may regard it as an invitation to the societies to favor them with their opinion on the subject. This is naturally the interpretation that I put upon it. It seems to me to say, that I have either not applied to the right department, or the right branch of the right department, or have not suggested the right remedy or the right mode of its application; but that, if deemed by those most interested to be of sufficient importance to call for the intervention of my Lords, they would then be willing to take up the subject, with the view of providing a remedy in the right way and through the right department.

It is with the view, then, of obtaining the opinion of those most interested in the subject that this meeting has been summoned, and having been asked to open the discussion with a paper, I propose to take advantage of the opportunity to examine the subject from some points of view which I did not touch upon in my previous letter. I feel that the weak part of that communication was the tentative remedy that I suggested. It was only touching the fringe of the evil. I shall now regard it from a more extended point of view, and endeavor to show how it may be dealt with in a more comprehensive and efficient manner.

I begin by making one or two assumptions, which I presume will be granted me, but which, if disputed, can be easily proved. I assume that, besides the occasional great injury done by insects, by which whole districts are ravaged, a continual drain is constantly kept up by them which constitutes a very perceptible percentage of deduction from the cultivator's profits. I say that much of this is preventable, and I assume that, where it can be prevented at less cost than the loss occasions, it should be prevented.

So far, I imagine, we must all be at one, but we may not be all at one as to the possibility or means of prevention, or at least of prevention except at a price greater than the loss that would be sustained by leaving matters as they are. I do not mean mere money cost—that would be easy to deal with, for whenever you come to actual figures you can cipher them out, but I mean the interference with a man's liberty of action in conducting his own business. That is the critical point of this question. How far it would be wise, and under what precautions it would be desirable, for the general benefit to interfere with the inalienable privilege of an Englishman to do what he likes with his own. None of us are so Quixotic as to maintain that there are no bounds to this right—but as a body, Englishmen are pretty decided in their aversion to paternal government; and, before accepting any proposition tending in that direction, they would require not only to be satisfied that the object was really for the general interest, but also that it can be attained in no other way. That the object is for the general interest is one of the assumptions that you have permitted me to make, and that it can be attained in no other way than by entrusting power to some executive authority (it matters not whether that authority be the actual government or another government instituted for the purpose) will be plain, if we consider for a moment the nature of the work contemplated. If we wish to rid a district or a country of an injurious insect, and if, as is very generally the case, we have the power of doing so by attacking it at a particular date, and in a particular manner, it is obvious that, to be effective, the attack must be simultaneous and combined, for to what purpose would it be if I cleared my farm while my neighbor did not clear his, or if I cleared mine one year and he cleared his another? We should each preserve an ample reserve of our pests to replenish the cleared fields of the other. A central authority, therefore, a power to which both he and I, and every other farmer in the district, must bow, is needed to secure united action, and what is such authority but paternal government, compelling us to obedience for our own good?

As to the advantage of the general principle of stamping out, and the necessity of an executive authority to direct it, there cannot, therefore, be much difference of opinion, but there remains the more difficult question, how much and what kind of interference may be tolerated, and by what safeguards it should be surrounded, and how far it is workable or not? The administrative machinery by which it should be carried out need not concern us. If government resolve to interfere, it must fall to them to make their own plans, but as a contribution towards elucidating the various points which they would have to consider, I think I may usefully draw the attention of the meeting to a few of the different ways in which interference might be beneficially exercised.

The simplest, the most powerful, and the most efficient of these is what I may call county or district rotation of cropping. Farmers know well enough the advantage of a rotation of cropping (or its equivalent) on their own farms. By long-continued growth of the same crop on the same land the soil becomes exhausted of some of the elements necessary for the proper development of that kind of crop, and a change of crop brings other elements into use, and relaxes the demand upon those that have been too much drawn upon.

