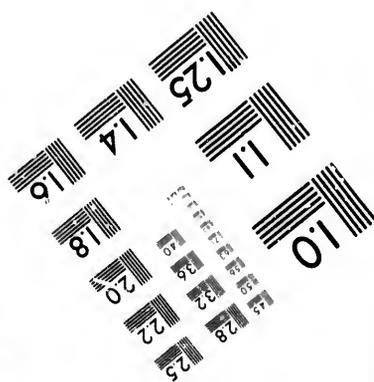
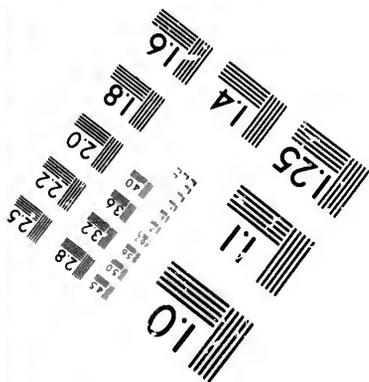
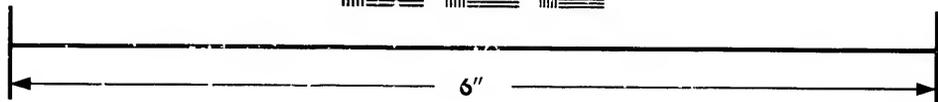
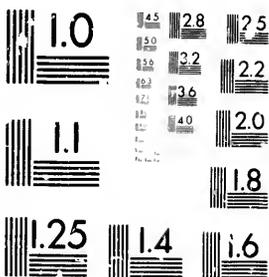


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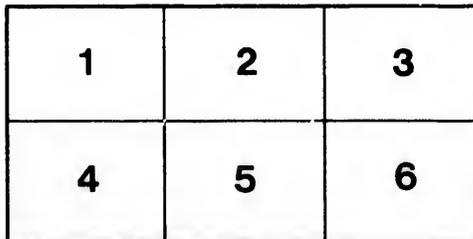
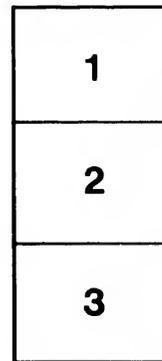
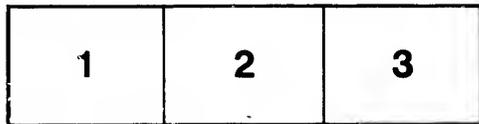
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THE

Colorado Potato Beetle

(*Chrysomela Decemlineata*)

AND

HOW TO OPPOSE ITS RAVAGES

BY

J. C. TACHÉ.

TRANSLATED FROM THE FRENCH

BY

DOUGLAS BRYMNER.

1880.



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Colorado Notata Heelle

How ... ITS RAVAGES

J. C. TACHE.

TRANSLATED FROM THE FRENCH

BY

NICHOLAS BROWNER.



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TRANSLATOR'S PREFACE.

The pamphlet published by Mr. J. C. TACHÉ, Deputy of the Minister of Agriculture, with the title "La Mouche, ou la Chrysomèle des Patates," is the only work that supplies, in small compass and in accessible form, the fullest information on the subject of the pest known as the Colorado Potato Beetle. The investigations into the habits of the insect have been very carefully conducted, and I may add that the results agree with my own observations.

The pamphlet has been so well received in the original, that it has been thought desirable to reproduce it in English so as to give it a still wider circulation than it has had. The translation is published with the sanction of the author, by whom it has been read over and approved.

DOUGLAS BRYMNER.

OTTAWA, CANADA, July, 1880.

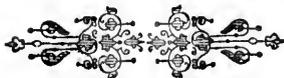


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I am not aware of any complete monograph of the ten-lined Chrysomel. The largest work on the subject appears to be that published by Mr. Charles V. Riley of St. Louis, Missouri, in November 1876, entitled: "Potato Pests; being an illustrated account of the Colorado Potato Beetle and the other insect foes of the potato in North America." New York, Orange Judd Company, 245 Broadway.

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The numerous reports and almost innumerable articles published in the United States on the subject of the Potato Beetle are chiefly to be found in special reviews, agricultural journals, in the reports of the Department of Agriculture at Washington, and in the reports published by the Agricultural Associations in the different States of the Union. Of these, I restrict myself to the mention of the following:—

The correspondence of Mr. J. Egerton in "The Prairie Farmer," in 1861.

A paper by Mr. Benjamin D. Walsh in "The Practical Entomologist," in 1865.

A paper by Dr. Shimer in "The Practical Entomologist," in 1866.

The report of Professor A. J. Cook in the thirteenth report of the State Board of Agriculture of the State of Michigan, 1874-1875.

The report of the experiments by Mr. W. McMurtrie in the monthly reports of the Department of Agriculture, Washington, for May and June, 1875.

In Canada there have been published, among others:

"Report of an enquiry on the Colorado Potato Beetle," by Messrs. William Saunders and Edward Baynes Reed, Toronto, 1871. It is reproduced in "The Canadian Entomologist," volume III, 1871. Different articles by the Abbé Provencher in "Le Naturaliste Canadien."

In Europe, the scourge has attracted and is attracting more attention every day. Fortunately, there has been there no opportunity yet to study, on a large scale, either the habits or ravages

of the beetle. Attention has been chiefly directed to the dangers arising from the importation of the insect in its various stages, and to the most effectual means to prevent its introduction.

The insect having recently made its appearance on the banks of the Rhine, the German Government had the potato plants and insects in the infested field destroyed by petroleum and fire. There have been produced by a Cologne firm, the Messrs. Stollwerck, small boxes containing *fac similes* in coloured plaster of the beetle, its eggs, larvæ and nymphæ, for distribution through the country, and instructions have been given to destroy the insect, wherever and in whatever form it may make its appearance.

THE POTATO BEETLE.

I.

INTRODUCTION.

In Canada there is at this moment no question affecting agriculture and domestic economy demanding more careful study for its solution than that forced upon us by the presence in our fields of the destructive insect known by the vulgar name of the "Potato Bug."

This small work is the result of studies carried on for a considerable time, which I have lately completed by means of observations and experiments, either made alone or in common with friends whose crops have afforded opportunities for conducting investigations.

Few persons have formed a just idea of the importance of the potato crop in the agricultural production of northern countries, and of the rank it occupies among the alimentary resources of mankind, the true value of which can be brought home to us only by its failure. So far as regards Canada, neither the imminence nor the extent of the damage which threatens our potato fields can be exaggerated. By the last census, we learn that the annual product of this crop amounted, in the Provinces of Ontario, Quebec, Nova Scotia and New Brunswick, to nearly 48,000,000 bushels, and the comparison of the figures contained in the censuses of 1851, 1861 and 1871 demonstrates the growing favour (a favour due to necessity) towards this article of food, whose whole produce must now have reached the total of about 60,000,000 bushels for the whole Confederation.

Hence it is easy to imagine the consequences to the country of the ravages of the insect in question if it were allowed to multiply in the ratio of the number which can be produced by its appalling fecundity.

The following pages treat of the natural history of the insect and the history of its migrations; but the essential part is that

which is devoted to the practical question of the cultivation of the potato under the conditions introduced by the invasion of this scourge—that is, by taking the insect into account and fighting against it with the imperative obligation of conquering it and of securing a crop in spite of its attacks. The technical part, less generally understood than the other, is yet as necessary for the perfect understanding of the subject, on the part of those who should direct the common efforts.

