

THE SCARLET MITES OF THE GENUS
BREVIPALPUS AS PESTS OF TEA IN CEYLON

B. A. Baptist & D. J. W. Ranaweera

All mites belong to the group *Arachnoidea*, which comprises spider-like animals with piercing and sucking mouth parts, which, when full grown possess 4 pairs of legs instead of the 3 pairs of true insects. Mites belonging to the genus *Brevipalpus* have been popularly known as scarlet or orange mites on account of their distinctive, reddish colour. They are all plant-feeding species of minute size and flat, oval form. Several species of these mites have been recorded as causing serious injury to the host plants which they attack and amongst the most serious is the damage caused to tea.

The genus *Brevipalpus* is described by Baker (1945), who recognised its validity as a distinct genus and separated it from *Tenuipalpus* with which it had been held synonymous. He (Baker, 1949) also described the entire range of about 47 species of this genus.

Three species have been collected from tea in Ceylon, the most common being *Brevipalpus australis* Tucker, previously known as *Tenuipalpus obovatus* Donn. This species is also found on tea in India (Andrews and Tunstall, 1945), Malaya (Corbett, 1932) and Java (Dainmerman, 1929). In Java it is considered to be the most serious of the mite pests on tea. The other species which have been found on tea in Ceylon are *B. phoenicis* Geijskes, and *B. inornatus* Banks (Loos, 1954). *B. phoenicis* has also been found breeding on *Grevillea robusta* and *Albizzia moluccana* (Loos, 1954) and occasionally in negligible numbers on other shade trees such as *Gliciridia*, dadap and *Acacia*. Scarlet mites are also known to occur on other trees and miscellaneous plants in Ceylon (Light, 1926) but their specific identity has not been recorded.

As a pest of tea in Ceylon, the scarlet mite was first recorded by Green in 1890, at which time it was not considered to be an important pest. Later he (Green, 1900) records it again, but this time as causing serious damage to tea plants, and states that in some instances bushes had been actually killed. Later, in 1914, Rutherford mentions it as a serious pest, recording outbreaks in the Matale, Badulla and Passara districts. Subsequent to this it appears to have receded very much into the background as a pest, though King (1936) reports it as causing a certain amount of defoliation. Last year, however, it was noticed again in serious proportions in the Maskeliya, Dickoya and Dimbula districts (Loos, 1954) and these outbreaks, which have largely persisted since, have also included attacks on shade trees such as *Grevillea* and *Albizzia* as well. Previously the only record of serious attack on shade trees was in 1944 by Gadd, when it was observed to be causing serious damage to *Albizzia* in the Hatton district.

Description and Bionomics.—EXTERNAL STRUCTURE.—The *Brevipalpus* mites are all very minute in size, being only about .3 mm long and have flat egg-shaped bodies (Fig. 1). They are also characterised by having needle-like mouth parts (ch), 2 pairs of lateral, lens-like eyes (cy), a distinct dorsal suture (ds) dividing the body into 2 parts, an anterior part called the propodosoma (pr), carrying the mouth parts and the first two pairs of legs (l_1, l_2), and a posterior part or hysterosoma (hy) carrying the remaining two pairs of legs (l_3, l_4). They have also a reticulate skin pattern

and wrinkled legs with a pair of claws, pulvillus and tenent hairs. The palp (pp) on either side of the mouth parts is 4-segmented, in which the large 2nd segment bears a single seta, the 3rd a pair of setae and the minute fourth segment 3 setae.

Of the 3 common species met with in Ceylon *B. australis* is further distinguished by having the tarsi or terminal segments of the 2nd pair of legs provided with 2 characteristic, rod-like, sensory setae (Fig. 2 rs), the dorsal aspect of the body provided with 7 pairs of marginal hysterosomal setae (Fig. 1 hs 1-7) and the reticulate skin pattern (Fig. 1 rp) covering the entire dorsal aspect of the propodosoma. *B. phoenicis* is distinguished by having the tarsus of the 2nd pair of legs provided with 1 terminal rod-like seta, the hysterosoma with 6 pairs of marginal setae and the reticulations not meeting dorso-medially on the propodosoma. Finally, the reticulate pattern on the venter of the hysterosoma does not extend to the posterior ventral hysterosomal setae. A third species *B. inornatus* Banks, is identical to *B. phoenicis* except in the last feature mentioned, in which it has the reticulate pattern on the ventral aspect of the hysterosoma extending anterior to the posterior ventral hysterosomal setae, a pair of well-developed setae situated about the middle of the ventral aspect of the hysterosoma between the bases of the 4th pair of legs. In size they are all very much the same, measuring approximately .28 mm in length including rostrum and .15 mm in width.