Exactly the converse of this takes place with regard to certain insects. The great majority of vegetable-feeding insects do not feed on all kinds of plants indiscriminately; most of them are restricted to one kind of plant, and if by cultivation of that plant its numbers are enormously increased, so will naturally be the number of the insects that feed upon it, while, if we should cease to grow that plant, the number of the insects would correspondingly diminish. Thus, for instance, if a district is almost entirely in pasture, there will be very few wheat-feeding insects in it, but if it is turned into a wheat country, they will be in myriads. If these numbers reach such a pitch as to deteriorate the crops, the remedy is plain. Change the rotation, and grow some other crop instead of wheat. Allow me to illustrate this by an actual example. There is nothing like a real instance for bringing a fact home to our minds. Last summer I spent the month of July at Broadstairs. In my rambles about the place I was immediately struck with the wheat crops. At a little distance they looked tall and strong, but on examining the ears I found them so ill-filled that I should have said they were only three-quarters filled. The blade or leaf was throughout almost entirely white and dry, and I have no doubt that if I had asked any farmer what was the cause of the poor ears he would have said drought, as shown by the bleached and dried-up leaves. Mr. Mechi informs me that this is what is commonly known as blight; but there may be more than one kind of blight, and blight from more causes than one. I shall, therefore, not stand upon its name; whether it be blight or not, it seems to me plain that, if the farmer's assumption that the bleaching of the leaves was due to drought had been true, his conclusion would have been quite right. It was the deficient action of the leaf that stayed the flow of nutriment to the ear. There is not much fear of the farmer making a mistake upon this point. He, at least,

ought to be (or, if not, he is not master of his craft) perfectly alive to the fact that, if you want a good crop of any kind, you must have abundant and healthy foliage. Try to grow any plant, and see what kind of crop you will have if you constantly deprive it of its leaves. But, although he would be quite right in describing the deficiency of weight in the ear to the failure of the leaf, he would, in this instance, have been wrong, in ascribing the failure of the leaf to drought. It was due to the mining of the larva of a small fly, named *Agromyza graminis*, which lays its eggs under the skin of the leaf at its tip. From thence the young larvæ mine downwards, feeding on the parenchyma of the leaf, leaving nothing behind but the empty husk, consisting of the upper and under walls of the leaf. If the leaf is small, they entirely consume the interior; if large, they may not reach entirely to the bottom of the leaf, but will have consumed about three-fourths of it before they pass into the pupa state—as may be seen from some leaves which I have preserved, and which I hand round for examination. The diagram shows this, and the place where the insect lies is indicated by a darker spot. Now, of course, I cannot tell what amount of damage this insect did. Had I guessed that I was likely to be now reading a paper about it to the Society of Arts, I would have got the ears dried and weighed, and endeavored to give chapter and verse for a specified proportion. But not having done so, all I can do is to leave those who are familiar with the subject to work it out for themselves, merely premising that almost every blade in the whole district seemed attacked. Still, for the purpose of my next point it is necessary for me to make some estimate of the proportion of loss. I have said that the ears seemed only three-quarters filled. They continued so until reaped. Let us suppose that this is too much by half, and take an eighth. This would give a loss of upwards of 12 per cent. on the grain crop, and to make the margin still wider, and the figures manageable, let us reduce it to 10 per cent. The actual percentage of loss is not of much consequence if I can satisfy you it was considerable, and my object is less to show the amount lost than where it falls.

Now we all know that the total yearly produce of a farm has to be distributed between three accounts—one is in repayment of the cost of cultivation; another is in payment of rent; and the third is the tenant's profit. It is plain that no reduction can be got either from the expenses of cultivation or the rent on account of this insect damage. The tenant or cultivator has to lose the whole of it, and you will also see that although the loss on the whole crop may be only 10 per cent., that is by no means the percentage of the loss on his profit. Ten per cent. loss on the whole crop means, of course, 30 per cent., if all thrown upon a third of it. If, for example, we suppose that the tenant's profit on the entire produce is one-third, and that the total gross produce of the wheat crop was £500, 10 per cent. loss on that is £50, but 10 per cent. loss on the tenant's profit would only be £16, whereas a deduction of the whole £50 would be equivalent to upwards of £80 per cent. You will thus see that this, in its present stage, is entirely a cultivator's question. The landlord (not a cultivator) has only a prospective interest. If arrangements could be made by which such insect damage could be annihilated, no doubt, as leases terminated, a readjustment of rent suited to the improved production would take place, but in the meantime it is the tenant who suffers, and who will be the first benefited by stamping out such insects.