It must not be forgotten that in the case of the potato beetle, as with the wheat and other flies, it is not the perfect insect, but the larva, which is most destructive to plants.

The accompanying plate is intended not only to facilitate the study, but also, and especially, to enable those who do not yet know them to recognise at first sight, and to distinguish from all others, the insect, the eggs and the larvæ, which must be destroyed always and everywhere. The plate represents, nearly of the natural size and colour, leaves of the potatoes attacked by the beetle, and the insect in its different stages and under its different aspects, as follows:—*a*, a group of eggs; *b*, the larvæ after having been a few days hatched, they are then of a general chestnut brown colour; *c*, the larva increased in size; *d*, the larva completely developed and prepared to bury itself in the ground to undergo its transformations; *e*, pupa formed in the earth, it is of a chrome orange colour; *f*, side view of the perfect insect; *g*, back view of the perfect insect; *h*, ventral view of the perfect insect. The general colour of the insect, with the exception of the wing-sheaths (*elytra*), as indicated, is of a clear brown, marked with black bands, spots and points; the wings, hidden by the sheaths, are of a beautiful rose colour, having transparent pale ash-coloured extremities.

II.

NATURAL HISTORY OF THE POTATO BEETLE.

The potato beetle is called by American authors, and by most writers after them, *Doryphora decemlineata*, although this insect does not belong to the order *doryphora*, a name originated by Illiger and adopted by all entomologists. The characteristic of this order is the presence on the breast of a spine—whence the name *doryphora* (spear-bearer)—a character entirely wanting in the potato beetle, although it has been generally attributed to it

on the strength of this unfortunate nomenclature. At one time in the United States it was called the "ten-lined spearman," and even yet American entomologists seem desirous to retain this name, doubtless to avoid a change, as the reasons they give for retaining it are scarcely even specious.

Count Dejean, the celebrated historian of the Coléoptera, has classed this insect with the sub-tribe of *Polygramma* of Chevrolat, giving it the distinctive name *decemlineata*. (*) I will here adopt what seems the more appropriate name of *Chrysomela desemlineata*.

The potato beetle, ten-lined Chrysomel, belongs to the order of the Coleoptera, class Tetramera, family Cyclica, tribe Chrysomelida. The perfect insect is of ovoid shape, less than half an inch long (see plate, letters *f* and *g*), ten to eleven millimetres, when it is contracted, but is larger when, in action, it has the head and prothorax disengaged and elevated; its breadth is from seven to eight millimetres (about three-tenths of an inch), and height about six millimetres (quarter of an inch). The female assumes larger proportions in the abdominal region when the receptacle is full of eggs. The head is small, oval, sunk in the corselet; it is of a more or less clear brown, bordered with black, and marked with a triangular black spot in the centre of the forehead. The prothorax is wider than its length, arched, of the same colour as the head, marked with black points and by two vertical lines on each side and in the immediate neighbourhood of the median line; the dorsal part of the rest of the thoracic region, concealed under the wing-sheaths, or elytra, is black; the flanks and sternal region are of a clear brown, marked with black; the abdomen is of a clear brown, striped with black lines, transversely to the centre, and marked with black points on the sides. The antennæ are not nearly so long as the body (four millimetres), moniliform, and inserted near the mouth.

The legs are of a clear brown, with black joints and extremities. The wing-sheaths are very hard; yellow outside, white within, and marked with five fine black lines on each sheath (see plate, letters *f* and *g*); two of these lines occupy the two edges of each sheath; of the three others, in the centre, the second and third always, but sometimes all three, are joined behind. The wings, larger than the body (thirteen to fourteen millimetres), are of a brilliant rose colour from their insertion to a little beyond the foldings.

The potato chrysomel appears to be monogamous. The female is larger than the male and is distinguished by the greater development of the abdominal part; when she is loaded with eggs the distended part always encroaches on the wing-sheaths and shows on the edge of the latter like a yellowish-brown border,

(*) *Catalogue des Coléoptères*, Paris, 1837, page 421.

which enables her to be distinguished from the male at some distance; becoming more distended, the abdomen forms a sack below the wing-sheaths. The general character of the structure and organization of the insect are those of its order and tribe. Neither the larvæ nor the perfect insects have hairs; all the integuments are of extraordinary solidity.

The eggs are deposited in rows and by groups, of which the number most frequently ranges from ten to forty; but groups have often been observed of all degrees of numerical value. In the course of numerous experiments which I have made with insects kept separate, I have seen groups of all numbers, from a deposit composed of a single egg, up to one of 112 eggs, laid without quitting the spot, by a female kept in close seclusion.

The eggs are usually deposited on the lower side of the potato leaf, but sometimes also upon the stalk, or on the upper side of the leaf; on other plants, and occasionally even on other objects. It is curious to witness the work of laying. The egg, which swims in a yellowish liquid in the receptacle, is pushed against the object to which it is to adhere, preceded by a little drop of the liquid; it is held in this position for at least a minute, often much longer, according to the humidity of the surrounding air, to be completely expelled by an upward movement, only when the dessication of the glutinous liquid by which it is firmly fixed has taken place. The eggs are small, oblong, sharpened at the ends, of a fine orange color, and glossy from the protecting varnish which covers them; they are about a millimetre and a half in length and are very slender. The receptacle of a pregnant female, when much distended, can contain at one time a large number of eggs in different states of development, and, as the observations adverted to above have demonstrated to me, certainly more than a hundred, all perfectly developed, besides those which are in progress. These cases, however, must be rare, for in the numerous dissections I have made, I have never found more than sixty-five eggs which had arrived at their perfect growth at one time.

The larva when hatched is little more than a millimetre long, having its head and feet black, and with two black rings on the first segments; the rest of the body is of a dark red; it is furnished with six feet, is very vigorous and moves with ease. In a few days it grows to the size of a large bug, to which it bears a resemblance, at a distance, at this stage of existence. In the process of development, the larva passes through red, brilliant rose colour (plate, letter *c*) to a colour approaching orange, which it assumes at the time of burying itself in the ground to undergo its transformations. During its whole existence, the head, legs and above-mentioned rings of the larva are black; it is plainly

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marked with two rows of black points on the sides (plate, letter *d*); these points are found under the abdomen of the perfect insect, with the exception of the row which has disappeared or become transformed. The larva always retains the ovoid form, is fairly active, and travels, when necessary, from one field to another. At the time of burying itself, it has grown nearly to the size of the perfect insect, and always retains a repulsive appearance, in spite of its brilliant colours. The pupa calls for no particular notice (plate, letter *e*); it is of a dingy orange colour.

They mate at intervals whilst the laying of eggs continues, a period of about thirty days for each female. The total number laid is from 500 to 1,000 (some observers have reported the laying of 1,110 by one beetle). (*) Three generations of perfect insects succeed each other every year in our latitudes, and during the fine season the laying for the species is subject to no interruption. It follows that the first generation deposits eggs until the first-born of the second generation begin to reproduce in turn, the first generation producing eggs daily for more than forty days, and the two other generations for a longer period.

