NEW DATA ON THE LATEX TUBE BORE IN RUBBER*

AT the end of 1928 Mr. H. Ashplant, the rubber specialist, United Planters' Association of Southern India, gave a lecture on latex tube bore before the Rubber Growers' Association in London; it was published in the Bulletin of the "Rubber Growers' Association," Vol. X., No. 12, December 1928, p. 796. The original ideas and the new data, put by him before his audience, stirred up somewhat the rubber world. Most research workers in the rubber-growing industry were sceptic about the new method, a selection based on the latex tube bore, as a means for improving the planting material with rubber. In more than one station investigations about the new subject were started, but heard little about the results. Recently one of the members of the staff of the AVROS Experiment Station in Sumatra, Dr. Frey-Wyssling, has published the results of a careful study of the tube bore character (in the *Arch. v.d. Rubbercultuur in Ned. Indie,* Vol. XIV., No. 3, March 1930, p. 133, "Investigation into the relation between the diameter of the latex tubes and rubber production of Hevea brasiliensis"). Dr. Frey-Wyssling's data do not confirm Mr. Ashplant's theory.

Before going into the subject we must mention here a serious handicap for Mr. Ashplant. Circumstances did not allow him to give us further details about his method and more data on the application of it. There was certainly an excellent starting idea in his work. If we could find a reliable character to make out, if a young seedling in the nursery belongs to the group of future high-yielders always found among seedlings, this would mean an immense progress for the rubber-growing industry. Mr. Ashplant had the original idea to try to find it in the latex tube bore and he found a clever solution for many difficulties in relation to it by choosing the leafstalk for studying this character. Whatever the future development of Mr. Ashplant's method may be, he has certainly the merit of having given a new stimulus to investigations into the anatomy of Hevea bark.

The Difficulties of the Technique.—Up till now Mr. Ashplant has not described the technique of his method and Dr. Frey-Wyssling had, therefore, to spend much time in working out a flawless micro-technique for measuring the diameter of the latex tubes. He has given a very complete description of his methods; the results showed how difficult and delicate a work the measuring of the latex tubes is. To make the microscopical preparations two methods were tried; (1) the maceration method, and (2) the Eau de Javelle method. For calculating each average figure 100 measurings were made. The following figures were found:

(1) The figures are taken from Dr. Frey-Wyssling's article but some details are left to make the form as clear and plain as possible.

* By Dr. P. J. S. Cramer, Wassenaar, Holland, in *The Malayan Tin and Rubber Journal*, Vol. XX, No. 22, 1931.

Table I

Average Diameter of Latex Tubes

Individual number	In the bark Bark samples prepared by mac. method	In microne 1 Bark samples prepared by E.D.J. method
(a) Artificial crosses seedlings.		
Tree No. 1	26·7	23·8
,, No. 4	28·2	27·0
,, No. 6	27·9	24·7
(b) Marcots of cl. 180.		
Tree No. 8	25·6	22·9
,, No. 10	57·6	23·3
,, No. 12	26·6	22·7

The figures show that samples of the same tree, prepared by the maceration method, gives us always a higher figure, sometimes a considerably higher figure (Tree No. 10, 4·3 microns) than the Eau de Jevelle method. The three last trees are all marcots of the same clone and should, according to Mr. Ashplant's theory, all have the same average for the tube bore; even prepared with the same method, the samples show a difference for the average of 2 microns. This makes this method unreliable.

Dr. Frey-Wyssling used for calculating his averages 100 measurements of the same tree; by a mathematical reasoning he shows that this figure is sufficient, but that, if only 10 measurements were made per tree, quite valueless averages would be obtained.

Mr. Ashplant assures that this method can be applied with 80 per cent. efficiency. Without a detailed description it is not clear how he avoids the difficulties mentioned by Dr. Frey-Wyssling. With the experience of the last, one would say that, when the method has to be applied in estate practice and the measurements made by native staff it will require a good deal of supervision to get, with such a delicate and complicated method, reliable results.

I would not dwell further upon this point. Let us take it for granted, that the men, who do the work, do it as well as the botanists in the laboratory and examine them, if the method gives the results Mr. Ashplant expects from it.

The Figures with Buddings.—The difficulty is, that we need years to compare the character—the average width of the latex bore in young plant with the yield of the adult tree. Dr. Frey-Wyssling tried to overcome this difficulty by using six months old buddings, instead of six months old seedlings. We have the advantage with buddings, that we know beforehand, what they will give as adult trees.

Dr. Frey-Wyssling used for this test twelve popular AVROS-Clones all planted on a large scale now in Sumatra and for the largest part also used in experimental plots, for which the yield has been studied for a number of years. He gives his results in a table, which we have rearranged to make it speak more clearly. For each clone the average width of the latex tube was measured and calculated.

We have now classified the clones according to the width of their tubes.

Table II

Yield and Tube Width with Clones.

