THE LENGTH OF THE PRUNING CYCLE

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The first part of my talk to you to-day will embody an outline of our present knowledge of the changes that occur in the tea bush during the interval between successive prunings. Our investigations are by no means complete, so that I shall not be able to describe the whole of the picture to-day. As Stevenson says "You have your little handful of facts, little bits of a puzzle, and you sit and think, and fit them this way and that, and get up and throw 'em down, and say damn, and go out for a walk." I shall not, however, stress the more puzzling aspects, so although you may say 'damn', I hope you will remain to listen to the speakers following me.

The length of existing pruning cycles has been in the past roughly adjusted to give the best yield under a given set of conditions. The focussing of attention upon quality rather than yield in the last few years has resulted in more thought being given to the advantages or disadvantages of a longer cycle. Suffice it to say here that both laboratory experiments and estate experience has shown conclusively that better teas are made as the age of the tea from pruning increases, while the improvement continues, at this elevation, even during the fourth year from pruning. Thus the change is a progressive one and is not sudden or irregular. Now it has been found that similar progressive changes occur in the bush and in the character of the crop and it is for that reason that I have chosen to describe them today.

Commencing with the pruned bush, which has suffered a drastic reduction in its leaf surface, its branches, and its shoot initials, (or buds), we find that it reacts by attempting to restore the *status quo ante*. The rapidity with which it succeeds is at first relatively great but this falls off until at the end of the cycle the changes are, in comparison, very slow.

The first stage is the production of the primary shoots from the pruned frame. The number formed is largely influenced, though not entirely controlled, by the number of buds upon the frame. It is also affected by the amount of young wood in the

frame. Thus, a high cut-across produces such a profusion of primaries that tipping is quite unnecessary. Associated with the large number of primaries is less vigorous growth on the part of individual shoots and plucking may be carried out as soon as they have developed sufficiently. With more severe types of pruning the number of primaries produced is far less, and, being developed from different levels upon the frame, their attainment of a sufficient height above the pruning level is by no means simultaneous. There is no point in collecting, at relatively high cost, poor quality leaf and so they are allowed to develop freely until tipping is performed. The stage at which this is performed will be dependent upon the crop position, but the aim is the same whenever it is done — namely, to produce a level plucking surface and to increase the number of shoots in it. The formation of laterals upon the primary shoots is not entirely dependent upon tipping, since if the process is delayed many secondaries will be found at the tipping level, but if it is done before these are naturally produced, the process is hastened. At no stage save that of the production of primaries does the number of shoot initials upon the bush seem to limit the number of shoots produced. In fact, it appears that at the end of a three-year cycle the average bush has several thousand dormant and unused buds upon it.

Normally, the first tipping is succeeded by a second and third at varying intervals, but this appears to be an unnecessary extension of the process. It would seem more reasonable to delay the first tipping a little (if necessary) in order to enable the majority of the primaries to be dealt with on that occasion. Then, when young shoots appear upon the surface of the bush, commence the normal succession of plucking rounds. This would permit of a reduction of labour, while, providing tipping was not done too early, the leaf obtained at the following plucking would not be of the so-called "tipping type".

The operation of plucking results in multiplication of the number of shoots in the plucking table and in the production of shoots in various stages of development. Thus we must recognise a second stage in the history of the pruned bush, namely the formation of an efficient plucking table in which the number of shoot initials is sufficient both to ensure that the new shoots are practically all produced near the plucking surface and not deeper in the bush, and to provide a succession of developing shoots to provide crop at subsequent plucking rounds.

The time occupied by this stage will depend upon the number of shoots in the surface formed at tipping, and this in turn will depend upon the type of pruning employed, and also upon whether the tipping was sufficiently late to allow of secondaries being present in the tipping surface. Thus cutting-across results in this stage being relatively short, while at elevations where dieback is prevalent as a result of low carbohydrate reserves, lung-pruning has a similar effect. Again, the stage is relatively short where bushes which have been rested for a moderate time are tipped high. This is due to the relative density of shoots in the tipping surfaces of such bushes.