The insect begins to lay about ten days after leaving the ground; hatching is completed from six to seven days after the eggs are laid; in from fifteen to twenty days the larvæ become completely developed and bury themselves to undergo their metamorphoses; they remain in the earth from ten to fifteen days, with the exception of the last brood, of which the larvæ, the pupæ and the perfect insect remain, in our climate, in the ground in a state of hibernation during the whole of the rigorous season. So that from the mating of the parents to the time of leaving the ground, the full growth of the insect occupies, in Canada, forty-one days at the least, and fifty-two days at the most, or from thirty-one to forty-two days, dating from the laying in the summer season. Messrs. Saunders and Reed, who, in 1871, made an enquiry on behalf of the Province of Ontario, say "Each female deposits from 700 to 1,000 eggs, and these attain to the perfect beetle state within fifty days." (†)

On leaving the ground, some time during the month of May—earlier or later, according to the season, and some much later than others,—they seek the potato in pairs. Usually mating takes place when the plant is sending out its first leaves. Before beginning to propagate they appear generally to wait the presence of their favourite food, the stimulus of which has carried their fecundity to the frightful degree from which we now suffer.

(*) Professor A. J. Cook, *Report of Board of Agriculture of the State of Michigan for 1874*, published in 1875, page 107.

(†) *Canadian Entomologist*, London, Ont., Vol. III, page 43.

In its perfect state, the potato beetle is abstemious, except for a few days after leaving the ground—the mischief it commits is often unnoticed by careless observers—but the larvæ are very voracious; the field left to them is doomed to destruction. The perfect insect and the larvæ further damage the plant by soiling the stalks and leaves with their ordure and their disgusting excretions. The perfect insect passes from one field to another, to great distances and in a short time, by a jerking but powerful flight. When it displays its rose-coloured wings, raises its variegated wing-cases, and shows the beautiful brown and black tints of its body glittering in the sun, the insect presents a fine appearance. In flight and descent, the wing-cases seem to act as sails and parachutes. It is chiefly in spring and at the period of the great heats that its flight is powerful and prolonged. When the period of laying is over, the potato beetle abandons the cultivated fields; it wanders everywhere, crawling along, or attaching itself to all sorts of vehicles, enjoying the sunshine a little longer, then seeking a grave in which to die. At no period of its life does the insect seem to seek escape from the hand stretched out to grasp it, but, gathering itself together, motionless, it simulates death.

Every year in our climate three generations of the perfect insect lay each a brood of eggs, consequently three generations of larvæ succeed each other. It must not be forgotten, however, that the products of the eggs of the third generation of perfect insects are to issue from the ground only next spring. I believe, without wishing to speak positively, that this fact is due rather to an organic law of the insect than to climate.

Professor C. V. Riley, Entomologist of the State of Missouri, and President of the Entomological Commission of the United States, affirms that the perfect insect buries itself in the ground for the purpose of hibernating, after having left it and lived in the open air. He says: "The Colorado potato beetle hibernates in the perfect state, beneath the surface of the ground, or under any rubbish or other shelter that it can find. It has been exhumed from depths varying from a few inches to several feet, though its habit is not to burrow deeper than ten inches." Elsewhere, Mr. Riley adds: "The whole cycle of transformation from the egg to the perfect beetle, rarely requires more than a month, and the last brood of beetles issues from the ground early in the fall, and, as we have just seen, enters it again to pass the winter." (*) It is with reluctance I am compelled to cast doubts on the correctness of the latter statement; but I believe that the

(*) *Potato Pests*, by Charles V. Riley, M.A., Ph.D., &c., New York 1877, Orange Judd & Co., pages 28 and 29.

perfect insects which are found at any depth in the ground have never enjoyed life in the open air.

So far as regards Canada as a whole, the following is a general calendar of the order and time in which the beetle appears and during which it remains each year :—

Successive generations.	Time of the presence of the perfect insect of each generation.	Periods of laying of each generation.	Period of the presence in the ground of each generation of the larvæ of the year.
1	May, June.	May, June.	June, July.
2	June, July, August.	June, July, August.	July, August, September.
3	July, August, September, October.	July, August, September, October.	August, September, to the month of May following.

The perfect insect leaves the ground in Canada some time in May, according to localities and seasons. From this time till October it is constantly seen in the fields, the second and third generations making their appearance before the total extinction of the first and second. It is especially at the end of the season that the remainder of the year's phalanxes are scattered everywhere, even in towns, clambering on every kind of land or water conveyance, trusting themselves even to the currents of rivers and streams, and not much inclined at this time to make use of their wings. It is probable that they then seize the last hours of pleasure before they seek the shelter of the grave, are near the hour of their natural death, and, therefore, incapable of doing mischief. But this I dare not possibly affirm. The safest course is to continue the war of extermination even at this period of their lives.

One fact of some importance, added to others observed by myself, has just confirmed the idea I had formed as to the last stage in the life of the potato beetle, the examinations which I made by dissection having apparently shown me the presence, at this erratic period, of a progressive atrophy of the abdominal organs of the insect. The fact in question was communicated to

me by Mr. Kingsford, an Engineer in the Public Works, on the 20th of last June, that is the time when the Chrysomels of the first days of May (the season had been very early) had arrived at the last period of their existence. The plank-walk of a wharf at Cobourg Harbour, in the Province of Ontario, had been raised for repairs; when the operation had been completed, the overseers of the work were astonished at seeing on the loading stones of the wharf an enormous number of potato beetles; thousands, in rows about an inch from each other, covered a considerable space, and were living although apparently in a torpid state. A day or two after, the insects had disappeared, having, no doubt, gone to look for a new cemetery in some neighboring retreat.

The first of the eggs are seen under the leaves in May, earlier or later, according to the season and the forwardness of vegetation, and continue to show themselves till the end of the season, so long as the leaves keep green.

The larvæ appear for the first time in the course of the last fortnight of May, sooner or later, according to locality and season, and remain constantly thereafter till October, or so long as the leaves continue.

The period of laying and the life of each individual lasts for only a certain number of weeks; for the species, it lasts uninterruptedly during the whole of the open season. For about seven months, from October till May, neither eggs, larvæ nor perfect insects are seen in the fields; during these months the soil affords shelter to the larvæ and to the two products of their metamorphoses. The only time in the year during which the ground contains neither larva nor pupa nor perfect living insect is a longer or shorter period in May and June, according to locality and season. All then existing are in the open air.

The vitality of the potato beetle, in all stages, is astonishing; it resists scorching heat, storm and cold, and survives under conditions which, it would seem, must cause its death in a few hours. The autumn larva, as we have seen, buries itself in the ground, penetrating, before the frost, to considerable depths, whence it issues a perfect insect, after remaining in the earth for seven or eight months, according to locality and season, in the North American regions.

We are confronted, in this insect, with a phenomenon of fecundity which I believe to be without a parallel. In spite of its natural enemies of the animal kingdom, in spite of the war of destruction carried on by man, this insect, which has so recently become known, has, in less than twenty years, covered with its legions over a million and a quarter square miles, which it occupies to such a degree that the slightest neglect, in any place whatever over this vast extent, is followed in the same year by

the more or less complete loss of the potato crop thus left to the ravages of the insect; for all the eggs which are not destroyed by an enemy of some kind, except those of the latter part of the season, seem to produce with certainty a perfect insect, whatever, generally speaking, be the atmospheric vicissitudes.

