## Original Articles.

# A Review of the Present Situation Regarding Tea Tortrix in Ceylon.

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THE problem that is presented by the Tea Tortrix of Ceylon is, in the present state of our knowledge, one of the most elusive nature. Although Tortrix does not offer so formidable a menace to the tea industry as do the termites that are causing such damage in various parts of the island, it must, nevertheless, be classed as one of the chief pests that the tea planter is called upon to face.

It appears that this year (1926), more than ever, Tortrix has made its presence felt in the tea-growing districts which it usually frequents; Maskeliya, especially, has suffered so universally that scarcely an estate in that district has remained untouched.

One aspect of its attack is especially worthy of note. In the earlier days of this pest, when it first commenced its ravages in Maskeliya, sharp outbreaks occurred in restricted areas; one portion only of an estate would suffer severely, while the rest remained almost untouched. More recently, on the other hand, (I am informed), its tendency has been to produce a milder attack spread over the whole estate (although this year, the attacks have been both wide-spread and severe). It is this tendency that makes the problem of control so much more difficult, for whereas a concentrated attack may, by several different means, be readily subdued without a great deal of difficulty, an attack that is spread over a large area cannot be entirely controlled without considerable demands on labour and supervision.

The mode of infection of estates by the Tortrix moth is certainly a feature of the greatest importance, involving, as it does, the factors of natural habitat, distribution and manner of migration of the moth.

As regards the distribution, it appears from experience that Maskeliya is the chief breeding centre of Tortrix, and there seems little doubt that with the S.W. monsoon the moths migrate in a general North-Easterly direction, infecting Hatton, Dikoya and Dimbula. These districts constitute the main infested areas,

but at the same time, occasional flights of Tortrix are experienced in outlying regions, such as Nanu-oya and Badulla in the N.E.. and Ratnapura in the S.W. It is generally understood that the migration commences at Adam's Peak and follows a definite line in the direction indicated above. But from observation by the writer and others, it seems likely that a great part of the high jungle bounding Maskeliya on the Western side acts as a regular breeding-ground of the moth, as, perhaps, do some of the smaller jungle areas that occur at random in the infested districts.

Supposing this to be the case, it is obvious, at the start, that the idea of altogether exterminating Tortrix is at present out of the question. All that can be done now is to apply measures that will reduce the damage in the infested areas, and protect them as far as possible from the ravages of this pest.

During the last two years, much discussion has arisen regarding the various methods that have been suggested and adopted by planters for the control of this insect. It may at once be said that almost every method put forward has its justification to a certain extent and in certain circumstances, but the mistake has frequently been made of generalising a suggestion that is applicable only to a particular case. It now appears advisable to collect these different suggestions and to review briefly their respective merits and failings, with a view to discovering, if possible, those that show the greatest promise of success in the object for which they were designed.

Provisionally, these suggestions may be divided into two groups:—(1) " Active,"—where the carrying-out of some definite and repeated action is involved. The majority belong to this group.

(2) " Passive,"—where advantage is taken of some natural feature tending to the control of the pest, without necessitating much active co-operation on the part of the planter.

The following comprise the " Active " group:—

**Egg-Mass Collecting.**—This method consists of the collection of all leaves bearing egg-masses, and also embraces, usually, the squashing by hand of attacked and rolled-up leaves, with the object of destroying the caterpillars that are lodged within.

The collection of egg-masses is a mode of control that has for long been practised in entomology (especially in the earlier years, when the science was yet undeveloped), in cases where, owing to the nature of the crop, or to other adverse conditions, remedies such as spraying were impracticable. In the case of Tortrix, egg-mass collecting was one of the first methods to be advocated for the control of this insect after its recording as a pest of tea by E. E. Green in 1889. From that period to the present time, egg collecting has been more generally followed than any other single measure adopted.