Now a change of crop, if carried out over a sufficiently wide district, supplies an easy and effectual cure for the attacks of this insect. Its habits lend themselves to such a remedy. It feeds only on wheat and a few allied pasture grasses. At Broadstairs there were crops of barley and crops of wheat growing side by side, the only separation between them being a footpath, not two feet in width, running through the field; and while, as I have said, every wheat blade was mined, I could not find one touched on the barley, which, by the way, had correspondingly escaped damage. Furthermore, the insect is only an annual. If it could be banished for one year it would be banished entirely, or until reintroduced. Now if there were a controlling authority in that district, what would be easier than to say to farmers, "Gentlemen, in the common interest you will substitute barley for wheat in your next year's rotation." The fly, deprived of its proper nidus, must then either lay its eggs in an unsuitable place, where they will perish, or have recourse to the pasture fields for *Triticum repens*, or other suitable grasses. By this, of course, the fly would not be exterminated, but its numbers would be so reduced as to render it comparatively harmless, at all events, for a time, when, if it again reappeared in force, the same means of defence could be again resorted to. Nay, it might be so arranged that two or more counties might brigade themselves together, so as to establish a permanent see-saw, by which they should play into each other's hands. But you will observe that no single man can carry out such a rotation. He may try it upon his own fields, but they will be replenished continually from the fields of his neighbors, unless they at the same time are compelled to follow the same rotation. Gentlemen, it is for you, who know the respective capabilities of soils, and the relative returns of wheat and barley, to say whether you would prefer to suffer a heavy yearly percentage of loss, or to submit to the substitution of barley, or some other crop, instead of wheat for a single year.

And if you thought it desirable to do so, can there be any difficulty in carrying it out? Are we so uninventive and destitute of resources that we cannot contrive some means by which the necessary power should be put in action? I could suggest half a dozen ways. Power might be given to the Lords of the Privy Council to carry it out at their own discretion and *ex proprio motu*; or to carry it out on the requisition of the county authorities; or on a requisition of a committee of the farmers of the district, appointed for the purpose of dealing with insect pests and similar questions; or on the initiation of the agricultural societies of the district; or an inspector might be appointed for every county, with the requisite power and authority; or a central board of experts might be appointed for the same purpose, but with wider jurisdiction; or each county might have a board for itself. Any man can plan out a scheme for it, but I think no man will maintain that there is any insuperable difficulty in devising means that will answer the purpose.

Before leaving this point, let me remind the meeting that the plan of excluding for a year a particular crop from the cultivation of a district will apply to almost every crop that we grow, whenever the insect is an annual (that is, does not live over one year), and this includes by far the greater number of injurious insects.

The next means of extirpation to which I shall advert is burning the nidus in which the insect, in whatever stage, passes the winter, and I may take as my example the species of a small fly belonging to the genus *Chlorops*, which specially attacks barley, although it also sometimes attacks wheat,

rye, etc. The larva makes a channel in the stem of the ear, causing abortion of the pickles, and gives it a stripped-looking appearance (as shown in the diagram), which, on a superficial examination, might be taken for the work of sparrows. The fly remains about the ear for many weeks after it is thrashed, and may be found in great numbers in winter in a semi-torpid state among the chaff. Now, is it not an intolerable abuse of the privilege of doing what a man likes with his own, that my neighbor should be allowed, for the sake of the small profit he can make out of his chaff heap, to preserve such a focus of infection to destroy my future crops? He should be compelled to burn it. In like manner we want some one to compel the burning of the heaps of couch-grass and weeds gathered from foul land, instead of keeping them to rot into manure. These are the focus and shelter-places of wire-worms and other pests, and contribute largely to their spread.

To the same class of remedies belongs the local treatment which I recommended for the onion fly. The plants attacked are readily distinguishable from those that have escaped—the former are sickly, flaccid, and yellow, the latter firm, erect, and green—and those attacked can easily be picked out and burned. Each plant attacked contains a nest of larvæ in the stem or bulb, as shown in the diagram. If these are destroyed the whole future family are annihilated. The carrot plants attacked by the carrot fly are equally easily distinguished and destroyed—but it is not certain that the grubs in them always keep to the same root. But both with them and similarly destructive insects that infest the cabbage and turnip, a year's avoidance of that crop throughout the district will relieve it from them.