Following upon this we get a stage in which the plucking table increases in area, and decreases in yield per unit area, until the bush is again pruned. The increase in size of the plucking surface does not keep pace with the decrease in its efficiency, so that the yield per plucking tends to fail. At the same time the rise in height of the plucking surface results in the weaker shoots being left behind, so that they are no longer plucked. They occur inside the bush but are especially numerous upon the sides of the bush.

These stages merge with one another and cannot be clearly separated, but throughout there runs the theme of increasing total shoot number, a theme which is unfortunately not adequately reflected in the crop obtained. Simultaneously, other progressive changes are found to occur, which may now be discussed.

TABLE 1.

Elevation in feet	Time of pruning	Mean weight in grams			
		1st year	2nd year	3rd year	4th year
4,600	Sept.	0·126	0·092	0·089	0·087
	Jany.	0·014	0·091	0·089	0·088
	May	0·100	0·088	0·089	0·087
1,600	May	0·141	0·118	—	—
200	May	0·134	0.112	—	—
	May	0·141	0·123	—	—

If the plucking standard and the length of the plucking round are held constant, a decrease in the average size of the flush harvested

may reflect either a decrease in the final size attainable by the leaf, or a slower rate of growth of the leaves and stem forming the flush, or a combination of both. It is well known, for example, that mature leaves produced after pruning are larger than similar leaves at the end of the cycle, while some indications of a slowing down of the development rate of the flush toward the end of the

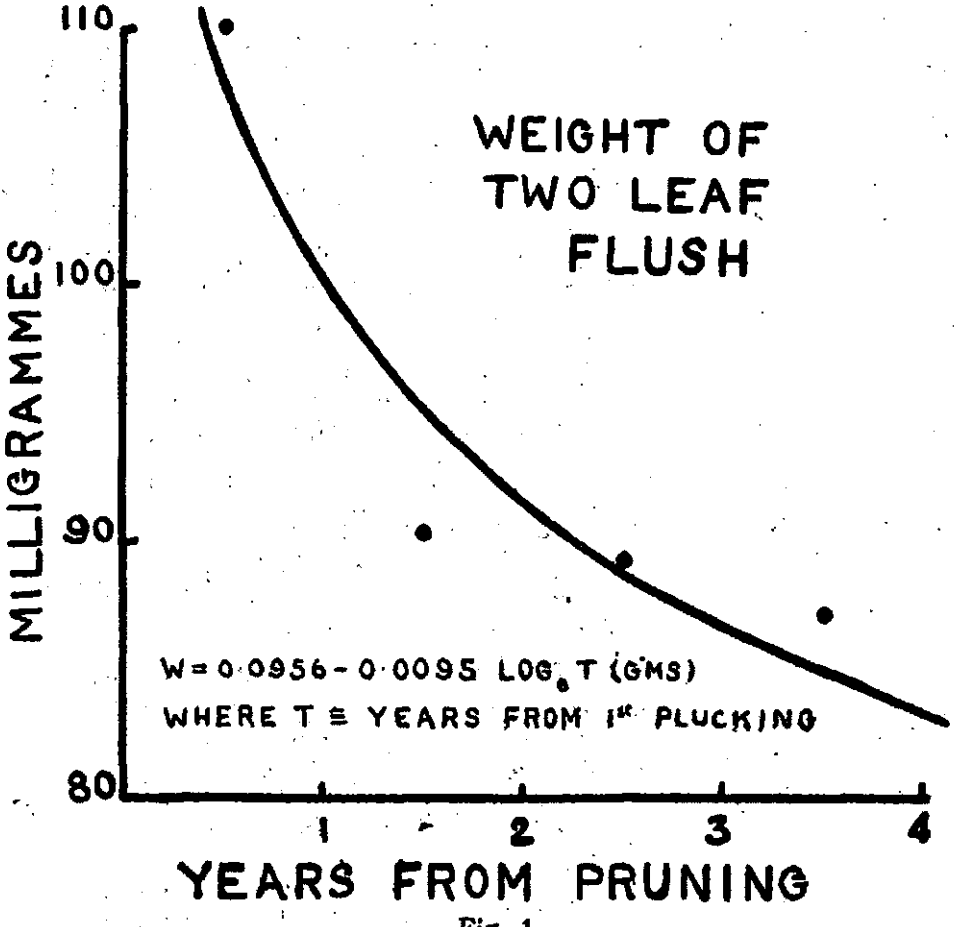

Fig. 1

cycle have been found. The figures in Table I illustrate the changes that occur in the weight of a flush consisting of two leaves and a bud. Bearing the interpretation I have suggested in mind, it will be seen that there is evidence of progressive changes during the cycle in the potentialities of the shoots.