Undoubtedly, one of the strongest arguments in favour of this method is its simplicity of execution. It requires little experience to enable one to " spot " an egg-mass, and the act of picking off the leaves and squashing the caterpillars is one that can readily be performed by the average estate coolie. Most people are ready to admit that egg collecting is an easy matter in the case of the milder outbreaks, for, as has often been pointed out, if the work prove too much for the usual coolie gangs to combine with their normal plucking, the children can be turned on at a small cost per head, and they should have little difficulty in coping with the extra work.

The chief arguments against this method are, (1) inability of coolies to recognise and remove the egg-masses, (2) cost, and (3) lack of labour.

Dealing with (1) first,—it is true that frequently leaves are brought in bearing egg-masses that have already hatched (and are therefore useless economically), or that bear no egg-mass at all, but with a little experience and regular training, and payment only for true egg-mass leaves, it should not be a difficult matter to overcome this trouble. In this connection, however, it is necessary to mention the difficulty that may sometimes be experienced by anyone in spotting egg-masses when the bushes are near to pruning and are well covered with foliage. This fact may cause the pluckers to pass over a certain number of masses which will remain as a source of later infection. It has been suggested that collecting should be carried out only on bushes 5-6 months from pruning, which are then in a condition when the egg-masses can be readily observed. But to collect only at such times would be useless, for this would mean that attacks on later bushes would remain unheeded, and for eighteen months (or longer, in a three-year pruning cycle) the pest would be allowed to develop unchecked.

Another fact that must be borne in mind while considering egg-mass collecting is that Tortrix possesses a wide range of different food-plants growing amidst and around the tea; the number of these plants is steadily increasing, and on some of them it breeds quite readily. This increase may be illustrated by the fact that in a short Maskeliya tour the writer was able to nearly double the number of food-plants already recorded.

More serious are the questions of labour and cost. The expense incurred in dealing with mild attacks, by making egg-mass collecting a part of the estate routine, should be, if properly conducted, almost negligible. But when really serious outbreaks occur, a considerable demand is usually made on extra labour, involving additional cost; account must be taken, too, of the call for supervision in counting and weighing the leaves, and in pay-

ment for work done in egg-collecting. Actually, however, the important question here is, not " What is the total cost of egg-collecting?," but " Is the cost involved covered by the saving in yield of leaf?" This question it is impossible to answer definitely, for few records have been compiled from this standpoint, and none affords any conclusive evidence. The difficulty of supplying such proof will be obvious to any one with experience in tea planting. This lack of proof, however, extends almost equally to all the remedies that have been suggested, and must not be regarded as a derogatory feature of the methods to which it applies.

The discussion of egg-mass collecting will be resumed further on.

**Light Traps.**—Placing out, amidst the fields, lamps or other sources of illumination, with the intention of attracting the moths.

This principle is also one which was early advocated against Tortrix, but has now, I believe, been entirely abandoned.

The trap itself usually consisted of a kerosene or acetylene lamp, sometimes provided with a pan containing water and kerosene beneath, so that the moths, in fluttering around, fell into the liquid and were destroyed. Fires have even been utilised as sources of light. Tortrix, being a night loving insect, flies readily to these traps, and by this means large numbers have been captured. At the same time, many moths have been labelled as Tortrix that were quite distinct species. The sex of the captured moths is an important item, for only fertilised females are of value in this respect. One of the chief objections to this method is the liability of attracting not only the local moths, but also others from adjoining estates. The fact that operations have to be conducted at night is, also, a difficulty as regards supervision; again, only still, dark nights are really suitable for the purpose, since the moths fly little by moonlight.

For these reasons the use of light traps is not to be recommended as a control measure.

**Grevillea Leaves.**—It was early discovered that dry Grevillea leaves have a special attraction for Tortrix moths, and this was adapted to the controlling of the pest. Sticks or poles were erected among the tea, about 30 or 40 feet apart. At the top of each was attached a bunch of dry leaves or branches of Grevillea. In these the moths collected at night, presumably to shelter from the falling dew; early each morning, before the dew dispersed, coolies went round with " cooty " sacks, with which they enveloped the leaves, and destroyed the moths within by pressure of the hands or by beating the sacks on the ground.