Counting for one female the partially successful hatching of 500 eggs of her brood, there would be, as the product of about twenty days' laying in the month of May, 225 females for the months of June and July, of which each can produce 500 eggs, or 225 females for July and August, of which each would produce 500 larvæ, or 225 females for hybernation in the ground. A single female, or a single pair of the month of May, is capable, then, of leaving in the soil in autumn, for the following year, upwards of eleven millions of couples (11,000,000); more than twenty-two million descendants (22,000,000) of both sexes. It must be remembered that there are myriads of them on each mile of country invaded, endowed with such powers of multiplication, and that, notwithstanding, war properly conducted always succeeds, unfailingly succeeds, in saving the crops, and this under economical conditions which do not unduly detract from the value of the return from the potato crop; in fact, the expense and care would be almost insignificant if all proprietors of fields and gardens would faithfully discharge their duty in this regard.

In the course of about thirty days, each female lays daily. Hence the last eggs are much later than the first, and thus it happens that the first beetles give three generations of larvæ, whilst only two are produced by the majority of the eggs of the later beetles, the last comers of the succession being destroyed by the rigour of the season.

It is worth noticing, what I have observed several times during my experiments, that, when placed under conditions of food or situation absolutely repugnant to it, the potato beetle, as a species, partly destroys its own eggs. It also eats its own larvæ for want of other food. A larva and four pupæ, dug up with three perfect insects ready to leave the ground, were put together by themselves in a close box, free from interference and without food. At the end of three days the beetles were seen in the act of devouring the last remains of the pupæ and of the larva, on which they had fed themselves during the whole time of their confinement.

III.

HISTORY OF THE MIGRATIONS OF THE POTATO BEETLE.

The potato beetle appears to have been first observed by the American naturalist, Thomas Say, in 1823, in the course of the exploration of the Western and Rocky Mountain regions, the chief of the surveying party being Engineer, afterwards Colonel, Long, and to which Mr. Say was attached as naturalist. Say gave it the incorrect name of *Doryphora*, adding to it the designation of *decemlineata*. (*)

The insect lived in the place of its origin, on the slopes of the Rocky Mountains of Colorado and on the prairies, on wild plants, especially attacking a wild potato (*Solanum Rostratum*), and, according to all that was known of its early history, found on none of these plants the nourishment and stimulus suited to communicate to it the degree of vitality and of extraordinary fecundity which it has attained since it has found the cultivated potato.

The ten-lined Chrysomel appears to have attracted no attention except from entomologists, occupied with the preparation of catalogues of insects, until about the year 1859, a date which American writers distinguish as that of its first great ravages in the potato fields of Nebraska. This would warrant us in going back to about the year 1355 as the starting point of its march of invasion eastward. Now, as it reached the shores of the Atlantic Ocean in 1874, it follows that its innumerable legions have crossed the whole American continent from the Rocky Mountains as far as the sea, State of New Jersey, about 1,700 statute miles in a straight line, in less than twenty years, establishing every year permanent colonies in every point of the distance traversed. The annual mean of the distance cleared during the whole period of this migration, has been, as is evident, nearly ninety miles; the minimum occurs at the first of the invasion and appears to have been about fifty miles, the maximum of progress has reached two hundred miles in a year. In Canada the advance of the potato beetle has been almost the same as in the United States, since having made its appearance in the Province of Ontario in 1870, it has now, in 1877, reached the district of Quebec, having traversed a mean distance of about eighty miles a year in a straight line.

I give an analysis from American authors, and especially from Mr. Riley's "Potato Pests," already quoted, of the history of the march of this scourge through the States of the American

(*) *Journal of the Academy of Natural Sciences of Philadelphia*, Vol. III, quoted by Mr. Riley.

Republic. It has been shown that in 1859 the beetle had invaded a great part of the State of Nebraska; in 1861 it entered Iowa; in 1865 it penetrated into the State of Illinois, and then, hastening its march, the scourge spread consecutively into Indiana, Ohio, in 1870, Pennsylvania, the northern part of the State of New Jersey and the southern part of the State of New York, to the Atlantic, which it reached in 1874. The line which I have just described, included between the 40° and 42° parallels of latitude, was the line of most rapid march of the legions of the potato beetle from 1855 to 1874, from the time of its setting out from the Rocky Mountains till it reached the ocean. At the same time, however, lagging sometimes a longer, sometimes a shorter time behind the centre, the left and right wings of this army successively occupied, to the north of the indicated line, the States of Wyoming, Dakotah, Minnesota, Wisconsin, Michigan, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire and part of Maine; to the south of the same line, the States of Colorado, Kansas, Missouri, the southern parts of Illinois and Indiana, Kentucky, Tennessee, the south of Ohio, the two Virginias, Maryland, Delaware, and the southern part of New Jersey.

The portions of the territory of the Canadian Confederation into which the beetle has penetrated (I speak of large bodies), are the whole Province of Ontario and the western part of the Province of Quebec, as far as the city of Quebec and its environs.

The presence of solitary individuals in any locality may occur several years before the real invasion of the scourge. A certain number of perfect insects may even make their appearance during the fine season without leaving descendants. This happens from these precursors having been carried there at that period of their existence between their last deposit of eggs and their death; that period which continues for a few days or a few weeks only for each individual, but which in our climate lasts from June to October for the species.

IV.

QUESTIONS RAISED BY THE PRESENCE OF THE BEETLE.

The potato beetle colonises and spreads, but never loses a foothold. Once established in a spot, it remains there permanently, sending out every year, in every direction, swarms of

settlers. It is usually on the third year of its appearance in numbers, in any place whatever, that it may be considered as having definitely taken possession of the country; then the question of its multiplication depends on the vigour of the war carried on against it by man. Left to itself, the Chysomel would completely destroy the potato fields of the invaded territory. As it lives on other plants, and is thus preserved as a species, a potato famine affecting the population would not be the extinction of this enemy of the precious crop. Up to what point this state of things might be modified, or become modified, no one can tell, but such is now the problem for our solution.

The ten-lined Chysomel finds on the cultivated potato alone the abundance and quality of food, together with the stimulus by which it acquires all the degree of strength and fecundity of which it is capable. It is also the cultivated potato on which the insect prefers to deposit its eggs. But it feeds on a great number of plants, notably on the thistle, and deposits its eggs, not only on these plants, but sometimes even on fences and other objects. The plants of the *Solanum* family seem, however, to constitute the vegetable family at whose expense, in our regions, the ten-lined Chysomel prefers to feed. Among the cultivated plants of this family which it has been observed to attack in the United States are the tomato and tobacco.

The question has been and is still discussed, whether the potato beetle is poisonous to man when the liquid parts of the insect are applied to, or rubbed on, the skin, or on denuded surfaces, or when the emanations of the insect enter the air passages. Those who have made experiments say yes and no. The examination of their different testimonies leads me to believe that, as a general rule, there is not the least danger from the emanations of the insect, any more than in bringing the sound skin in contact with the insect or its products and liquid parts. It appears to be proved, however, that accidents have taken place from having put masses of matter, remains of insects, in contact with sores or excoriations, or from having incautiously breathed the exhalations from the boiling or burning of large numbers of insects. It may be seen, therefore, that the danger, if danger there be, is scarcely from the insect itself, and can only happen from extreme carelessness or from disgusting slovenliness.