LIFE CYCLE.—This has been worked out primarily with *B. australis* on tea, but observations on *B. phoenicis* on tea indicate no important differences. Observations were carried out at St. Coombs, Talawakelle, which had average temperatures of approximately 74°F (day maximum) and 64°F (night minimum) during the period of observation. Males are rare and copulation has not been observed. Females, whether fertilised or not, are capable of laying fertile eggs and commence egg-laying within 3-4 days of reaching the adult stage. Eggs are laid at the rate of about 1 a day over an average period of 7 weeks after which the females die. The maximum number of eggs laid by 1 female was 54 and the average 43. Mites transferred from *Albizia* on to tea continue their life cycle uninterrupted but quiescent periods are slightly longer. The longevity of the adult varies somewhat but does not exceed 9 weeks under laboratory conditions. Eggs are almost elliptical $.075 \times .1$ mm in size and bright scarlet in colour. They are stuck on singly to the under surface of the leaf and not easily dislodged. They take 13 days or nearly two weeks to hatch under laboratory conditions at St. Coombs.

The larva which hatches from the egg is a 6 legged creature, also scarlet in colour, and attains a size of approximately .15 mm. After an average feeding period of 4.2 days, it reaches a quiescent stage, which occupies about 3.3 days, then moults to give rise to the protonymph, which resembles the adult in having 4 pairs of legs instead of 3, but is only .2 mm in size. This stage lasts 7-8 days, comprising an average feeding period of 4.7 days and a quiescent period of 3.3 days, and then gives rise to the next stage, the deutonymph, which is .25 mm in size and occupies about 8 days, comprising an average active period of 4.5 days and an average quiescent period of 3.8 days. The deutonymph gives rise to the adult and the total life-cycle from egg to adult occupies 36-37 days or about 5 weeks.

The complete life history was not worked out on host plants other than tea but observations carried out over short periods on *Grevillea* and *Albizia* show no appreciable differences in the duration of the various stages.

Previous workers in Ceylon (Green, 1900; King, 1939) have described the life history of the scarlet mite as occupying approximately 4-5 weeks. Maglitz and Cory (1953), working with *Brevipalpus australis* on orchids in Maryland, describe the life cycle from egg to adult as occupying 26 days. McGregor (1916), working with *Brevipalpus inornatus* on privet in South Carolina, found the life-cycle of this species to occupy 3 weeks in the summer, while Morishita (1954), working on the same species on the garden violet in California at a temperature of 68°F, describes the maximum period from egg to adult as occupying 33 days.