In earlier days this method was followed by many planters, and large numbers of moths were often attracted and destroyed. A strong objection, however, is that the collecting of the moths must be done entirely in the early morning, so that large areas cannot be dealt with effectively. The practice has, therefore, been discontinued.

**Stripping the Bushes.**—This method consists of stripping off all the buds and flush at the first sign of an attack, so as to catch and demolish the young caterpillars, which are yet on the tender shoots. By the removal of the youngest leaves, which alone are suitable for the development of the recently-hatched caterpillars, the latter are unable to spin up a shelter in which to feed, and thus perish: such is the principle of this method. Finally, the flush is either added to the other leaf in the baskets, or is put aside and burned; this latter process, however, seems unnecessarily wasteful, except where the attack is localised in a small area.

For mild attacks and those concentrated in small areas, stripping would certainly appear to be a useful measure, and outbreaks might frequently be stemmed by prompt action. But the caterpillars develop and increase so rapidly that, in severe or widespread attacks, I do not believe that this method is capable of coping with them.

**Chemical Treatment.**—Little use has been made of insecticides for the purpose of destroying or deterring the Tortrix larvae, due largely, no doubt, to a natural reluctance to apply any chemical substance to the actual foliage of the bush, for fear of tainting the manufactured tea.

For the control of leaf-eating caterpillars of the size of the Tortrix larvae, a substance is employed, dusted or sprayed on to the foliage, with the intention of acting as an internal poison to the insects when feeding on the leaves. These compounds are nearly always arsenical in nature, and as such are barred from use on the tea bush, for obvious reasons. Lead chromate, at one time advocated for Tortrix, is sufficiently cheap to warrant its employment on this score, but it has been proved to be entirely ineffective in destroying the larvae.

Internal poisons being practically prohibited, the question is therefore reduced to one of contact poisons. Insecticides that kill by contact are usually so corrosive in action as to scorch or otherwise damage the foliage to which they are applied. There are, however, certain proprietary compounds, innocuous to the bushes, that have been claimed to be capable of destroying the Tortrix larvae by direct application. But here the question of cost comes in. On account of their high cost proprietary in-

secticides are usually employed, only for the treatment of small areas', and for such purposes they are frequently of great value. Although, therefore, the question of spraying and dusting insecticides has not received much attention, and should certainly be tested out, it is likely that such treatment will be of benefit only as an auxiliary measure.

This discussion of the possible employment of chemicals in Tortrix control would not be complete without the mention of a substance that has come to the fore of recent years, namely, Calcium cyanide, by which the poison is supplied in gaseous form. Preliminary tests on Tortrix have already been carried out in this country by Dr. W. E. Brittain, of Nova Scotia, assisted by the Department of Agriculture. These trials indicated that some difficulty might be experienced in dealing with the larvae, on account of their habit of harbouring inside the webbed-up leaves, which present a considerable barrier to the penetration of the gas. But it is only fair to state that these elementary trials were conducted under conditions that were far from ideal, and with improved apparatus and further experimentation, better results might accrue.

**Parasites and other Natural Enemies.**—Tortrix, like every other insect pest of importance, is subject to the attacks of numerous parasites. In 1918, seven species were recorded,—two egg-parasites, four larval and one pupal parasite. This number is undoubtedly much below the total number that actually attack Tortrix, for in a short preliminary tour in Maskeliya several additional larval parasites were taken by the writer.

As pointed out by N. K. Jardine in 1918, parasites that attack the egg are the most valuable, for they destroy the pest before it has committed any damage whatsoever. But, unfortunately, these are apparently rare. The actual number of eggs in a mass which are attacked by one egg-parasite is probably quite large, for when a single individual (Trichogramma sp.) was captured in Maskeliya, and allowed to oviposit in a Tortrix egg-mass, 35 parasites hatched out, although the conditions were unusually adverse. In addition to these, 19 more were discovered unemerged in the egg-mass, so that at least 25 per cent. of the eggs must have been parasitised by this one insect.