It will be seen that the crop consisted of smaller and smaller flush as the cycle progressed, and that the fall in size is most rapid in the early part of the cycle. Comparison of the data obtained at

4,600 feet suggests that while differences in climate affect the size to a fairly marked extent in the first year after pruning, in subsequent years it tends to become relatively constant. This suggests that it becomes controlled by internal factors, rather than external. When the average shoot weight is plotted against years from pruning it is found that they lie along a curve of definite form (Fig. 1). The close fit of the curve in spite of irregular changes in climatic conditions from year to year lends support to this view of the importance of the internal factors.

Not only does the size of the flush alter, but also the proportions in which the different components of the flush occur. A comparison of flush grown under the same climatic conditions, from closely adjacent bushes gave the following results (Table 2). The dry weights of the various portions of the flush are expressed as a percentage of the whole, neglecting the basal portion of the stalk.

TABLE 2.

	Months from pruning		
	5	48½	Difference
Bud	9·22	10·03	Not significant
1st leaf	22·61	26·61	Significant
2nd leaf	59·60	54·39	Significant
1st (Bud) internode	1·90	2·09	Significant
2nd internode	6·68	6·88	Not significant

They indicate that the internode supporting the bud and the first expanded leaf form a larger proportion and the second leaf a smaller proportion, of the flush from the 48½-month series, compared to that from the five-month series. One explanation of this would be that the leaves were developed from the bud more slowly, which would suggest that *both* of the factors previously mentioned as influencing flush size are at work.

The extreme case of slowing down of the bud's activity is exemplified by "banji" formation, when the bud becomes temporarily dormant. An examination of the occurrence of banji indicates that, while banji are always present, the proportion in which they occur

increases with the age of the field from pruning. This is reflected in a corresponding reduction in the percentage of flush, which is obvious from the data in Table 3 which were collected from the crop of fields of different ages from pruning.

TABLE 3.

Age from pruning in days		Percentage of flush (*Actively growing shoots*)
145	...	87.1
160	...	93.6
190	...	72.4
210	...	68.5
270	...	55.2
280	...	56.2
330	...	68.2
420	...	55.0
450	...	59.5
625	...	53.8
720	...	60.4
1,500	...	53.9

A similar relation with time is found to occur as was found in the case of the size of flush (Fig. 2). It is interesting to note that in this kind of curve, the rate of change is inversely proportional to the time elapsed, the decrease in both the size of the flush and the percentage of actively growing shoots (flush) being most rapid at first and becoming slower and slower. Now we have already noted that during the progress of the cycle the changes in the bush are those associated with increasing numbers of shoots upon the bush. Our information is as yet insufficient for proof, but it seems likely that these changes in the growth of individual shoots are connected with the increase in their number. Such a conclusion would lead immediately to the suggestion that competition between the various shoots was of importance.

It may be objected that the changes in the frequency of banji are not only associated with age from pruning, since seasonal fluctuations occur, their amount being less during periods of rapid growth. At first sight this does not appear to fit in with the idea of the importance of internal competition. Data on this are at present in course of collection, but meanwhile it is of interest to note that

seasonal changes in crop were found by Dr. Eden to be associated with similar changes in the percentage of nitrogen in the flush. In other words, when shoots were growing rapidly and when banji was