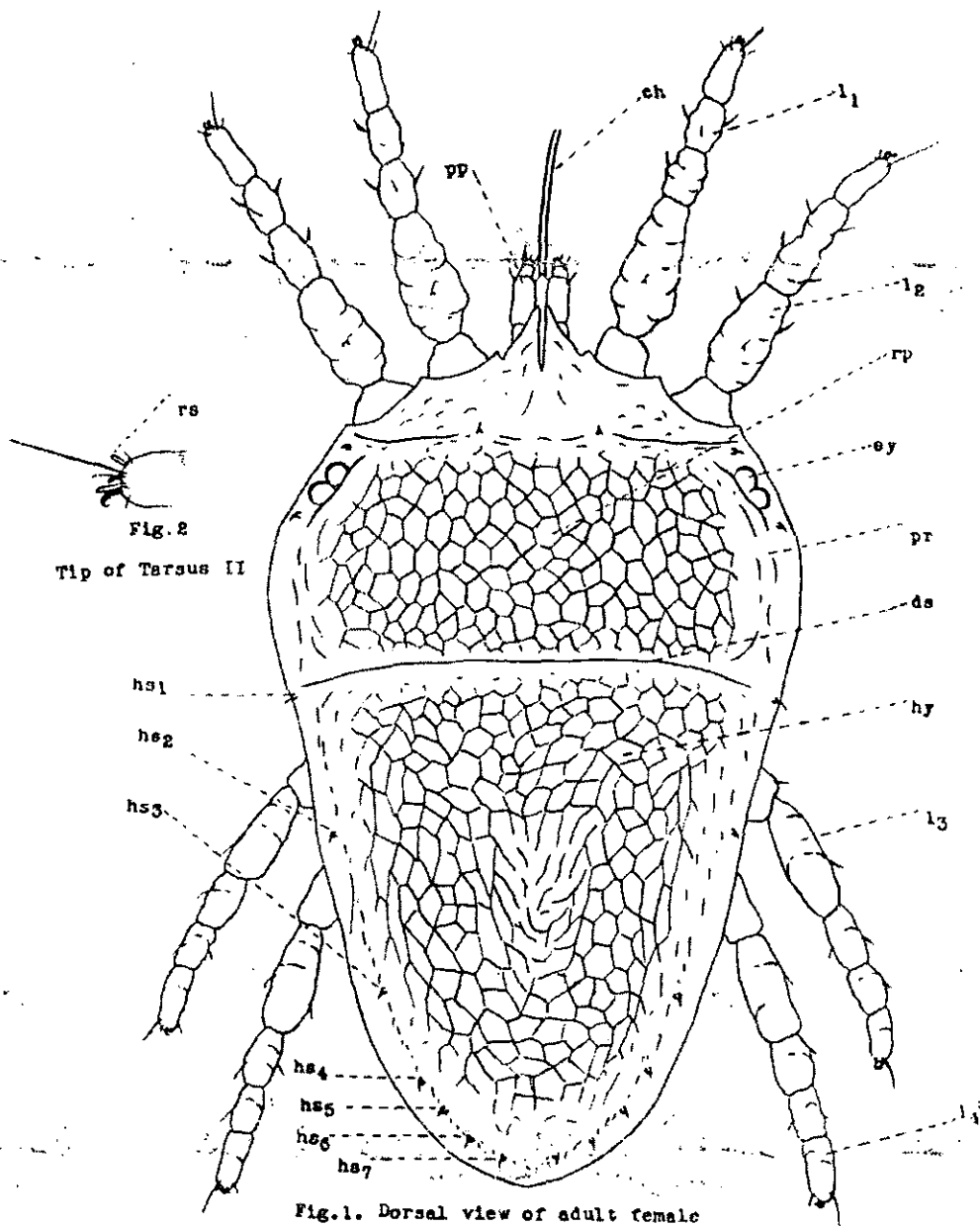


Fig. 2
Tip of Tarsus II

Fig. 1. Dorsal view of adult female

Figures 1 & 2. Semi-diagrammatic drawings to show details of external structure of *Brevipalpus australis* (Tucker). Very greatly enlarged.

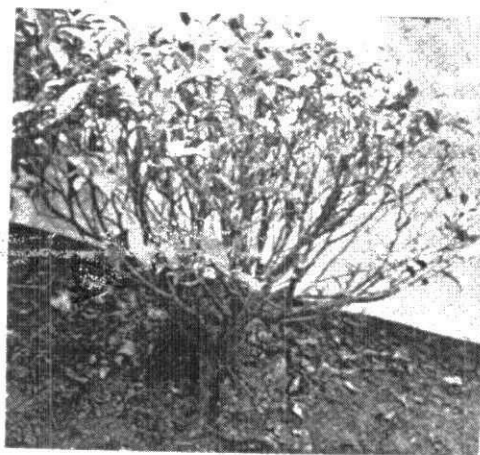


Figure 3. Tea bush infested by scarlet mite.

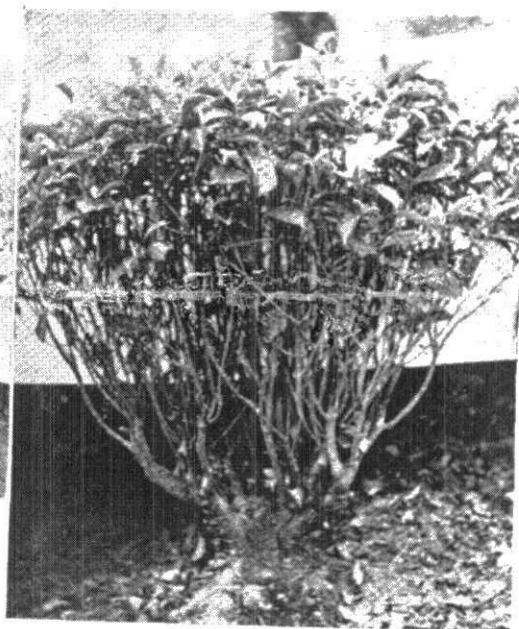


Figure 4. Tea bush recovering from severe scarlet mite attack.