Larval parasites, especially Braconidae and Ichneumonidae, are far more numerous, and in places, it would appear from observations by the writer, they are probably instrumental in suppressing attacks to a certain degree, provided the latter be not severe. This, however, needs confirmation. Perhaps the commonest species amongst the larval parasites is the Ichneumon, *Phytodiaetus capuae*, whose larva lives as an ecto-parasite attached behind the head of the Tortrix caterpillar.

Pupal parasites may be almost disregarded, since they rarely occur; unless abundant, such parasites are of little value, since their attack commences after the caterpillar has finished its full life of damage on the tea.

From the preceding remarks there naturally arises the question, " Can the factor of parasitism be utilised for the control of Tortrix? " This question must, for the present, remain unanswered, for no attempt has so far been made to introduce foreign beneficial insects for this purpose, or to propagate the existing native species. But on so many occasions have insects been successfully utilised in other countries for the purpose of combating various pests, that I consider it advisable that the possibility of this method should be investigated in relation to Tortrix in this island.

The advantages of this mode of control are obvious. Although a good deal of labour, and possibly expense, is necessary in the first place, yet if effective parasites should be established in the country, a great saving in time and money would result, and the minimum of co-operation would be required on the part of the planter. At the same time, it must be fully realised that, just as with the other methods employed, there is little hope of entirely exterminating the Tortrix moth by the use of parasites, for it is an essential feature of parasitism that the parasite can usually exist only on its own particular host (in this case Tortrix), and as the host is gradually killed out, the parasite correspondingly decreases in numbers. Thus no severe pest is ever entirely eradicated by parasitism alone. The actual control of Tortrix by parasites would consist of the appearance of the latter shortly after the commencement of an attack, and the rapid overhauling of the Tortrix pest, with the result of keeping it down to a low level, where its ill-effects would be almost negligible. This is what we might expect if parasites were effectively established in this country.

The chances of propagating the most useful of our native parasites, the egg-attacking species, are, I fear, remote, on account of their scarcity. Attempts would, therefore, have to be made to import foreign egg-parasites. One or two of the indigenous parasites of the Tortrix larva may possibly be worth cultivating. It is a fact, however, that the best results in other countries have been obtained by the use of foreign insects, owing to the many difficulties experienced in attempts to increase the naturally-existing numbers of an indigenous species. As an example of these difficulties, we may mention hyper-parasites, that is, insects that parasitise the parasites. In a week's tour in Maskeliya, while ten species of parasites were taken, seven different hyper-parasites were discovered.

It may be mentioned, incidentally, that there is little hope of obtaining effective parasites from India, since Mr. Andrews, of the Indian Tea Association, stated, not long ago, that although Tea Tortrix was widely distributed throughout North-East India, no parasites had so far been discovered. But that does not, of course, preclude the possibility of discovering a suitable parasite attacking an allied species of moth.

As far as is known, no predatory (as distinct from parasitic) insect has yet been found to attack Tortrix to an extent worth recording.

It is a well-known fact that Tortrix numbers amongst its enemies, not only insects, but bats, lizards, birds and other vertebrate creatures. It has, therefore, been suggested that birds should be utilised for the destruction of the Tortrix caterpillars. This question will be dealt with further on, under the heading of " Bird Encouragement."

The utilisation of the " wilt " disease that is so prevalent amongst the larvae, especially in severe attacks, was discussed in 1918, but I am not aware that any definite work was done in this direction. Although the artificial dissemination of this disease is much to be desired, the chances of success are extremely slight, judging by the negative results obtained from similar attempts in other countries.

**Cultural Treatment.**—The application of manures for the control of Tortrix has been but little followed, though observations have been made on this point by some planters. It would be difficult to prove that definite benefit had been derived from manurial treatment, and no attempts to do so have yielded definite evidence. It has, indeed, been claimed that potash has in some cases produced beneficial results, but the evidence is hardly conclusive; Andrews' experiments on Helopeltis in India appear to argue in favour of potash. Detailed experiments with various manures might throw light on the subject.