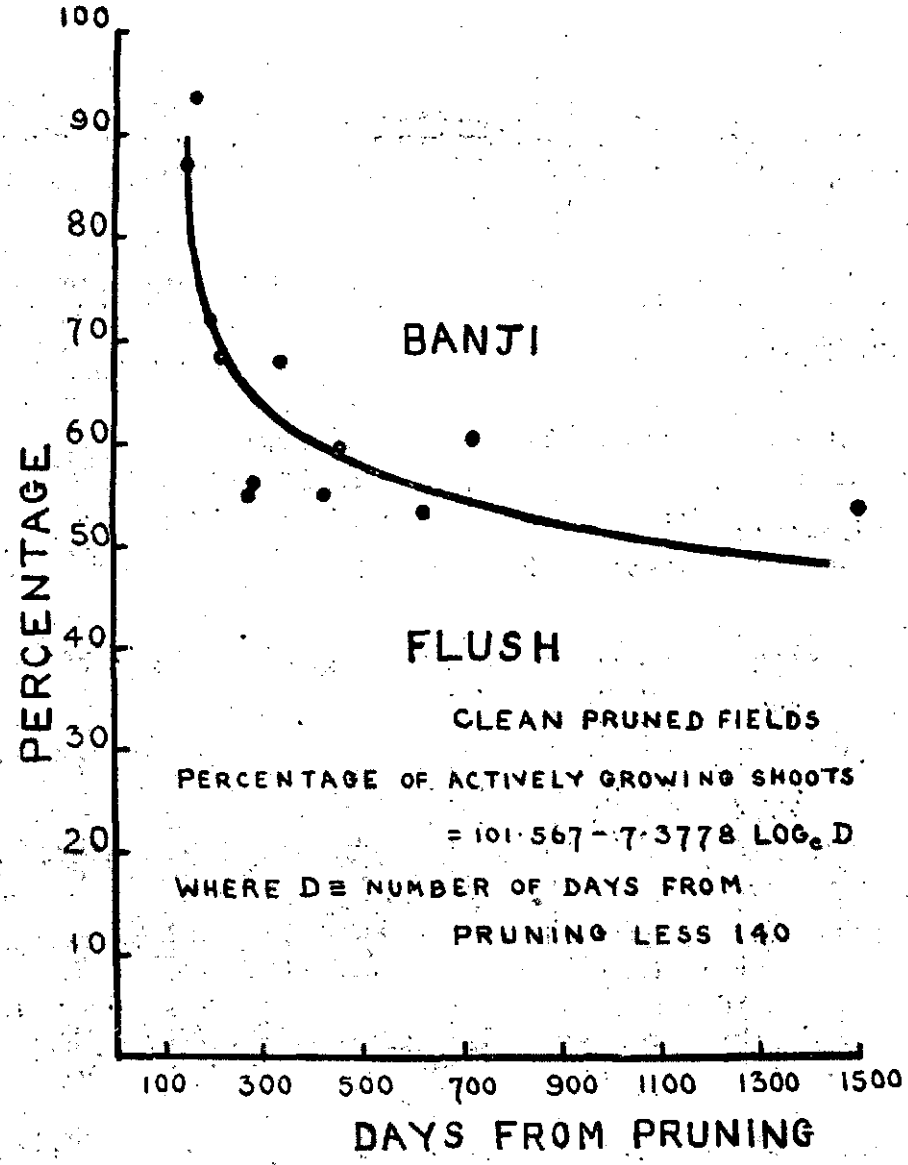

Fig. 2

presumably smaller in amount more nitrogen was available per shoot. So the seasonal changes that occur would not appear in the present stage of our knowledge to be a sound objection to the suggestion of competition.

We see then, that the ageing of the bush may be associated with a decreasing supply of nutrients per *shoot* as the total number of shoots upon the bush increases. If this is the case it leads immediately to the idea that if pruning is to be delayed, increased nutrient must be made available to the bush, and this has, in practice, been found to be the case. However, before discussing the measures to be taken when increasing the cycle I will briefly refer to some of the yield records obtained under a constant system of manuring throughout the cycle. I have already said that the increase in size of the plucking table is accompanied by a decrease in the yield per unit area in the latter part of the cycle, with the result that yield tends to fall. The rate of fall is influenced by manuring, but the yields shown in Table 4 were obtained from clean-pruned bushes when this was kept constant.

TABLE 4.