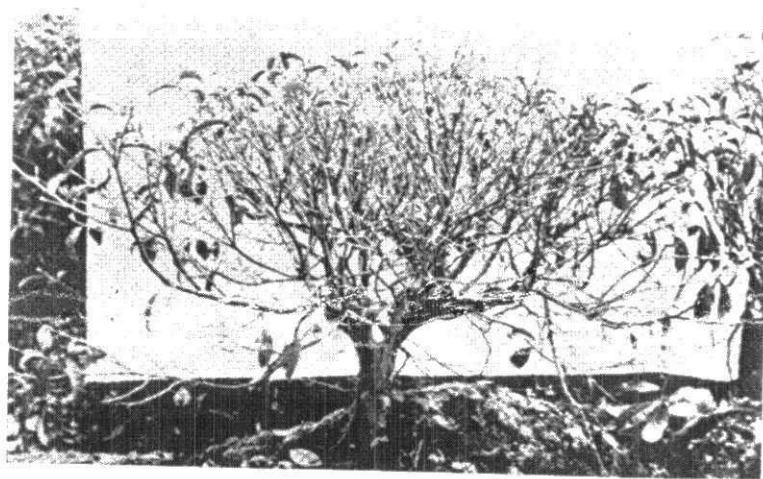


Figure 5. Tea bush very severely infested by scarlet mite.

FEEDING HABITS AND PLANT REACTIONS.—All stages of the mite are found on the undersides of the leaves. They feed by piercing and sucking the plant tissue with their stylet-like mouth parts, the undersides of the mature leaves along the petiole and midrib being the main sites of attack.

As a result of the injury inflicted by the feeding of the mites a reddish discolouration occurs on the parts attacked, chiefly at the base of the leaf and along the midrib. Intensive, prolonged attack leads to a general darkening of the lower foliage with a scorched appearance in the basal part of the leaf and a general reduction in size of newer foliage added. There is no twisting or distortion of the foliage as is common with yellow mite damage. As the attack progresses the mature foliage drops off and, with the invasion of the younger leaves and shoots by the mite, almost complete defoliation may take place. Figures 3 to 5 show photographs of bushes in different stages of scarlet mite attack.

With the partial defoliation of the bush, the rate of production of flush becomes greatly reduced and, if such bushes are allowed to continue in plucking until the stage of acute defoliation is reached, subsequent recovery becomes problematical and the bushes often fail to survive the pruning which follows later. Both Green (1900) and Light (1928) have also recorded very serious defoliation of bushes by the mite resulting in some cases in the death of the bush. Sloan (1946) describes a comparable damage to passion-fruit vines by a *Brevipalpus* species.

MULTIPLICATION AND DISTRIBUTION.—As compared with the more familiar yellow mite and red spider mite, the rate of population increase is relatively slow and this has an important effect on the manner of spread. Under normal conditions scarlet mite populations take about 3 years from pruning to build up to economic proportions, but much depends on the initial numbers left after light pruning as well as subsequent possible reinfestation from infested, defoliating shade trees. The intrinsic vigour of the bushes, general conditions of growth and the nature of the rainfall also have an important influence on the mite population. If factors are specially favourable, attacks of serious intensity may develop even within 6 months from a condition of apparent freedom from infestation.

The study of specific infestations from time to time has shown that one of the most potent factors contributing to the development of infestations is a regular succession of dry-weather or relatively light rainfall periods, the importance of which become accentuated or augmented by the prevalence of unlopped shade, and the adoption of exceptionally light pruning.

Overhard plucking may also seriously reduce the ability of individual bushes to withstand the attack of the mite. No direct relation has been found between copper spraying for blister blight control and the prevalence of scarlet mite.

A study of the distribution of the mite shews that it has a particular partiality for bushes on the sides of roads and footpaths. This suggests that the greater variation in temperatures which would normally prevail in such habitat niches has a definite stimulating effect on development. This is also supported by the fact that the period of most intensive development has been found to be from January to March when the degree of variation between day and night temperatures are the greatest. The comparative slow rate of spread and relative isolation of attacked bushes is most probably due to individual bush resistance, either physiological or genetic or both.