The ten-lined Chysomel has, among insects, reptiles, birds and even among the smaller quadrupeds, a large number of enemies; certain insects attack the eggs of the Chysomel, others the larva, others the perfect insect, but as hitherto these enemies have had little appreciable effect upon the intensity and extent of the scourge, I will dispense with speaking of them, referring those who desire detailed information on this part of the subject

to the works of naturalists. Attempts have been made to induce poultry to feed on the potato beetle; the reports as to the results differ, but once more the great fact of the multiplication and migration by myriads of the devastating insects in spite of these means, in addition to the infinitely more active measure of destruction by poison, demonstrates that the first alone have not been able till now to constitute, in any appreciable measure, a barrier to the devastation of the potato beetle.

The ravages of the beetle have affected, and still affect, both the quality and quantity of the products every time the cultivator relaxes in the employment of the means of fighting against them. For a time, when the methods for the destruction of the insect had not yet been reduced to a system, and when people contented themselves with little besides hand-picking, the price of potatoes rose in the Western States to \$2 and upwards a bushel.

The quality of the produce suffers as much as the quantity from the damage committed by the beetle on the stalks and leaves of the potatoes. I lately visited farms on which, for many years up till last year, large quantities of potatoes of the finest quality had been grown. The beetle had attacked the fields on these farms, and, although the scourge had been fought against with such energy as to prevent the quantity from being greatly lessened, but not enough to free the plants completely from the ravages of the insect, the result was that, all other conditions remaining the same, there were produced during these two years only potatoes of a very inferior quality. This fact, which is readily conceivable, has been constantly observed in the United States.

Apart from the slight help which the natural enemies of the insect may afford to the population, there is the most urgent necessity to use in respect to it the means which a hard experience has taught those who first and every subsequent year since, have been the victims of this plague. Let us repeat again, most positively, that every attempt to employ other methods has been fruitless, and that the false confidence inspired by illusory expedients and the time lost in their application have been invariably followed by disastrous results.

V.

ONLY EFFECTUAL METHOD OF FIGHTING THE ENEMY.

The only sure means of fighting the insect, and these only completely successful when employed with perseverance and without relaxation, are the gathering and destruction of the per-

fect insect. the crushing of the eggs and especially the use of arsenite or copper (Paris green) for the larvæ, the latter of which succeeds of itself, and is the only one which is unfailing. Undoubtedly any means whatever besides these, which would accomplish the destruction and death of the insect at all stages and degrees of growth, without hurting the plant, would be efficacious, provided that it suited the purse and available labour of the farmer; but innumerable attempts of every imaginable kind of remedies have been made for more than fifteen years, by hundreds of thousands of persons, superintended by scientific men, and practically tested on a large scale but without success. With such results, is it not deplorable to find expedients, often of the most absurd kind, and quack preparations, recommended even in agricultural journals? Is it not painful to see the press raising objections and exciting prejudices, a hundred times met and refuted, against the only remedy which has been found efficacious against a plague which Europe views with dread at a distance, instead of seeking to gain approval for the methods now practised and firmly established in places where the same objections and the same prejudices have, under the lash of necessity, been compelled to yield to reason?

Before entering on details, I will quote some American authorities, in which will be found summarized the conclusions of several years' experience and the application of scientific prescriptions, by the use of which alone can the potato be cultivated in the United States in sufficient quantity, of good quality and at a reasonable price.

"In conclusion," says Mr. Riley, "while no one denies the danger attending the careless use of Paris green, and all who have recommended its use have not hesitated to caution against such carelessness, a careful enquiry into the facts from the experimental side bears out the results of a long and extensive experience among the farmers of the country, *viz*: that there is no present or future danger from its judicious use, in the diluted form, whether as liquid or powder, in which it is now universally recommended. It is in this as in so many other things, a proper use of the poison has proved, and will prove in future, a great blessing to the country where its abuse can only be followed by evil consequences. Poison is only a relative term, and that which is most virulent in large quantities is oftentimes harmless or even beneficial to animal economy in smaller amounts. I would, therefore, say to those agriculturists of the East who are in any way alarmed by what has been written on this subject, and who hesitate to use the Paris green mixture, profit by the experience of your more Western brethren, and do not allow the voracious

Doryphora to destroy your potatoes when so simple and cheap a remedy is at hand." (*)

In their report to the Commissioner of Agriculture for Ontario, Messrs. Saunders and Reed, after having said that their experiments on Paris green, when used for the destruction of the potato beetle, confirm the opinion expressed by experts in the United States, and, after recommending its use to Canadian farmers, say: "As this mixture is of a poisonous character, ordinary care should be used in handling it, to avoid inhaling much of the dust when applying it, to wash the hands after each application, to keep it out of the reach of children and to exclude live stock of all kinds from fields where the poison is used.

"With these precautions, no danger need be apprehended; it does not injure the leaves to any appreciable extent unless very heavily applied, and cannot possibly affect the potato itself. We make these remarks because we have met with several individuals who entertain a foolish prejudice against the use of this mixture, for fear that it might injure the potatoes." (†)

One of the leading agricultural journals in the United States, published in the Capital of the State of New York, has every year, for several years back, given prominent place in its columns to articles and communications regarding the potato beetle. On different occasions it has refuted the arguments against the use of Paris green, and invariably speaks in favour of the use of this substance in all its answers to enquiries on the subject. It opened the campaign, in the year 1876, with the following words: "Farmers are advised to have a supply of Paris green on hand, and fight them (the beetles) in earnest as soon as they begin their depredations." (‡)

The Commissioner of Agriculture at Washington, reporting on the crops in different parts of the United States, for 1876, has frequently, in the course of his report on potatoes, such remarks as this: "Good crop where the beetle has been fought with Paris green."

VI.

ANSWERS TO OBJECTIONS.

The objections to the use of Paris green, which the quotations given in the preceding chapter answer by anticipation, are, in brief: 1. That there is a social danger incurred by the fact of

(*) *Potato Pests*, pages 74, 75.

(†) *Report of an Inquiry*. Toronto, 1871, page 8.

(‡) *The Cultivator and Country Gentleman*, Albany, N.Y., Vol. XLI, page 169.

the practice of putting a virulent poison into the hands of everybody, so to speak. 2. That the plants must absorb poison, and, consequently, become poisonous. 3. That the soil itself will become saturated with poison, to the detriment of plants, of man and of animals.

In answer to the first objection, I may say that it is, no doubt, painful to recommend the general use of a poisonous substance; in fact, it would be improper to do so were it only on a question of minor importance; but when it affects, neither more nor less, public prosperity, and the comfort or misery of whole communities, it then becomes a necessity to which, willingly or unwillingly, we must, sooner or later, submit. If sooner, with direct and immediate advantage; if later, then only after having been subjected to wretchedness, suffering and irreparable loss.

Besides, if there is the danger of thus putting poison into the hands of everyone, it is not the only poison; generally accessible; there are several whose use is universal. Was not this very Paris green, before the discovery of its being the best, in fact the only efficacious means of fighting the beetle, in general use as a paint? It could be purchased by anyone anywhere.