Elevation in feet	Mean yield in lbs. per plucking (1,500 bushes)			
	1st year	2nd year	3rd year	4th year
4,600	12·66	10·92	8·18	5·82
1,500	12·13	10·44	—	—
	8·33	7·24	—	—
200	8·01	12·45	—	—
	7·78	12·28	—	—

It will be seen that except at the low elevation where dieback after pruning is prevalent, the highest rate of yield occurs in the first year. Considering the case of low-country estates first, the effect of dieback is to increase the actual severity of the pruning and thereby to delay the formation of an adequate plucking surface.

Increasing the rate of formation of the plucking table as a result of reducing dieback by lung-pruning increases the yield per plucking in the first year, while the relatively "ready made" character of the table resulting from a high cut-across has an even more marked effect. These points are illustrated by the data given in Table 5 which refer to the experiment conducted at Galatura (200 feet).

These figures suggest that low-country estates on which the tea is in good heart may not be running as long as possible. As indicative of the state of the tea to which I am referring the yield was 2,192 lbs. per acre in two years, during which time it received

TABLE 5.

	Mean yield in lbs. per plucking (250 bushes)		
	Clean	Lung	High cut-across
First year	1·30	1·49	2·18
Second year	2·05	2·27	2·44

a *total* of 120 lbs. nitrogen per acre. It would be of interest to attempt, say, a thirty-month cycle on a small area of such tea, keeping the bushes in control by careful and continuous breaking back after the first fifteen months from pruning. It is essential, however, that the leaf area should not be reduced by such treatment during the first year, when yield and leaf area are so closely connected.

On by far the largest area of tea in Ceylon, however, the question of longer cycles will depend upon whether they can be obtained without a reduction in crop so large as to render them uneconomic, or alternatively, without the manuring programme necessary to maintain crop being too expensive. For relatively few is the question of crop of prime importance at present and I would suggest that the present time provides the opportunity of discovering whether under your particular conditions, an extended cycle is likely to be of advantage.

Assuming that the decision to extend the cycle is taken — either over the whole estate or on one or two trial fields — what should be the programme ?

It is the custom in Ceylon for the cycle to be a whole number of years in duration, the number of estates having cycles of, say, 30 months or 39 months being relatively small. I suggest that it is desirable that the cycle should not be a multiple of years, in order that an alteration in the season of pruning of individual fields should occur. Even in this district, where the climate cannot be regarded as grossly vagarious, it appears from the limited data at

our disposal that August and September are the most favourable months from pruning. Why should one or two fields receive the benefit of always being pruned at this season ?

The length of the proposed new cycle being settled, the initial pruning should be proportionately more careful. The less frequent pruning involved by longer cycles demands that extra attention be paid to the removal of snags and dead wood, the preservative treatment of pruning cuts, and the encouragement of spread by carefully leaving the fringe branches. No saving, therefore, should be made in the cost per pound of the pruning operation over the cycle.

Plucking will obviously demand greater care. Whereas in a short cycle the bushes are easily managed, irregularity in the plucking surface due to inefficient breaking back must result in poorer plucking when the bushes are getting high. I am not suggesting that the plucking table should be flat — in fact on a long cycle it is impossible to prevent the centre rising unless very severe breaking back is done. But I do not think it is a coincidence that those estates I know of that succeed in obtaining good yields in the last year of an extended cycle are also remarkable for the even surface of the bushes and the absence of exaggerated doming in the centres.

In the absence of Dr. Eden I do not wish to say much on the subject of manuring, but its mention is necessary in connection with the lengthening of pruning cycles. The suggestion I have made, that there is an increasing competition between the shoots during the course of the cycle immediately brings the subject into prominence, and suggests an obvious series of tests. If banji formation, for example, is partly an effect of this competition, additional nitrogen should have the effect of reducing its frequency. Dr. Eden's manurial experiments afforded the opportunity of making preliminary tests on these points.

These investigations have not yet been finished but so far the indications are that the percentage of banji occurring in the crop is decreased by nitrogenous manuring. The effect of nitrogen upon the size of the flush is not large and it requires further investigation; it would appear that the effect on the proportion of banji is the main one.