Control.—The control of any pest is normally considered from two main aspects, preventive and curative. The former is closely associated with cultural and environmental factors and is of significance in that it is useful in preventing outbreaks from occurring in the first instance, while also providing unfavourable conditions for

the development of casual or incipient occurrences of the pest in question. The curative aspect comprises chiefly the application of chemicals toxic to the pest, known in the case of mite control as acaricides, which becomes necessary in the case of outbreaks already well established when first noticed, in order to wipe out the pest without delay by direct action.

PRUNING.—The normal pruning of tea is a very important mechanical means of reducing existing populations to unimportant levels of infestation, but under conditions of serious infestation it cannot by itself serve as an effective control of the pest. In this connexion clean pruning may have some advantage over light pruning, but this may not be advisable on account of the exhaustion the bush may have already suffered on account of the attack of the mite during the period immediately prior to pruning. There is also the possibility of reinfestation from *Grevillea* and *Albizia* shade which can be quite appreciable in severely infested areas. In the pruning of infested areas it is, therefore, desirable that, though lungs or low branches should be left as is normally done, special action be taken in connexion with them so as to prevent them from being a source of infestation. This can be done effectively by the actual removal of such branches as soon as sufficient early foliage is formed, the removal being followed by an acaricidal application.

RESTING.—Closely associated with pruning is the resting of the tea, which, though not strictly a preventive measure, is a very important preliminary in enabling the bushes to recover from the attack already suffered, while other control measures are in progress. Above all it enables the bushes to recover sufficient vigour to stand the normal pruning operation. If the attack has not proceeded very far, resting in itself can eventually enable the bush to carry the attack up to pruning without further defoliation or serious setback, but of course at the expense of the crop since no leaf will be removed by plucking for such a period.

MANAGEMENT OF SHADE.—This is a very important factor in scarlet mite control owing to the possibility of shade trees carrying infestations of mites and by the regular shedding of leaves thus continuously reinfesting tea. The significance of this is greatest in the case of shade which is not normally lopped and defoliates continuously rather than seasonally. The periodic lopping of shade is an important method of reducing mite populations on the shade trees and should be adopted as a standard practice in chronically infested areas. Moreover, in infested areas a special lopping, amounting more or less to a pollarding of the shade, should be done, and so synchronised with the pruning of the tea that it is effected prior to pruning and within as short a period of pruning as deemed practicable under the particular conditions of the tea in question. In any case pollarding of shade must be done in the particular case of severely infested shade trees as soon as the attack is evident and such loppings should be burnt in situ.

RAIN.—Another factor which appreciably reduces mite populations is very heavy and continuous downpours of rain. This applies particularly to recently pruned tea in which the frame of the bush is more or less exposed to the direct action of the rain. On the other hand, owing to the relatively protected position of the mites on the under surfaces of the leaves, comparatively normal and well distributed rain has no detrimental effect on scarlet mite populations, and in fact forcing weather as such quickly brings the attack to a head.

Trials with acaricides.—The acaricides utilized in these trials were sulphur, chlorobenzilate and karathane.

SULPHUR.—This is available for application in three forms, namely a water-dispersible powder, a liquid lime-sulphur preparation and a dusting powder. Preliminary tests indicated that 1 lb. of dispersible sulphur per 25 gallons water and 1 gallon lime sulphur to 40 gallons water were the most satisfactory spray concentrations and these were therefore used in all the trials. In dusting it was found that

25-30 lb. of dust were required per acre. Sulphur has no mammalian toxicity at the strengths used. Tests carried out earlier have shown that it has a strong tainting property, which may be retained on foliage up to periods of 3 weeks after application, necessitating the discarding of the pluck for this period.

CHLOROBENZILATE.—This is an organic acaricide being 4, 4-dichlorobenzyl acid ethyl ester. It is a specific acaricide and is available in a commercial form as 'Akar 338' emulsifiable concentrate, containing 25 per cent. chlorobenzilate. It is also available as a 2 per cent. dust. Its mammalian toxicity in concentrations necessary for mite control is negligible and, in tests specifically carried out to ascertain tainting potentiality, it was found that tea leaf collected 1 week after application shewed no taint. Preliminary tests with various concentrations indicated a 1 in 1,000 concentration, or a .025 strength, to be the most satisfactory although a fairly good mortality was obtained with a .0125 per cent. concentration or a 1 in 2,000 strength. It is also available as a 2 per cent. dusting powder and about 25-30 lbs. are required to treat one acre.