**Miscellaneous Measures.**—In addition to the " active " methods already enumerated, various others have, from time to time, been attempted, but with little success.

The use of smoke-screens, presumably with the object of stopping the flight of the moth, possesses so many obvious disadvantages, not the least of which is the effect of wind, that it hardly merits consideration.

Slaked lime has been dusted over the bushes as a destructive, or at least a deterrent, agent to the larvae, but its results, as witnessed recently by the writer, would appear to be absolutely nil.

Beating the bushes, so that the larvae fall to the ground, has more foundation for success. From brief observations that

have been made, it appears that the larvae, when shaken to the ground, lose, for the time being, their sense of direction, and wander about aimlessly, seeking to escape the rays of the sun. They are thus more exposed to the attacks of birds and other predators, but ultimately, one imagines, if they escape these, they arrive beneath the shelter of a tea bush and possibly re-ascend into the foliage. No data, however, are forthcoming with regard to this point. In any case, beating the bushes can only be described as an auxiliary measure.

The use of trap-crops (this is, strictly, a "passive" method) gives little hope, since, of the many food-plants of Tortrix it evidently greatly prefers tea.

The following form what I have termed the "passive" measures of control:—

**Laisser-Faire.**—The principle of leaving Nature to herself, in the hope that natural agencies may in time bring about the suppression of the pest.

The chief foundation for the proposal is the occurrence of " wilt " * disease amongst the caterpillars. It is clear from a little observation, that when attacks are severe, and the caterpillars become abundant and closely crowded, this disease invariably occurs, and is probably one of the chief factors in ultimately suppressing the attack. " Wilt " is greatly assisted by rainfall; damp conditions certainly hasten its effect.

On this account, therefore, it has been stated that it is preferable to leave an attack to itself rather than to apply partial measures of control that will result in merely thinning out the caterpillars, with a consequent strengthening of the stock and resultant increase. This is probably true, and serves to emphasise the fact that control measures must be carried out whole-heartedly. But since there is no evidence to show that on estates where " laisser-faire " has been followed (and this method has been in practice for the last 30 years), the least advantage has been gained, this principle cannot be said to promise success.

One of the arguments put forward in support of the theory is that after an attack a luxuriant output of flush results, which compensates for what is lost through damage to the leaves. This suggestion may be entirely set aside by the reflection that in mild attacks the increase in yield is negligible, and in severe attacks, whereas the increase lasts for one round of plucking only, the damage done may extend to three or four rounds.

**High Shade and Bird Encouragement.**—A great deal of attention, both in discussion and practical endeavour, has been devoted to the use of high shade, in the form of Albizzias, Grevilleas and other estate trees. Considerable difference of

* This term includes, here, the condition described by Jardine as "scour."

opinion exists as to the actual effect of these trees in minimising a Tortrix attack.

Numerous estates have distinct evidence to show that on areas where high shade is closely grown, attacks have almost invariably been less severe than on areas with little or no high shade. So many confirmations of this exist that it would appear that some deterrent effect must be exercised by the presence of the trees. On the other hand, it is certain that this effect is not invariable, for it has frequently happened that the most densely-shaded areas have suffered equally with, if not more than, the unshaded portions of the estate. At the same time, I believe, from personal experience and from the opinions of the planters themselves, that high shade has, usually, a definitely beneficial action in preserving the tea, at least partially, from the attacks of Tea Tortrix. The explanation of this action is another matter, and one that is at present wrapped in uncertainty.

One of the most significant suggestions that have been put forward is that high shade favours the activity of bird life in suppressing the pest, but, although this is probably true, little proof exists of the effectiveness of birds as a controlling factor, and even shaded estates, where birds are highly encouraged, are sometimes severely attacked. The exact relations between bird life and high shade, as affecting Tortrix, have not been discovered, and yet remain to be worked out. At present, all that can be said is that certain species are decidedly more partial than others to a diet of Tortrix larvae; amongst the most useful in this respect are the species of White-eye, the Ceylon Robin, Babblers and Minivets.