We have already noted that the relative sizes of the various portions of a single flush change with age. The percentage weights

of the components shown in Table 6, reveal no indication that extra nitrogen tends to produce a more "juvenile" type of flush in this respect.

TABLE 6.

	0 lb. N.	20 lb. N.	40 lb. N.
Bud ...	13.71	13.80	13.81
1st leaf	28.85	29.23	27.73
2nd leaf ...	49.10	48.17	49.77
1st internode	2.08	2.21	2.18
2nd internode ...	6.26	6.50	6.51

Thus we see that indications have been obtained that, while extra nitrogen tends to reduce the effects of increasing age from pruning that I have tentatively attributed to internal competition, it does not appear to alter the gross morphology of the shoot itself.

In passing, another point connected with the length of the cycle may be mentioned. The occurrence of flowers upon the bush is often taken as indicating that it needs pruning. This is an indirect and, if not very cautiously used, an extremely fallible guide. The change from vegetative growth to the formation of flowers is usually well marked in temperate trees, which are in general characterised by well-marked periodicity in their type of growth. Species which are found in more uniform climes in which seasonal alterations are relatively small are found to display a much more bewildering habit. We know in our garden trees that one may be leafless and the other covered with foliage; one flowering, and the other fruiting. Nor is this confined to different trees, for of the branches on the same tree, some may be in the so-called reproductive phase, while others are growing vigorously. Tea appears to behave similarly. Flowers on the low side branches which are not being plucked need not be worried about; it is only when the branches composing the flushing table start to flower that yield is likely to be affected.

Examination of the occurrence of flowering in fields of varying ages showed that some bushes start flowering almost as soon as they are pruned, but that the numbers doing so rapidly increase after about nine months from pruning in the case of the mixed jât we have on St. Coombs (Fig. 3). There is only a very small increase in the percentage of bushes flowering after the third year from pruning. The graph suggests that if we were to prune when flowering showers a rapid increase, we would be on a nine or ten-month cycle !

Flowering therefore affords no real criterion of the best length of cycle. Yield combined with the character of the made tea is the only criterion we should accept.