Now comes the remedy, in the shape of some application that is fatal to the insects. This is the plan adopted in America for the destruction of the Colorado beetle, where Paris green is dusted in powder or sprinkled in solution over the larvæ on the potato plants. It is the plan used by our horticulturists to get rid of the red spider in their hot-houses, where sulphur is the medium. Manufactured into Gishurst compound, or made up into some soapy solution, sulphur is also largely used by them to destroy green fly. Sulphur has also been successfully used on a small scale against the hop fly, and might be advantageously used on a large scale. There are various other supposed specifics (such as hellebore for the gooseberry caterpillar, etc.) which are more or less in favor with different individuals. As a remedy, however, such applications seem better adapted for individual protection than combined stamping out, although it would be foolish to forego the advantage of using them where they seem to meet the requirements of any special case. Such a case most certainly is the destruction of what are called ticks and lice upon sheep. Every one knows how readily such vermin can be communicated by contact or even proximity, and it does seem a very hard case that a man, who has kept his flock clean by taking proper precautions, should be liable to have them infected by a neighboring neglected flock, by stray sheep, or even by sheep passing along the road. I have no personal knowledge on the subject, but I am told that, *ceteris paribus*, the difference in value between a sheep that has been kept clean for the season and one that has been worried by vermin will be 20s. If that is so, I wonder that sheep farmers have not long since clamored for some supervision.

The picking and gathering of the individual caterpillars, or perfect insects, is a remedy that has been tried largely on the Continent, but without any marked success. For ordinary crops it is much more clumsy than a change in the rotation, and for crops which cannot be so dropped out of rotation, as fruit or forest trees, it is almost impossible to collect the larvæ efficiently. At the same time it is right to add that this *échenillage*, or caterpillar collecting, can scarcely be said to have ever (any more than any other plan) had a fair trial, it having been generally conducted without regular system or combined and simultaneous action over a wide extent of country.

There remains the last refuge of all invaded countries, namely, destroying the resources of the country before the invaders, that they may perish for want of food. This can rarely be necessary, but beyond doubt it will be the proper course to follow should the Colorado beetle gain a footing in this country. In that event, the first that we shall hear of it will be that the larva has appeared in some potato patch near Cork or Londonderry, Liverpool, or Glasgow. The instant this is perceived, the vines of the potato field should be cut to the ground, and Paris green scattered over the field.

But this is not a course that can be adopted, even in a case of such urgency and importance, unless there is some central motive power having the necessary authority to act; for the notice that the Colorado beetle will give will be very short. The larval stage, in which alone it can be successfully encountered, only lasts about a fortnight, and, if no previous preparations have been made, I leave any one who knows the slow grinding of our administrative mills to say what chance there is of the larva having grown big enough to be noticed; of somebody having noticed it and reported it; of the report being considered and a course of action resolved on; of officers or agents being appointed to act; of their providing the necessary apparatus; and of their reaching the spot and putting them in operation—all within the short space of fourteen days.

I have nearly exhausted the list of my suggestions, but there is one which I must not forget. It is very small, but, in my view, very important. If you erect a great pump, with costly steam engine and machinery, and omit to put in a fang, all your pains and expense will be abortive for want of a little bit of leather. So here: power may be given to the Privy Council; you may have your committees and officers all ready to work as soon as an insect appears; but they may sit expectant and useless from one year's end to the other, unless some one comes and tells them that the insect has appeared, and where it is. They are exactly in the same position as the firemen and fire engines of our fire brigades. There they are at every station, horses, men, engines, fire escapes, and everything ready to start at a moment's notice, but of what good would all this readiness be if no one came to call them? and if they left it to chance, or to the owner of the house on fire, they might never be called until it was too late. What they do is not to trust to that, but to offer a reward to the first person that brings news of a fire. It is only a trifle that they give, but it answers the purpose. Let us follow their example by all means, call on the cultivator to give notice as soon as an injurious insect appears in any numbers on his farm; but do not trust to him. Promise a reward to the first person who shall communicate the intelligence of such a pest appearing. There are more entomologists scattered about the country than you think of. It may be that you would have some erroneous and some false reports, but proper precautions against deception could be taken. Specimens of the insects might be required to be

forwarded; and even although some deception and cheaterly did take place, it could be endured. The fire brigade does not cease to offer its reward for first notice, although some incendiaries have set places on fire for no other purpose than to claim it.