Clone Number	Aver. diameter of latex tubes in leaf-stalk	Grams of dry rubber per tapping in tapping year: In 1st Year	In 2nd Year	In 3rd Year
50	16·4 microns	6·1	14·7	30·3 grams
49	16·5 ,,	6·2	14·5	21·3 ,,
35	17·3 ,,	6·8	16·3	18·3 ,,
33	17·4 ,,	5·5	11·2	23·8 ,,
80	17·5 ,,	6·3	12·1	15·2 ,,
163	17·5 ,,	7·8	12·7	20·8 ,,
152	17·6 ,,	9·7	17·1	23·6 ,,
36	17·8 ,,	4·2	10·0	20·3 ,,
214	18·3 ,,	15·2	—	—
71	18·6 ,,	7·8	12·8	21·8 ,,
183	18·8 ,,	14·8	24·0	—
256	19·3 ,,	—	—	41·7 ,, (4th tap year.)

If we compare these figures with those for common seedlings, we find that none of these clones shows an outstanding figure for its tube diameter, compared to common seedlings. If we read through the figures for the yields in the second and third year we do not find back the same consequence as in the classification of the tube diameter. Clone 50, one of the best yielders in third year, heads the list, that means shows the lowest tube diameter. Clone 71, one of the lower-yielding clones, comes near to the top with its bore.

But more than these relatively small differences says the following case. The AVROS Station disposes of one clone, used for comparisons, of a very poor yield—in its first year it gave only 0·6 gr., in its second year only 1·3 gr., and the latex tube diameter of this very poor clone averages 18·1 microns, which places it among the ones with a diameter above the average.

Results of Selection on Tube Width.—Another way to put the selection method recommended by Mr. Ashplant through the proof is by applying it. We can use for such a practical proof the 239 trees Mr. Ashplant studied himself and further two sets of trees described by Dr. Frey-Wyssling. In these three cases the yield of the adult tree is given together with the average tube width in the leafstalk. As, according to Mr. Ashplant, this character remains constant throughout the life of the tree, we can figure ourselves that we selected the trees, when still young, on the tube diameter, planting out only those with the highest average.

(a) *Mr. Ashplant's Trees.*—Table III is copied from Mr. Ashplant's lecture; it is only somewhat simplified and a few printer's errors have been corrected. In the horizontal direction the trees are classified according to yield, in the vertical direction according to tube width. The average yield of all the trees is 32·5 cM^3. Mr. Ashplant has calculated, that early selection by means of bore measurements can give a stand of rubber 2½ times the yielding capacity of present stands on the same area. 2½ times 32·5 cM^3 is 81·2 cM^3. If we take the two trees with broadest tubes—those at the bottom of the table with a tube diameter of 20 microns—their yield is $78+99$ $cM^3 = 177$ cM^3, or the average per tree is $177 \div 2 = 88·5$ cM^3. If we add the class with second broadest bore, 19 microns, we find one tree with a yield of 60 cM^3; for the three trees together the yield would average $(177+60) \div 3$ or 79 cM^3, what is already less than 2½ times the average for all trees. It is easy to read from the tables that including further groups (with third widest tube bore 18·5 microns and so on) will reduce considerably the average yield of the selected trees. Mr. Ashplant says, after having cited the possibility to raise the yielding capacity to 2½ times the one of the present stands, that assuming only ordinary skill and experience and allowing for a few misses one can still safely reckon doubling the present productivity. Yes—if one plants only out of 239 trees in the nursery the two trees with widest bore, less than 1 per cent of the total number. It means, that for doubling the yield we have to raise and to submit to microscopical examination one hundred times the number of plants needed.

If we are less ambitious and use, say 33 per cent of our plants the 79 with widest bore, what will be the improvement? The dotted line in Table IV indicates which plants would be selected then. We can add up their yields and divide the sum by the number; the average per selected tree becomes then 49·5 cM^3, or 151 per cent the average for all 239 trees. Under ideal conditions the improvement by planting only 33 per cent of the trees with widest bore would be 151 per cent; in practice it would be, like in the former case, less, certainly well below 50 per cent.

(b) *Sumatra Trees, Common Seedlings.*—Let us now apply the selection of the plants Dr. Frey-Wyssling studied. The tables for his trees are reproduced here in a simplified form and the trees are classified according to tube width. The first set of his comprised 14 seedlings from a native place (Table IV). The average yield for all trees is 6·9 grams. We plant only the 33 per cent or 5 trees, with widest tubes; their average yield can be calculated at 9·2 grams, 133 per cent of the average for all 14. So the selection on tube bore would have improved the yield, but—even if no allowance is made for slips in the practical application—only with 33 per cent, not much more than half the gain with Mr. Ashplant's trees. And to reach this improvement we would have to reject 2/3 of our trees, after examining them all.