To maintain that a thing is dangerous when it is improperly used, does not mean that its legitimate use is to be forbidden. More accidents happen, a hundred-fold, from the use of illuminating gas and of chemical matches, than happen during the same length of time and in the same places by the use of Paris green. Does it enter into the mind of anyone to propose to stop the use of gas and matches, under the pretext that the one may asphyxiate and the other poison man and beast, and that both may set houses on fire? To ask is to answer the question.

I notice here a statement which has been copied by the Canadian press from an obscure paper in the United States, to wit: That since Paris green has been used in Western fields, new and incurable diseases have originated amongst the inhabitants, and so forth! It is only necessary to say that there is not a shadow of truth in the statement, which has been regarded by the journals and reviews in the constant habit of discussing such subjects, as too absurd to be mentioned.

To answer the question forced on the consideration of the farmers and proprietors of the West, and afterwards on those of the East, which have been stated above, namely: Can the arsenite of copper (*Paris green*) be absorbed by the plants, so as to render them dangerous as an article of food; and can the continued use of Paris green affect the composition of the soil to such an extent as to injure the growth of the plants? Mr. McMurtrie, Chemist of the Department of Agriculture at Washington, entered on a series of experiments, which are the more conclusive as they agree

with and confirm the correctness of experiments made elsewhere. Besides, these results were anticipated by the already ascertained fact, that, on soil of volcanic origin, the presence of arsenious poisons, in moderate quantity, does no harm.

The results of Mr. McMurtrie's experiments, the details of which may be found in the *Monthly Reports* published at Washington, (*) prove incontrovertibly: 1. That plants cultivated in soil largely mixed with Paris green contained not a particle of Paris green or its components in their substance; 2. That the quantity of Paris green in the soil required to begin the work of deterioration in the vegetable growth is such that the use of Paris green in the quantities necessary to protect the crops from the beetle might be continued for ages in the same field without any appreciable effect, on the impossible supposition that the total mass of the poison would remain intact all the time; in other words, that there is not the shadow of such a danger.

Mr. McMurtrie found that to produce the slightest sensible effect, it would be necessary to add to each cubic foot of arable soil 145 grains of Paris green; or, in other terms, upwards of 900 pounds per acre. Now, the employment of Paris green against insects, even in excessive doses, would not cause such an accumulation in the soil, even supposing such accumulation possible, in four centuries. If it is objected, as has been done, that it is not on the depth of a foot of earth that the calculation must be based, but on the superficial depth of about six inches stirred by cultivation, I answer: even then, two hundred years must elapse before a sensible effect would be reached. But as the potato is not cultivated in the same field for centuries, and as Paris green cannot accumulate in the soil without modification of its active principles, it follows that such terrors are childish.

Again, as to the dangers incurred by the ordinary employment of Paris green in cultivation, it should be understood that these are the same as arise from the employment of any poison, or of any dangerous substance or agent whatever, in the arts or in the ordinary business of life. These are avoided by the exercise of prudence. So far as regards Paris green, the precautions which are sufficient to prevent accidents are as simple as they are efficacious. These consist in putting the substance in a place known to all the members of the family and out of the reach of children; in having it packed away so that it can neither be attacked nor dragged about by animals; using vessels and utensils for this and for no other purpose; in allowing of no carelessness in this respect; in preventing the cattle from getting into the fields where the poison is used. In a word, in applying in this matter all the

(*) *Monthly Reports of the Department of Agriculture, Washington, May and June, 1875, pages 231, onwards.*

rules prescribed by prudence and charity, and in conforming to the laws regulating the sale and use of dangerous materials.

There is, no doubt, danger in employing a virulent poison, and the general use of substances of this kind should not be recommended except in cases in which it is demanded by great interests. But there never was a more vital interest to warrant the advice to employ poison than is the case in the present instance.

The accidents in the United States which have been reported, and which are very few, have, in each case, been the result of carelessness or of gross imprudence, and there are thousands of tons of Paris green made use of in the United States. I repeat, thousands of tons of Paris green have been employed against the potato beetle for fifteen years in the United States, and no inconvenience of a general nature has arisen from its employment (although at the beginning the quantity used was excessive); no deterioration in the potato, nor in the other plants seen in the same fields has been manifested. The very small number of accidents caused by the direct application of the poison to excoriations or wounds, or by its introduction into the stomach or lungs, by ingestion or inhalation, either among men or animals, have been invariably the result of imprudence, as already remarked, or of malice—two causes of evil which produce their effects in any state of things, and prove nothing whatever against an article, the use of which is necessitated by circumstances.

It is proved that the prudent employment of Paris green is absolutely free from danger; it is equally proved that the application of Paris green may become a necessity, wherever the devastating insect has penetrated. The experience of nearly the fifth of a century in the United States is the demonstration of the practical truth, that Paris green is the only known effectual remedy, and that the farm culture of the potato can only be conducted profitably, in countries invaded by the beetle, on condition of using Paris green.

I might quote hundreds of testimonies to this truth, given by scientific men, agriculturists and farmers. I content myself with quoting a few, which embody them all. Mr. Riley, in the book already mentioned, says at page 69: "Indeed, scarcely any potatoes have been raised in the Middle States during these years without its use."

A report made by a Committee of the House of Representatives of the State of Ohio, gives, as its conclusion on the subject, the opinion of the Hon. Mr. Richmond, its reporter, and an extensive western farmer. He says: "My experience has convinced me that, while the Colorado beetle can be controlled the first two years by knocking them off by hand, the third year they

became so numerous on my farm that I had to resort to Paris green. In fact, I am satisfied, at any time when they become numerous, Paris green is the cheapest and best method we have for their destruction."(*)

Professor A. J. Cook, of the Agricultural College of the State of Michigan, in a paper on insects injurious to agriculture, speaking of the potato beetle, says: "Inasmuch as Paris green is so practical, so efficient and so cheap a remedy for this pest, I shall in this place do what every farmer had better do on his farm, ignore all other means, such as hand-picking, machinery, etc., as too expensive and not sufficiently thorough. With a little care, Paris green is entirely safe." (†)

I can confirm all these evidences by proof from my own observation, having, during the several seasons, followed the results of the employment of Paris green in the fields surrounding the Capital of the Canadian Confederation, and especially in the fields of Mr. Lowe, Secretary of the Department of Agriculture, my collaborator, and who has now thoroughly mastered the art of employing Paris green. I have been able to compare the results of different methods and the result of the neglect of any means.

By infinite care and great labour, hand-picking may be successful in the defence of a small field, but when the insect appears in force, small as is the field, the cultivator is soon compelled to capitulate. It is unnecessary to say that neglect, pure and simple, is followed by total loss. It is with Paris green, and with Paris green alone, that at the present moment the beetle can be kept in subjugation, and that it is possible to obtain by ordinary cultivation, a full crop of potatoes and any crop of good quality, at little additional expense for culture. Of course I speak of localities and fields invaded by the beetle. This caution is not unnecessary, for, in following the history of this scourge across the continent, it may be noticed that many people have raised a false argument from facts observed by themselves, in localities and fields in which the beetle had begun to make its appearance. All these illusions and the mistaken practices engendered by them are not long in receiving their contradiction. Therefore, I say to our farmers: Pray, do not you pay for an experience which others have bought at so dear a rate, but which you have at your disposal free of charge.