The above are suggestions relating to the machinery by which the extirpation of injurious insects might be effected. There remains another point which, supposing you to go in the main along with me, must also be considered, and that is, what the action of this Conference should be in regard thereto. If I might offer an opinion, it humbly appears to me that its office is rather to give a general verdict upon the importance of the subject and the practicability of dealing with it than to enter into the discussion of details which should more properly be left to the Government, who will be responsible for them should they resolve to deal with the subject. I have had to enter into details for the purpose of making my meaning clear to you, but I hope I have not committed myself to anything beyond general principles. On these I own that my opinions are very decided. I believe that no one has any adequate conception of the amount of loss that agriculturists suffer every year from insects. I cannot give any statistics on the subject because there are none. But although I can give you no statistics, we have the evidence of our own eyes for the existence of a vast amount of preventable loss. I know that it has been said that any attempt to control insect damage is visionary and unworkable. To some men everything that is troublesome or difficult is impracticable. But I am speaking to men whose boast and character it is not to make difficulties but to conquer them, and it is for them to say whether there is anything in the views I have had the honor to lay before them that is either visionary or unworkable.

ON GROUND-AIR IN ITS HYGIENIC RELATIONS.*

By DR. MAX VON PETTENKOFER, Professor of Hygiene in the University of Munich.

THE air in the ground has been somewhat a stranger to our minds; the terms air and earth, just like air and water, implied to our minds things contrary, and exclusive of each other. The earth seemed to have its limit where the air began. Common sense seems inclined to believe that there can be no air in that whereon we walk and stand. If we say of the surface of the earth that it is the limit of the earth and the beginning of the atmosphere, we are not correct in reference to the latter. The air begins much below the ground, and we ought to say that where the ground, which is a mixture of earth, water, and air, ends, from there the atmosphere exists alone. It is no wonder that no particular attention was paid to the air in the soil; its presence there does not make any direct impression on any of our senses; we infer its presence more from

FIG. 1.

other experiences and consequent conclusions. The human mind formerly looked upon the air as something unsubstantial, spiritual, although men saw the effect of hurricanes; no wonder, then, that no one thought of the air hidden in the ground, which cannot even blow the hat from our head.

We again meet here with the fact that, originally, only that calls forth ideas which impresses our senses directly. No one doubts that water penetrates the soil, and moves there according to hydrostatic laws, because we see it run, vanish into the soil, collect and run out again, or we pump it up; but hitherto not many have clearly understood that the whole surface of the earth, as far as it is porous and its pores are not filled with water, contains air, which is also subject to aerostatic laws. And why so? One feels nothing of that air: it is always calm, it has no color, no smell, no taste, in fact we take it for nothing. I have shown you already how great an error we commit when we suppose a calm air to be motionless. This applies just as much to the air in the soil, which, if its motion were even snail-like, would still travel from a good depth to the surface in one day.

Perhaps I shall succeed in giving you a better idea of the change of the air in the ground than of that in walls. To have a correct idea of that air and its relations, we must know, in the first instance, its quantity in proportion to the different kinds of soil. Let us first take rubble-soil, gravel, or sand, which support the largest and heaviest edifices. Here is a bottle which holds exactly one litre (1 $\frac{1}{10}$ pint) up to that mark on its neck. I have filled it slowly with gravel,

shaking it all the while, so that the gravel settled completely. The gravel reaches up to the mark. This high cylinder contains just one litre of water, and is graduated into one hundred parts. Now I pour the water into the gravel, till I find it just coming up to its surface, and I see that of the water in the cylinder thirty-five parts have entered the gravel and driven out the air, which before had therefore taken up thirty-five per cent. of the whole mass. This is certainly a great quantity of air, and if we build a house on such a ground its weight rests, no doubt, on the gravel alone, and not on the air; but for all that, this ground, as far as it is dry, consists to the extent of one-third of air. In building on gravel, we build as well on air, just as we build on water when we build on piles driven into a swampy soil and cut off under the water. We know well that a house standing on piles stands with its foot in water, that this water is drawn up by the walls till beyond the water-mark, that the water of the ground has a good deal to do with the house; why should we, then, refuse to acknowledge that the foot of a house built on dry gravel, stands also on the air, and that the air in the ground is in intimate relation with the house?