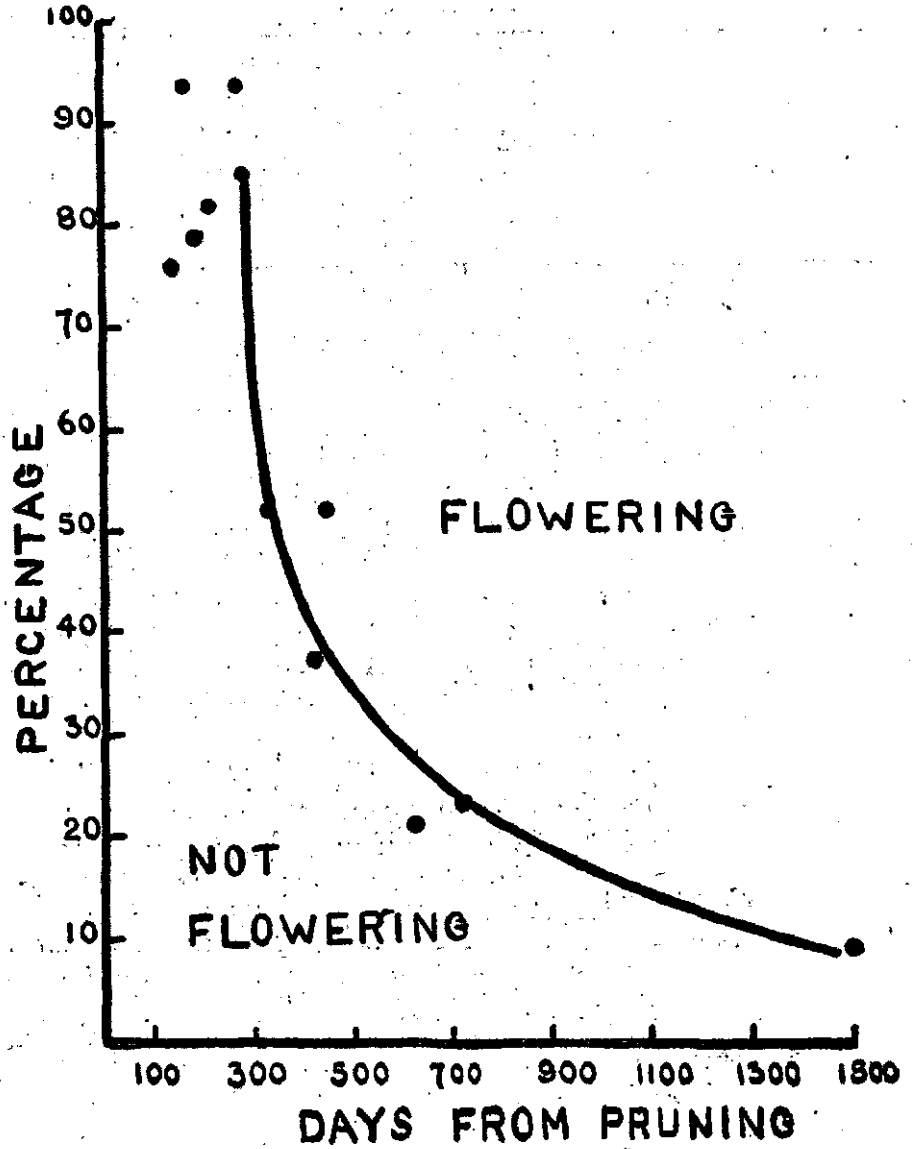

Fig. 3

You will notice that in this paper I have been assuming that a longer cycle is contemplated. I have asked Mr. Lamb to speak after me to give the reasons for this. While I certainly do not advocate rash extensions of the cycle without care and preparation,

we must remember that pruning is at best a necessary evil, to be inflicted as rarely as possible, while Mr. Lamb's investigations have shown improved teas may be expected from longer cycles. We see in Ceylon two, three and four-year cycles, and very few of say, three-and-a-half. Surely, the best cycle for each estate does not fall so conveniently into such arbitrary classes ? I put it to you that the length of pruning-cycle should not be regarded as fixed and immutable, but that its length should be carefully considered in relation to the conditions affecting the individual estate and, if found desirable, it should be altered.

DISCUSSION

Mr. Lamb said that in 1934 he found that a large rise occurred in the tannin content of made tea as the age from pruning increased, while associated with this were increases in the valuations. In his Annual Report for that year he stated that there was a slight indication of a fall in tannin content at the end of the pruning cycle. More recently he had the opportunity of doing experimental manufacture at St. Coombs on leaf from an estate on which certain fields were successfully run as long as 70 months. The data obtained from this latter experiment did *not* show any fall even at the end of this very long cycle. Tests over four consecutive months showed an increase in the tannin content of the 70 month old leaf amounting to 6 per cent of that of 16 months' leaf, as was shown in Table 7. Associated with this increase in tannin content was an increase in value of the made teas which amounted to 6 per cent in the Colombo valuations and to 9 per cent in the London valuations. Between

TABLE 7.

MADE TEA

Age in months	Percentage increase in		
	Theo-tannin	Colombo valuations	London valuations
16:70	6·0	6·0	9·0
16:40	3·6	3·0	3·5

16 and 40 months old leaf the increase in the tannin was 3.6 per cent, and in the valuations 3 per cent and 3.5 per cent in Colombo and London respectively.

He took that opportunity of thanking the Nuwara Eliya Tea Estates Co., Ltd. for supplying the leaf for those experiments, and Mr. E. C. Elliott for his very kind co-operation.

Leaf from Dr. Tubbs' pruning experiment that he had manufactured showed, over a period of 13 months, the results given in Table 8. In that table a cross indicated a significant difference in favour of the older tea. No significant difference in favour of the younger tea was found. It should be noted that a difference of only four months in age resulted in detectable improvements even at the end of a cycle of four years. It thus appeared that at this elevation the increase in the value of the made tea had not ceased even in the fourth year.

TABLE 8.