One of the most important questions to answer in dealing with high shade is the following:—" Does the shade protect the tea by affording an effective breeding-ground for the insect, or do the trees attract the moths and add to the infestation by increasing the numbers of the pest already on the estate, and forming an additional source of infection ? " There again, I am as yet unable to give a definite reply. However, in answer to the first part of the question, it may be stated that on occasion the shade probably does act as a protection, for from a brief study of various trees, I am able to say unhesitatingly that Tortrix is capable of breeding quite freely in certain species, particularly Albizzias and Acacias. Again, on estates where the tea is lightly infected, an infestation at least equal to that of the tea has been observed in adjacent shade trees. In this connection, it is important to note that Tortrix has been found by the writer breeding readily in Albizzias 40 feet from the ground. By a calculation made from examination of a number of infested shoots, it is evident that the number of Tortrix in various stages (excluding egg-masses) may amount, in the case of a large 50 ft. Albizzia,

to 5,000-10,000. On thickly shaded estates, therefore, considerable quantities of Tortrix, that would otherwise attack the tea, must be confined to the high shade.

On the other hand, in reply to the second part of my question, there is undeniable evidence to show that infestation from the trees can and does occur, for larvae have very frequently been observed, suspended by their silken threads, dropping on to the tea below. But the statement, as I have observed it in print, that the larvae drop down because they are *unable* to develop further in the foliage of the tree, is entirely erroneous in the case of Albizzias and Acacias, at least: this is shown by the fact that in the Albizzias above-mentioned larvae in all stages were discovered webbed-up in the leaves. With Dadaps there is certainly some likelihood of the statement being true.

A tentative explanation of this apparent disparity in the behaviour of Tortrix in high shade is that the insects may breed readily in the trees, provided that climatic or other conditions be suitable, but that when adverse conditions set in, the larvae drop down into the more readily adaptable tea.

An interesting point raised by the examination of the Albizzias is evidence to show that infection on estates may occur through larvae carried by the wind. The nature of this evidence, which requires confirmation, is as yet too early to discuss.

Turning again to the subject of birds,—I have already referred to the proposal that these should be utilised for Tortrix control. With regard to this, it has been suggested that a certain species should be selected and encouraged to feed on Tortrix from infancy; by this means a race might be bred up which would turn to Tortrix as their natural food. But it is necessary to point out here that the elementary laws of heredity indicate that such a happy outcome might not be attained through thousands of generations, if it ever occurred! One of the great difficulties to be faced in the encouragement of birds is, of course, the fact that estate coolies wantonly destroy all nests within reach. Another trouble is the increasing scarcity of natural breeding grounds, through the yearly opening-up of fresh land for tea-growing.

In summing up, I would say that although little explanation of the action of high shade is at present forthcoming, I believe that there is sufficient evidence to show that the encouragement of high shade is a measure to be recommended.

**Flight Breaks.**—By this term is indicated the establishment of belts of trees across the line of flight of the Tortrix moths, so as to impede their flight and offer protection to the tea. Flight breaks were advocated years ago by E. E. Green as a measure to apply on continuous stretches of tea-land open to Tortrix infection, and the scheme was elaborated more recently by N. K. Jardine.

From the beginning it may be said with confidence that flight breaks could never be applied as a general measure; for example, on steep slopes directly facing the line of flight, such belts would have to be almost as numerous as the rows of teas for real benefit to result. Under certain circumstances, however, I believe that flight breaks have a definite value. Few estates have taken up this method of control, and in most cases it is as yet too early to give a definite opinion on the result. In some cases the method has been abandoned for various reasons, but the only estate that has, to my knowledge given the method an extended trial, has been rewarded by marked success, and it seems reasonable to suppose that other estates may benefit in the same way. In this case the tea was allowed to run up for four years in belts two or three rows thick, accompanied by belts of *Acacia decurrens*, which are now gradually replacing the tea. Experiments are being conducted on the same estate with a view to testing species of *Hibiscus* as a possible medium for this purpose. There also appears to be some evidence of the utility in this connection of Boga Medeloa (*Tephrosia candida*).