What I have shown you in regard to gravel, can, in a similar way, be proved in regard to sand, clay, and even more solid stony and rocky soils.

Most kinds of sandstones are nearly as porous as loose sand. The rock of Malta has been proved by Leath Adams to suck up water on an average to one-third of its volume; consequently, when dry it must contain air to the same extent. One would not think that this was the case with the rugged cliffs and shores of that remarkable island, which look as if they were built from the granite of the Swiss Alps. Most buildings in Malta are built with this Maltese rock, which is much used also throughout Italy. It is not less porous than the Berlin sands; their penetrability for air and water is the same, but the grains of the Maltese rock are connected by some solid medium, while the grains of the sand are loose. In respect to their porosity they stand relatively as frozen and not frozen soil.

Many ships of the English navy have filters made of a certain kind of Maltese rock. I have tested one, and I have found that the filtering basin swallows forty-seven per cent. of its whole contents, when used for the first time.

A soil whose pores are filled partly by air and partly by water is called damp. It can take up more water till all its pores are filled with it, when all passage of air is stopped, just as we have seen with regard to the mortar of the house. That degree of humidity of the soil is called *ground-water*; it begins at the lowest limit of the air in the soil.

It is well known that water becomes solid at a temperature below freezing point. In becoming ice it changes its consistence totally, but its volume not very much, increasing it by about six per cent., one hundred volumes of water becoming one hundred and six of ice. In a frozen soil, there must have been a certain quantity of water. This water in freezing has become a kind of cement for the particles of the soil, and gives it a solidity which the liquid water could not impart. Although such frozen soil is as hard to work as stone, we have no right to assume that it is impermeable to air or gases of any kind.

Those pores of the soil which were free from water cannot be narrowed much by the expansion of the neighboring pores through the freezing of their water. It would be just as incorrect to deny the permeability to air of the frozen soil as that of the Maltese rock. Still, the most erroneous views have been formed on this subject, even by men distinguished in other branches of science.

Having given you an idea of the quantity of air in a porous soil, I have to give you a correct idea of the mobility of this air and of its change, and I shall try to do this in a roundabout way, as I cannot do it by direct impression on your senses.

There are things of whose existence we become only aware when they are absent. Probably the fish is as little aware of the water he lives in as we of the air, till he finds himself on the dry land. The creatures living in the air know nothing of its oxygen, but, when we place them in an atmosphere which has none or too little of it, or too much carbonic acid, they will feel and behave like the fish out of water. There is a difference in a want of oxygen between different animals; birds want a good deal proportionately. A canary bird takes about one and a third cubic inch of oxygen from the air in one hour. In one litre of air there are about thirteen cubic inches of oxygen, which the bird would have consumed in ten hours. But he would be dead long before, as he could not live in an air deprived of one half of its oxygen. The bird in this glass cylinder has been shut up between gravel for the last ten hours, and you see he is quite well. The cylinder is shut at its lower end by a wire netting, on which a stratum of gravel rests. The bird stands on the gravel, and above him there is another wire netting, which supports a stratum of gravel. The free space for the bird contains about one litre of air.

This bird is shut up in the same way as workmen sometimes are, digging at a well or at some kind of shaft. If accident does not kill them at once, they seldom die from want of air, even if it takes some days to dig them out, although man's consumption of oxygen is about a thousand times as great as that of the canary bird. Some years ago, in Saxony, two men who were shut up in the shaft of a well for ten days kept alive and were not much the worse for it when they came out again. I may mention here that the celebrated Fraunhofer, when still apprenticed to a glazier at Munich, was buried for several days under the ruins of his master's house, which had fallen in.

I expect Fraunhofer's luck will be shared by this bird, whom I intend removing to-morrow to his old cage.

You cannot longer have any doubt about the motion of the air through gravel; but I want to convince your senses; I want you to see the motion of the air, and to see that motion take place through a much thicker stratum of gravel than the strata shutting in the bird.

You see this high glass cylinder (Fig. 2), with a smaller glass tube inside, open at both ends. The cylinder is filled with gravel, and the glass tube connected with a manometer by some india-rubber tubing. As soon as I blow gently on the upper surface of the gravel, you see the liquid in the manometer moving. The motion of the air which I produce acts in the first instance on the surface of the gravel, propagates itself through the same to the bottom of the cylinder, enters the lower end of the tube, rises through it and through the tubing into the manometer, where it presses on the column of liquid, and sets it in motion.