Age in months	Taster	Colour	Strength	Pungency	Quality	Flavour	Valuation
38.42	A						Not valued
	B	X		X	X	X	Not valued
	C						X (0·8 cts.)
34:42	A		X		X	X	Not valued
	B			X	X	X	Not valued
	C						X (1·4 cts.)

X indicates significant difference in favour of older tea.

The data described, combined with the experience of those estates which had tested the lengthening of the cycle on a large scale, left little room for doubt that better teas could be made by lengthening the cycle.

The Chairman enquired whether anyone desired to ask Dr. Tubbs any questions.

Dr. Tubbs said that Mr. Durbin had kindly given him an advance copy of some questions he would like answered. The questions were:—

1. "If the vitality of the bush is fully maintained throughout the pruning-cycle, one would expect resting before pruning to do at least as much good as resting after pruning. How is it that in practice it is found that resting after pruning is more efficacious than before pruning."

Dr. Tubbs replied that the question of efficacy depended on the particular conditions of the estate. If the bush was considered alone and apart from economic considerations, it did not matter whether resting occurred before or after pruning. If internal reserves were sufficient, resting after pruning merely resulted in the increased growth being spread over those portions of the

frame that were going to remain there for the next cycle. If resting was performed before pruning the increased growth was spread all over the bush, and much of it was removed at the subsequent pruning. By leaving the pruned bush to rest, the new shoots which were going to make the frame for the ensuing cycle had the opportunity of free growth and gained advantage thereby.

2. "It is recognised that after a long pruning cycle the bushes take longer to recover from pruning. Is this not a sign of loss of vitality ?"

Dr. Tubbs said that he did not consider it a sign of reduced vitality. The speed of recovery could not be regarded as a measure of vitality. The much older branches formed in long cycles bore older buds which took longer to shoot, because they had been inactive for a much longer period. As he had mentioned previously, younger buds grew more rapidly than old ones after pruning. He did not regard the longer time taken for recovery from old wood as indicative of loss of vitality. For example, they all knew of an abandoned estate nearby on which the bushes after being pruned into very heavy wood, naturally took some time to produce shoots, but no one would say that this was indicative of poor vitality. Some of these bushes were about 30 feet high, and as gorgeous looking tea as he had ever seen — considering tea as trees and not as bushes! It should be remembered that although older wood took longer to burst into growth, the individual shoots formed grow more vigorously. Thus the average growth, over a longer period than that taken in the bursting of the buds, was not necessarily low.

3. "Is it not correct that flower and seed draw heavily upon food reserves and after producing a large crop of seed, would the bush not be low in reserves and therefore in poor condition for pruning ? When green manures have flowered and seeded we are told that they have lost nitrogen and are unfit for direct incorporation in the soil."

Dr. Tubbs said that seeds drew upon the reserves, but that the main drainage was of carbohydrates which formed the main bulk of the food supplies that went into the seed. Green manures were considered from the point of view of their general nitrogen content, and that is why lopping before seed formation was recommended. Actually above about 2,000 feet he did not consider there was any necessity to worry about the drain upon reserves caused by seed formation, and even below that elevation he would not regard it as serious.

4. "Can you tell us roughly the proportion of food reserves which would be used up by a bush producing 1 lb. green leaf as compared to one producing 1 lb. seed ?"

Dr. Tubbs replied that he could give no exact figures. The flush probably manufactured about half its dry weight, roughly speaking, and the fruit only very little.

5. "Is it not a fact that the bushes which seed freely are actually the bushes which are not remunerative from the cropping point of view, and might therefore be considered weakly ?"

Dr. Tubbs considered that to be true only when, as he had mentioned before, the branches which formed the actual plucking table commenced flowering, and the whole bush became reproductive. Dr. Cohen Stuart of Java had pointed out that some of his high yielding bushes were those which flowered relatively early in the cycle, and that high-yield was not necessarily adversely affected by flowering. High-yielders might also be found to flower relatively early in the cycle.

The latter part of the question was misleading as a bush that was not yielding owing to all its branches being in the reproductive phase could not be regarded as necessarily unhealthy.

The Chairman then called upon Dr. Gadd to read his paper.