With regard to the height that flight breaks should be allowed to attain, I do not think that any definite limit can be fixed: this must be ascertained by trial and observation for different cases.

At one time, spraying flight breaks for the destruction of the accumulated larvae was advocated, but this suggestion is open to some comment. The troubles accompanying the spraying of tea would be incurred, with the addition that more powerful, and therefore more unwieldy, apparatus would be required to spray the belts of trees. Again as mentioned before, no substance has yet been established as suitable for dusting or spraying against Tortrix on a large scale: although there would be no fear of tainting, as with tea, in using arsenicals, the usual difficulties with native labour would be encountered.

One of the features of this method that has debarred many planters from adopting it is the fact that 4 or 5 years are necessary for the full effect of the flight breaks to be attained. This is true enough, yet at the same time, if flight breaks prove a success, they will afford a measure of control for future use, and will require little to maintain them.

Finally I would emphasise the fact that flight breaks cannot be applied as a haphazard measure; before their use is attempted, a careful study is necessary for such considerations as the lie of the land in relation to the Tortrix flights and to the prevailing wind.

**Conclusion.**—A study of the methods enumerated above makes it evident that the majority are probably of little or no value as measures of control. The only ones that hold out any

promise of success as general measures are the employment of parasites, egg-mass collecting and the use of high shade, combined perhaps with the encouragement of birds. Flight breaks, although not of general application, might be of value in some cases: stripping and the use of insecticides offer partial control. Manurial treatment is at present an unknown quantity.

Since none of these plans has been proved capable of solving the problem, what obviously remains to be done is the testing-out of the most promising methods in the endeavour to find one that will fulfil the necessary conditions of control. In the meanwhile, it is essential that some definite and organised line of action be adopted during the period necessary for research on this subject.

None of the measures that are now in use is ideal: this, it is hoped, is freely admitted on all sides. But of all these, the only active measures that can at the present juncture be advocated with any degree of confidence, are egg-mass collecting and the allied methods. Other methods may offer greater promise ultimately, but they require more evidence for recommendation, and further study in manner of application.

It has been argued by more than one planter that they have given the system of egg-collecting a thorough trial, without success. But it is possible that such estates as theirs are particularly liable to infection from other quarters, whereas those where collection has proved successful are not exposed to infection to the same extent. Thus in this method one of the main considerations is, in all probability, infection from adjoining estates. And this introduces a factor in egg collecting upon which the greatest emphasis must be laid, namely, the necessity for co-operation. It is extremely likely that the lack of universal co-operation in the past has frequently accounted for the repeated failure of egg-mass collecting on various estates, especially in the Maskeliya district. The reason for this is obvious; no amount of destruction carried out on a given estate will stem the tide of Tortrix if a constant supply is passing over from neighbouring estates where the same endeavour to eradicate is not in progress. Whether or not egg-mass collecting will suffice to deal with Tortrix by reducing its attacks to a negligible quantity, remains to be seen; one thing, however, is certain, that the only fair trial that can be applied to this method is the co-operation of the whole of the infested areas in an united campaign of egg-mass collecting.

I recommend, therefore, that the collection of egg-masses and the squashing of caterpillars should be adopted as part of the routine of the estate, by a special gang if necessary.

Stripping off the young growth on an affected area might be adopted as an auxiliary measure where small areas are attacked, but it should not replace the collection of egg-masses.

At the present time, no other recommendation is possible.

*Note.*—It should be explained that this article was prepared before the publication of Dr. Hutson's notes in the Year Book of the Department of Agriculture for 1927.

## References.

There follows a list of references to the more important publications that have appeared on the subject of Tea Tortrix. Since this insect occurs only as a minor pest in India, little information is to be gained from Indian publications.

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