KARATHANE.—This is also an organic acaricide chemically known as dinitro capryl phenyl crotonate. It is a specific acaricide and fungicide and is available in a commercial form as 'Karathane W. D.', wettable powder containing 25 per cent. of active ingredients. It is also available as a dusting powder. Its mammalian toxicity is negligible and it resembles chlorobenzilate in its nontainting properties, leaf tested 1 week after application shewing no taint in the manufactured product.

PROCEDURE.—In the application of the acaricides, normal spraying machines as employed for blister blight control, but fitted with high-volume jet, angle-bend nozzles, were used. Each bush was sprayed individually and application directed from below so that the undersides of the foliage received a good application of spray. The applications were repeated at weekly intervals.

The major estimations of mite populations in these trials were done by counting of all stages of mites on a prescribed area. This was the area lying within an arc 1 cm from the base of the petiole of leaves from selected bushes conforming to a specific degree of attack. In each trial except the first, 3 such bushes are marked and 2 or 3 leaves taken from each bush, the leaves being chosen at random but being always the 2nd leaf below the fish leaf.

RECORDS AND RESULTS.—The population records in the case of the comparative trials are given in the tables following.

Table 1. *Trial No. 1. Sulphur and chlorobenzilate (Akar) in spray and dust form.*

Time of estimation	Mite populations found									
	Sulphur spray		Akar spray		Sulphur dust		Akar dust		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage	Number present	Percentage	Number present	Percentage
Before application	453	100%	513	100%	461	100%	574	100%	491	100%
2 days after 1st application	239	53%	259	50%	340	74%	382	67%	579	118%
1 day after 2nd application	156	34%	164	32%	229	50%	225	39%	715	146%
2 days after 3rd application	68	15%	103	20%	157	34%	216	38%	736	150%

In the 1st trial, the effect of sulphur is compared with chlorobenzilate (Akar), the two acaricides being used both in the form of an aqueous spray as well as in the form of a dispersible dust. For the sulphur spray, 'Spersul' was used at the rate of 1 lb. in 25 gallons, and for the chlorobenzilate spray, Akar at 1 in 1,000 dilution. The dusts were applied in both cases at the rate of about 40 lb. per acre. The two acaricides appeared to be more or less equally effective, but the spray treatment in each case appeared to be more effective than the dust. Only 3 applications were given and this appears to be not quite sufficient for satisfactory control.

Table 2. *Trial No. 2. Lime-sulphur and dispersible sulphur sprays.*

Time of estimation	Mite populations found					
	Lime sulphur		Dispersible sulphur		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
Before application	209	100%	239	100%	191	100%
6 days after 1st application	28	13%	18	8%	248	130%
6 days after 2nd application	7	3%	11	5%	288	151%
6 days after 3rd application	3	1%	6	3%	216	113%

In the 2nd trial, a comparison is made between lime-sulphur and dispersible sulphur. For the former, 'Fernasul' was used at a dilution of 1 in 40 and for the latter, 'Thiovit' at the rate of 1 lb. in 25 gallons water. The figures represent in each case the numbers found on the basal segments of 9 leaves taken from 3 bushes. There appears to be little to choose between the effectiveness of the 2 sprays, and 3 applications gave good control.

Table 3. *Trial No. 3. Chlorobenzilate (Akar) in light and heavy spray.*

Time of estimation	Light spray		Heavy spray		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
Before application	257	100%	165	100%	210	100%
5 days after 1st application	191	74%	73	44%	193	92%
6 " " 2nd "	160	62%	29	18%	224	107%
6 " " 3rd "	106	41%	6	4%	180	86%
6 " " 4th "	95	37%	1	1%	201	95%

In the 3rd trial a comparison is made between 2 different types of application using Akar. One application was a light spray applied from above as for blister blight control, but treating bushes individually. The other application was that of a heavy or thorough spraying of each bush both from above and from the sides. The records shew that the light spraying while reducing the numbers somewhat is not sufficiently effective to give good control even after 4 applications.

Table 4. Trial No. 4. Chlorobenzilate (Akar) spray in two concentrations.

Time of estimation	Mite populations found					
	Akar 1 in 1000		Akar 1 in 2000		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
Immediately before application	131	100%	104	100%	98	100%
7 days after 1st application	53	40%	59	57%	124	116%
7 days after 2nd application	26	20%	70	67%	147	150%
5 days after 3rd application	10	8%	36	35%	168	171%
7 days after 4th application	6	5%	32	31%	150	153%

In the 4th trial, 2 different dilutions of Akar 1 in 1,000 and 1 in 2,000 are compared, 4 applications being given. The more dilute application of 1 in 2,000, while reducing the numbers appreciably when the population is high, appears to have comparatively little effect on the smaller populations and is insufficient for satisfactory control if a limited number of applications are given.