(*) *Ohio Agricultural Reports for 1871*, second series, Columbus, 1872, page 544.

(†) *Thirteenth report of the Board of Agriculture of the State of Michigan* Lansing, 1875, page 108.

VII.

GENERAL CONSIDERATIONS.

The importance of the question which forms the subject of this work cannot be too strongly insisted on, and I feel the necessity of returning to this point, from having seen the culpable indifference shown by many of the owners of potato fields in the vicinity of the Federal Capital. Neglected fields have not only had their crops of potatoes either deteriorated or destroyed, but, which is a much more serious matter, they have served as hot-beds, whence issue millions of the insects, to scatter over all the neighboring fields and to proceed to more distant localities to propagate the plague.

Those who cannot, or who will not defend their fields in an adequate manner against such an enemy, should not cultivate the potato. That is in their own interest and is only a matter of justice, since otherwise they spread the pest to the injury of others without benefit to themselves.

The farmers of Quebec, with few exceptions, have not yet had seriously to enter on the struggle. The insect has only begun to make its appearance, and so far has invaded only a portion of the fields in the Western part of the Province. But already it has been seen at work, and has, this year, settled on a comparatively large extent of country. From this moment war must be waged without relaxation on the second generation which is now actively at work, and on the third which will follow. The subject must still be carefully studied, so that next spring no measure may be neglected.

European States have so far understood the importance of the subject as to have become, and to remain, alarmed at the prospect, although they are, as a rule, less interested in potato culture than we are, and have the ocean as a barrier against the invasion of the beetle. The most energetic measures have been taken or determined on, to prevent the anticipated dangers of its importation. When an individual of the species brought on board ship by accident, is seen anywhere, warning is at once given and the most minute search is made to discover if it may not have been accompanied by others.

During the first years of the appearance of the potato beetle in any locality whatever, it was the cause of all varieties of opinion. People would scarcely believe the reports of its ravages elsewhere. They frequently fancied that they had discovered new methods of getting rid of it without trouble, without expense, and so forth. That often happened because the insect not being known, a mistake arose as to its identity, or because the

individuals observed were in the stage following the period of reproduction; or again, because there was only an insignificant swarm to deal with. It is not many years before these illusions are dissipated; but they have in the meantime produced deplorable effects, for the truce has given the enemy time to multiply.

Errors again occur in consequence of exceptional facts, whose causes cannot be ascertained—facts for which imaginary causes are assigned, on which are based theories which the vulgar, as is their habit, accept in preference to the results of sound reason and experience.

Quackery, on its side, has not missed so fair an opportunity of speculating on public credulity, so inexhaustible in its nature, with marvellous and non-poisonous *powders*, which were offered by hundreds, loads of them having been sold through the country. On the other hand, respectable, well-intentioned, but deluded men, recommended means in whose favour they secured adherents. In this way I have recently seen the newspapers recommend a mixture, the uselessness of which a friend and I ascertained when acting in concert. This compound, when brought into contact with the insect, killed it; but when employed in practical agriculture, it was either useless or pernicious. Potato plants which we treated with this substance were destroyed when it was abundantly used, or remained a prey to the beetle after its more moderate application. Setting aside its being so poor a remedy, subject to still further objections, the expenses of the requisite hand labour in applying it would be sufficient to dictate the abandonment of its use.

It should be understood that the discovery of a substance capable of killing the insect, gradually or instantaneously, is not the discovery of a practical means of fighting the potato beetle. There are hundreds of substances possessing this property, but which do not meet all the multiplied conditions of a problem like that before us, and which Paris green alone has solved, after thousands and thousands of fruitless researches, conducted by scientific men and by agriculturists, with a commission to make enquiries, and the qualifications necessary for the proper conduct of the investigation. It is not merely an insecticide, pure and simple, which is necessary; it is the establishment of a method of practical agriculture which demands the employment of an insecticide capable of remaining effective, and of lending itself to the other conditions of the problem.

Picking machines, insect gatherers and other mechanical contrivances for taking the crop of beetles and larvæ from the potato plants have been tried; but, in the end, these are not worth the trouble and expense, and the enemy thus attacked is always the conqueror.

There remain as the only practical means, the hand-picking of the perfect insect and larvæ, the crushing of the eggs on the leaves and the employment of Paris green.

The hand-picking of the perfect insect on its first appearance in spring, and the crushing of the eggs on the young plants, also in spring, are proceedings which are commendable, and which should be carefully attended to during the first weeks of the sprouting of the potatoes, in May and at the beginning of June. But when the larvæ have begun to make their appearance in numbers, and when the potatoes have many leaves, there is then only the one means to employ, which, fortunately, has of itself been sufficient always and everywhere, and that is Paris green, the only agent capable of making head against a real attack of the beetle, whatever be the extent of the field.

One of my friends having some leisure time had in the neighbourhood of Ottawa a small field of about half an acre of potatoes, which he attended to every day, clearing it, by the process of picking, of the beetles and larvæ which had attacked it. He often congratulated himself on being able by this means to protect his fine potatoes, when one day he came to me, saying: "I can keep them out no longer; the place is overrun, and my field is terribly damaged already." "The remedy is easy," I said, "use Paris green." "You assure me there is no danger?" "Not a shadow, provided you are satisfied to give the green only to the potatoes and to the insects on them." He went off with the Paris green, and saved his crop. I have now the pleasure of numbering him among the most zealous advocates of the true method, and he has already done a great deal of good in his own neighbourhood.

VIII.

ARSENITE OF COPPER AND ITS APPLICATION.

The arsenite of copper is in the form of an impalpable powder of the most beautiful green, very heavy, and adhering persistently to objects on which it falls. It is insoluble, or nearly so, in water. From its tenuity it colours relatively enormous quantities of water in which it is held in suspension, or of flour with which it is often incorporated to be used against the potato beetle. It is known to be a virulent poison, which acts in extremely minute doses.

The arsenite of copper, or Paris green, like almost every other article of general commerce, is usually adulterated and its effects consequently diminished, in the ratio of the nature and amount of the adulteration.

On the demand of the Minister of Agriculture, the analyst of the Federal Government received orders from the Minister of Internal Revenue to examine the Paris green offered for sale in different parts of the country. Dr. LaRue, Professor in Laval University; Mr. J. B. Edwards, of Montreal, and Mr. W. H. Ellis, Professor in Trinity College, Toronto, analysed samples purchased in different places in the Provinces of Ontario and Quebec. The result was that of 44 samples tested only 14 were found to be pure. The most common adulteration was the addition of sulphate of baryta, or the after introduction of an excess of white arsenic into the Paris green. The quantitative analysis of these frauds amounted, in one sample, to upwards of thirty-three per cent. of the mass, constituting a diminution in the value at least equal to that proportion. One of the samples analysed was not even Paris green, but a mixture composed of white arsenic, sulphate of copper, sulphate of iron, alum and a vegetable powder, the whole forming a drug quite as poisonous as Paris green, for man and beast, but in no respect suited for the use for which it was sold.

It is to be hoped that the authorities and commercial firms themselves will be on the watch to put a stop to such proceedings. As the names of the sellers and the results of the analyses are published in the official reports, I think it right to state, in justice, that many of these frauds were not committed by the sellers, but by the furnishers of the article. I am personally aware of the honourable character of several of the firms named in that list, and I have been a witness to the indignation of one of these merchants on learning that he had been furnished with, and made to sell, a fraudulent article. Once warned, it is the duty of every man to satisfy himself of the value of what he offers to public sale.