Why does the liquid move in the manometer? Because the air, after the migration just described, presses with greater weight on the surface of the column it arrives at than the outer air on the surface of the other column. If there were no liquid in the manometer, the moved air would finally flow out of the manometer, and, as you see, now that I have emptied the manometer, nearly blow out this candle.

In this way I believe that I have convinced your senses that the air can move through porous soils.

If the air in the ground can be set in motion by the pressure of air or wind against its surface, there can be no doubt that the same can be effected by differences of temperature, and by diffusion, and generally by all causes which can produce movement of gases. As long as the air in the ground is of a different temperature or composition from the free atmosphere, there must be exchange and motion. I

FIG. 2.

will only, in order to leave no doubt on your mind, direct your attention to several well known facts, which can only be explained by the change of the ground-air.

All Christian nations bury their dead in the earth, to give back to dust what came from dust. There are burial grounds in which a corpse decays completely in six to seven years, and others in which it takes twenty-five to thirty years. The regulations about a second occupation of a ground depend on this difference, and therefore towns with an equal population may be obliged to have burial grounds of very different sizes. There are other circumstances of some influence on the process of decay, but the principal one is the amount of, and the facility for, the change of the air in the soil. Rubble and sandy soils do the work much quicker than marl and clay soils. Striking experiences in this respect have been made on the French battle fields, chiefly near Sedan, where a Belgian chemist, Louis Creteur, had to disinfect the large dead pits. The bodies were buried in chalk, quarry, rubble, sand, argillite, slate, marl, or clay soils, and the sad work lasted from the beginning of March to the end of June. In rubble the decay had taken place fully, but in clay the bodies were surprisingly well kept, even after a very long time, and even the features could be identified.

As the processes of putrefaction and decay are intimately connected with the activity of certain lower organisms, which prey upon the dead, it is sufficiently clear that these organisms must thrive differently in different kinds of soil. A lively change of air and water in the ground appears to be of great influence in this respect; the more air in the ground the richer the underground life.

Remarkable testimony as to the permeability of the ground, and of the foundations of our houses, has been given by gas emanations into houses which had no gas laid on. I know cases where persons were poisoned and killed by gas which had to travel for twenty feet under the street, and then through the foundations, cellar vaults, and flooring of the ground-floor rooms. As these kinds of accidents happened only in winter, they have been brought forward as a proof that the frozen soil did not allow the gas to escape straight upward, but drove it into the house. I have told you already why I take the frozen soil to be not more air-tight than when not frozen. In such cases the penetration of gas into the houses is facilitated by the current in the ground-air caused by the house. The house, being warmer inside than the external air, acts like a heated chimney on its surroundings, and chiefly on the ground upon which it stands, and the air therein, which we will call the ground-air. The warm air in the chimney is pressed into and up the chimney by the cold air surrounding the same. The chimney cannot act without heat, and the heat is only the means of disturbing the equilibrium of the columns of air inside and outside the chimney. The warm air inside is lighter than the cold air outside; and this being so, the former must float upward through the chimney, just like oil in water. It continues to do so long as fresh cold air comes into its neighborhood from outside. As soon as we interrupt this arrival, the draught into the chimney is at an end. Any other way of looking at the action of chimneys leads to erroneous views, which have many times stopped the progress of the art of heating and ventilating.

Thus our heated houses ventilate themselves not only through the walls but also through the ground on which the house stands. If there is any gas or other smelling substance in the surrounding ground-air, they will enter the current of this ventilation. I have witnessed a case in Munich, where not the least smell of gas could be detected in the street, but a great quantity of gas found its way into the ground-floor room of a house where no gas was laid on. In another case the gas always penetrated into the best heated room and produced an illness of its inmates, which were taken with typhoid fever.

The movement of gas through the ground into the house may give us warning that the ground-air is in continual intercourse with our houses, and may become the introducer of many kinds of lodgers. These lodgers may either be found out, or cause injury at once, like gas; or they may, without betraying their presence in any way, become enemies, or associate themselves with other injurious elements, and increase their activity. The evil resulting therefrom

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