Table 5. Trial No. 5. Karathane and sulphur sprays.

Time of estimation	Mite populations found					
	Karathane		Sulphur		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
Immediately before application	77	100%	129	100%	95	100%
7 days after 1st application	35	45%	57	44%	147	155%
7 days after 2nd application	19	24%	32	25%	151	159%
5 days after 3rd application	5	6%	10	8%	126	133%
7 days after 4th application	1	1%	2	2%	119	125%

In the 5th trial, Karathane W. D. at a strength of 1 lb. in 100 gallons water is compared with dispersible sulphur (Spersul) at the rate of 1 lb. in 25 gallons. The results show that Karathane is quite as effective as sulphur in reducing the mite population, 4 applications being necessary to give good control.

Table 6. Trial No. 6. Chlorobenzilate (Akar) and Karathane sprays.

Time of estimation	Akar 1 in 1000		Karathane 1 lb. in 25 gals.		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
	Before application	333	100%	356	100%	236
7 days after 1st application	134	40%	51	14%	164	69%
7 days after 2nd application	50	15%	10	3%	160	68%
7 days after 3rd application	25	8%	4	1%	113	48%

In the 6th trial Karathane at 1 lb. in 25 gallons is compared with Akar at a 1 in 1,000 dilution. The former appears to show some slight superiority over the latter, though this is not significant in view of the great drop in population even of the control.

In general it will be seen that although there is a very heavy reduction of mite population after the 1st application of acaricide, there is a very appreciable remnant population under field conditions until at least 2-3 more applications are given. A light application from above, as is normally given for blister blight spraying, was found to be relatively ineffective in reducing the mite population on tea in plucking, but may be effective in clean-pruned tea in the period immediately following pruning. Dusting was generally less effective than spraying, even under very good conditions for the application of dust.

Though all three acaricides are very effective in causing the mortality of active stages, resting stages and eggs are comparatively little affected. Karathane shews some superiority in this respect causing an appreciable mortality of the eggs. Contact action and residual activity in the field appears to be about the same in all cases. No residual effect in the field however, can be detected 1 week after application in the case of any of the acaricides.

Recommendations for acaricidal control.—**DOSAGE:**—The recommended strengths for curative application are:—

- (1) *Sulphur*. 1 lb. of dispersible sulphur in 25 gallons water or a 1 in 40 dilution of lime sulphur.
- (2) *Chlorobenzilate (Akar)*. 1 in 1,000-2,000 dilution of Akar.
- (3) *Karathane*. 1 lb. of Karathane W. D. in 100 gallons of water or at strength of .025 per cent active ingredient.

APPLICATION:—In the application of acaricides the rows of the bushes must be dealt with individually and the application directed so as to hit primarily the underside of the mature foliage and not the superficial flush only as in blister blight control. This entails a heavy application of spray and requires more labour per unit area than that used in the case of blister blight control. About 50 gallons per acre will be required for pruned tea while at least double this quantity will be required for fully grown tea. If dusts are used about 25 lb. of dusting powder will be required per acre.

Although the cost of application of sulphur is about half that of the other acaricides, it has the disadvantage of tainting and cannot therefore be used on tea in normal plucking. Equipment used in applying sulphur should also be washed out before being used for blister blight control on tea in plucking. Nevertheless whatever acaricide is used, the application should be given after the plucking round, and even with non-tainting acaricides one week should elapse between the application of the acaricide and the following plucking.

Owing to the relatively protected position of the mites and the relative ineffectiveness of the acaricides to cause appreciable mortality of eggs and resting stages, it is necessary to repeat the application about 4 times at weekly intervals to obtain effective control.

Application of acaricides is easiest and most effective in the period following pruning. The number of applications given will vary with the intensity of the infestation but in any case two further applications will be necessary after the removal of low branches or lungs which should be done as soon as sufficient foliage has developed. If bushes had carried a severe infestation at pruning time it is also desirable that they should be stripped of any old foliage before the final applications are given. If very thorough application has been given following removal of lungs, further applications can be dispensed with. As an extra measure of precaution, however, the special applications may be augmented by the addition of a few additional applications, which may be combined with the normal blister blight spraying by adding the acaricide to the copper spray in the proper proportions. Of the sulphur preparations lime sulphur alone cannot be used in this way as it is not compatible with copper sprays.