It is proper here to repeat the notices as to the sale and use of this poison, the cost of which now forms an essential part of the expense incurred in the cultivation of the potato. The packages containing Paris green should be ticketed in a particular manner, giving warning as to the poisonous nature of the contents. Great care should be observed in keeping Paris green out of the reach of children, and in taking every precaution to prevent animals from obtaining access to the place in which it is kept, to the utensils used or to the fields in which it is employed. Paris green must be used as an insecticide upon no plants except the potato—the exceptions to this rule are of too delicate an

application for the general public. The utensils which have been employed in the distribution of Paris green must be used for no other purpose, in any manner or at any time, for particles of this substance persistently adhere to wooden or tin vessels, brooms, etc., so employed. Care must be taken not to inhale the poison, and not to allow it to come in contact with skin affected with cracks, chaps, cuts or wounds of any kind. All other precautions, also, which care and prudence suggest, should be observed.

When the fact has once been recognised that of all known and tried substances the arsenite of copper (Paris green) is the only one which meets all the requirements of the problem to be solved, there remains the systematizing of the process, that is, the method of producing the greatest effect with the smallest expenditure of poison and labour.

The smallest imaginable dose of Paris green is sufficient to destroy the beetle and its larvæ, whether this minimum portion be swallowed by the perfect insect when feeding on the leaves which have been sprinkled or watered, or that it has been absorbed by the larvæ from contact. The death of the insect occurs sooner or later, according to the dose; but, as it is of little, if any, consequence whether the death should occur instantaneously or in a few hours, it follows that with so fine a powder as Paris green the quantity may be very minutely divided; consequently the quantity of poison to be administered may be brought down to very slight doses, thus reducing to the utmost the cost of the article and the carriage to the field of the substances made use of as the vehicle for its distribution. The price of the Paris green (the capital which the farmer must expend), and the labour of distribution are both reduced now to a comparatively small amount, which would be almost insignificant were everyone who possesses a field of potatoes, large or small, to undertake the duty of protecting it. Unfortunately, as I have already said, the negligent abound, and in neglected fields, the insect is produced by millions upon millions.

Extensive and multiplied experiments have proved to me that, by careful application, we may successfully employ doses much smaller than those generally given now, and which are themselves enormously reduced from the quantities first employed in the United States.

There are two methods of applying Paris green: in a dry and in a liquid state. Each of these has its peculiar advantages and disadvantages, and each has its adherents. The advantages of the dry state are, its adhering better to the leaves, and in the absence of heavy rains, its retaining its power for a longer period

the advantages of the liquid state consist of the facility with which it is applied, and the diminution of the danger attending its use.

In using Paris green in the dry state, it is mixed with from twenty to thirty times its volume of ground gypsum, ashes, slack lime, or still better, with flour—the worst as good as the best for this purpose. The more intimately it is mixed the better and more economical will be the result. When Paris green is of superior quality and carefully mixed with finely ground flour, one part of poison to forty of flour is sufficient.

After repeated trials of both modes of application, and notwithstanding the preference expressed by a large number of American authors and practical men for the dry over the wet method, a preference which on their authority I adopted last year, I do not now hesitate to recommend the liquid method as far superior for ordinary and general use to the dry. The diminution of the possible danger, the great ease in its preparation, the simplicity in its application, seem to me to be considerations which cannot be set aside.

In the application by the liquid method, which I think should be generally adopted to the exclusion of any other, a teaspoonful (level, not heaped) is sufficient, that is, about a hundred and ten grains (quarter of an ounce) of Paris green, of superior quality, to an ordinary pail, holding from two to two and a half gallons of water. A pound of Paris green is sufficient, therefore, for sixty-four pails of water, or about 140 gallons. Should the Paris green be of inferior quality, or adulterated, a greater quantity, proportioned to the reduced value, would be necessary.

According to the number of insects, at all stages, appearing on the potatoes, there must be used, for each application per acre, from two to eight pails of water, into each of which has been put a teaspoonful of Paris green. The number of applications vary with the number of insects attacking the field; the owner must be sure to make a fresh application on every renewal of the attack. The rule is, not to suffer the insect to devour and soil the potato plants. It must not be forgotten, either, that heavy rains wash the poison from the leaves.

The following is the mode of application: The Paris green being measured in a spoon, or, which is better, having been previously divided into papers containing the requisite quantity, is put into a pail of water. If the poison has been divided beforehand into papers, the paper, after being simply opened, is thrown into the pail, so that further manipulation is unnecessary. Care must be taken then, and whilst sprinkling it, to stir the mixture, for Paris green, being insoluble, must be kept in a state of suspension, so as to be equally diffused through the water.

Furnished with a small broom, with a handle long enough to prevent the hand from being needlessly thrust into the water, the operator enters the rows of potatoes, carrying the pail in one hand and the broom in the other. Whenever a perfect insect or a larva is observed on the stalks or leaves, the liquid should be stirred up with the broom, which then takes up the water well coloured with green; with it lightly sprinkle the insects and the plants on which they appear; sprinkling right and left the two rows between which the operator is walking. This process is continued till the whole field has been traversed, always taking two rows at once, thus reducing the labour of going over the field by one half, taking care to agitate the liquid every time the broom is charged, and sprinkling the plants and insects on both right and left. (*)

This operation should be performed rapidly but carefully, and be renewed as often as the insect appears. In fields which are very badly attacked, it is often necessary to go over them twice a week, or even three times if there have been rains. The process, as may be seen, is very simple and cheap; anyone may in this way go over and protect several acres during the time which would be scarcely sufficient to hand-pick a single acre, with the further advantage that Paris green effectually clears it, a task which can never be accomplished by hand-picking.

Such is the potato beetle, such the losses with which we are threatened, such the simple and cheap means to fight against the enemy. It is the interest, as it is the duty of all, to take an active part in the measures forced on us by circumstances. Let everyone assist, by word and deed, in a propaganda which affects the most important question, in a material point of view, with which our people have to deal.

In conclusion, we have to do with a dreadful scourge, but yet one which may be kept under control. It is the duty of all those who cultivate the potato—a duty to themselves as well as to others—to have recourse to the most suitable means of attacking

(*) Light pails and brooms should be selected, to lessen the labour and exertion. Ordinary painted pails and small corn brooms, or "whisks," used for brushing clothes (they are all the better of being a little worn) are the most suitable.

Pure Paris green should not cost anywhere, by retail, more than two shillings currency (about forty cents) a pound. As two pounds and a half of pure Paris green is sufficient to protect an acre for a year, it follows that the cost of poison cannot exceed a dollar an acre.

the evil. The methods to be employed are of two kinds: The destruction of the insect by hand-picking, and by the use of Paris green. The first of these, practised unceasingly, is always good, and in certain cases may be effectual; but in farm culture, and when the insect multiplies, it becomes entirely insufficient. The other, Paris green, employed intelligently and perseveringly, unfailingly succeeds, and needs no other help.

The destruction of the insect must in all its stages be continued in autumn, even after the potatoes are no longer exposed to injury, for the larvæ which are not destroyed now will be perfect insects in spring.