For tea in plucking application is more difficult but is carried out on the same lines, except that light applications such as those used for blister blight spraying are not recommended. Also, if selective plucking is to be done in the area concerned, sulphur should be replaced by a non-tainting acaricide such as chlorobenzilate or Karathane. Affected bushes however should be rested for about 3 months.

The exact procedure for the routine application of control measures will vary with the condition of the tea and the intensity and distribution of the infestation. Exact schedules of application are therefore given with reference to specific conditions for guidance in the appendix at the end of the article.

DISCUSSION

The scarlet mites as compared with the red spider mites have only been of minor importance and, though recorded as occasional pests of certain economic crops, have received no very great attention with reference to ecology or control. In fact the present ravages of the scarlet mite in Ceylon appear to be economically the most significant recorded for this group of mites. Little is definitely known still of the specific reasons for the occasional build up of the mite in certain situations or what influence, if any, is exerted by biological agencies in controlling the mite population. A significant feature is the long life cycle and the presence of a long, quiescent period during each stage of development.

In Ceylon up to quite recently the mite received scant attention owing to its relatively minor nature as a pest of any importance and apart from general aspects of life history and control little detail had been studied. The present work has been carried out as a preliminary study to an intensive investigation of the bionomics and control of the mite with special reference to its significance in the cultivation of tea in Ceylon. The data obtained opens out several avenues of investigation, the most important of which are the study of the factors of resistance of the tea bush to mite

development and multiplication, the specific evaluation of weather and climatic factors in the build-up of mite populations and the reactions of these mites to new acaricides, especially those which appear to produce very specific effects while being non-toxic to possible predatory and parasitic species of insects which may occur in the tea. The use of new systemic acaricides, particularly with reference to the control of mite on shade trees, also deserves some attention, while the effects of shorter and longer cycles and suitable management and rotation of shade are likely to repay further examination.

It can, however, be claimed that in the present state of our knowledge it is possible to effect definite economic control of the pest without serious increase in the cost of production of the crop if the ravaging effects already produced by the undetected and uncontrolled activity of the pest are eliminated by immediate and intensive curative action. If this is done serious outbreaks or attacks can be reasonably forestalled and prevented.

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APPENDIX

Schedules of application of control measures.

A. SEVERELY INFESTED AREAS IN 2ND OR 3RD YEAR OF CYCLE.

1. Throw the entire field out of plucking temporarily.
2. Lop all visibly affected (sickly looking) *Albizia* and *Grevillea* shade and burn all loppings in situ.
3. Carry out 4 applications of acaricides at weekly intervals giving special attention to severely attacked bushes. If selective plucking is to be done, a non-tainting acaricide should be used.
4. Continue to rest the field, or, if preferred, affected bushes only, for a further two months, using during this period a non-tainting acaricide if plucking is being carried out. This application may be combined with the blister blight spraying.

B. SEVERELY INFESTED AREAS DUE FOR PRUNING WITHIN THE YEAR.

1. Throw the field out of plucking partially or completely and rest for 2-3 months prior to pruning.
2. Carry out the general lopping of shade and pollarding of sickly-looking or affected shade within as short a period from pruning as possible.
3. Give 2 thorough applications of acaricide after pruning within 1 week's interval of each other and another 2 applications after removal of low branches or lungs, the latter being carried out as early as feasible without causing detriment to the tea.
4. As an additional measure of control a non-tainting acaricide may be incorporated into the blister blight spray for the 1st 4 months after pruning.

C. MILD OR SMALL SCATTERED INFESTATIONS.

1. Pollard affected shade trees and lop all other shade if suitable and appropriate for lopping.
2. Mark out affected bushes by application of lime or other device and carry out at least 4 applications of a non-tainting acaricide given immediately after the plucking round.
3. Rest all treated bushes from for at least 3-4 months, but unaffected bushes in the field may be normally plucked if a non-tainting acaricide has been used.
4. Use a non-tainting acaricide in the blister blight spray for 4 months.
5. If tea is due for pruning carry out schedule of treatment under B.

Note.—If sulphur is used, leaf must not be plucked for manufacture in the same field for at least 3 weeks after last application. If blister control equipment is used for application of sulphur spray in affected areas, such equipment should be thoroughly rinsed out before being used for blister spraying in plucking areas. Other than lime sulphur other acaricides are compatible with blister spray and may be used together if desired.