Table IV

Common seedling trees in Sumatra classified according to diameter of latex tubes:

Tree Number	Diameter of latex tube in leafstalk	Average yield per tapping In 6th year	Average yield per tapping In 7th year
No. 1	14·4 microns	—	3·3 gr.
,, 5	14·5 ,,	5·0 gr.	5·2 ,,
,, 11	14·9 ,,	5·1 ,,	7·4 ,,
,, 4	15·7 ,,	5·5 ,,	7·0 ,,
,, 2	15·8 ,,	—	2·1 ,,
,, 10	16·2 ,,	7·2 ,,	9·2 ,,
,, 13	16·7 ,,	4·4 ,,	3·6 ,,
,, 9	17·0 ,,	—	3·3 ,,
,, 7	17·2 ,,	6·5 ,,	8·0 ,,
,, 14	17·4 ,,	2·3 ,,	3·3 ,,
,, 8	17·7 ,,	7·0 ,,	6·8 ,,
,, 3	18·2 ,,	6·8 ,,	8·8 ,,
,, 12	18·2 ,,	12·5 ,,	19·2 ,,
,, 6	19·1 ,,	4·7 ,,	7·7 ,,
Average for all trees:	16·6 microns		6·9 gr.
Average for ⅓ of trees with highest yield	17·8 microns		10·6 gr.
Average for ⅓ of trees with widest latex tubes	18·2 microns		9·2 gr.

Table V

Average for all seedling trees, raised from seeds 157 x 185, classified according to diameter of latex tubes:

Tree Number	Diameter of latex tube in leaf stalk	Average yield per tapping In 6th year	In 7th year
No. 3	16·1 microns	16·6 gr.	19·2 gr.
,, 5	16·3 ,,	23·1 ,,	28·8 ,,
,, 1	16·4 ,,	15·6 ,,	23·7 ,,
,, 9	17·0 ,,	14·7 ,,	20·0 ,,
,, 6	17·3 ,,	26·5 ,,	32·5 ,,
,, 7	17·4 ,,	22·9 ,,	34 9 ,,
,, 11	17·4 ,,	36·6 ,,	49·3 ,,
,, 8	17·4 ,,	21·9 ,,	32·0 ,,
,, 10	17·7 ,,	24·1 ,,	32·7 ,,
,, 14	17·8 ,,	5·4 ,,	6·0 ,,
,, 4	18·8 ,,	24·4 ,,	34·6 ,,
,, 2	18·3 ,,	12·5 ,,	17·0 ,,

Average for all trees:	17·3 microns	27·6 gr.
Average for ⅓ of trees with widest latex tubes:	18·0 microns	22·6 gr.
Average for ⅓ of trees with highest yield:	17·7 microns	37·9 gr.

(c) *Sumatra Trees, High-Class Seedlings.*—Dr. Frey-Wyssling describes also a set of 12 trees, grown from seeds obtained by the artificial crossing of two high-yielding trees (Table V). They are far more productive than common seedlings; the average yield is 27·6 grams, or four times the average of the last.

If out of these 12 trees we take the ⅓ with widest tubes—4 trees— and calculate their average yield, we find that it is only 22·6 grams, 5 grams less than the average for the unselected trees. So applying the selection on tube bore would have reduced the crop of our trees, instead of improving it.

The result of selecting the ⅓ of the trees with widest bore is, that in our case—with Mr. Ashplant's trees—we obtained a maximum improvement of 51 per cent; in another case of 33 per cent and in the third case no improvement, but a lowering of the average crop. These figures show, that the selection on tube width does not stand the proof and that it is certainly not reliable enough to be recommended to the practical industry.

Comparison of the Three Sets of Plants and Buddings.—Besides trying the effect of tube diameter selection on the three sets of trees, we use them also for comparing averages. If there is a close correlation between tube width and yield, we may expect that the groups of trees with same average yield show the same average for the diameter of the latex tubes, and vice versa that if the average of the tube width is the same, the yield will not differ much either. To render such comparisons easy I have made table VII. For each set of trees we have calculated the average yield and the average tube diameter, at first for all trees, and then for the ⅓ of the trees with widest tubes and the ⅓ with highest yield.

Table VI

Comparison of the averages for latex tube diameter and for yields with the groups of trees studied and the effects of the selection in per cent increase :

Ashplant's trees.			Average yield per tapping in grams effect
Unselected	...	...	10·8
Sel. acc. t. tube	...	....	16·4 + 31 per cent.
Sel. acc. t. yield Sumatra trees, common unselected	...	...	6·9
Sel. acc. t. tube	...	...	9·2 + 33 per cent.
Sumatra trees, 157 x 165 unselected	...	...	27·6
Sel. acc. t. tube	...	...	22·6—18 per cent.

The yield for Mr. Ashplant's trees has been calculated from his figures in cM³ by dividing them by 3 to obtain the yield in dry rubber.

It is curious to state, that there is a marked difference between the common seedlings Mr. Ashplant described and the ones in Sumatra in relation to tube bore, a difference as much as 2·7 microns, nearly 20 per cent of the average. We would not expect this and I cannot find an explanation for it. But, what is still more curious, the average yield is for both sets of trees practically the same. With the large difference in tube bore, no difference in yield corresponds.

If in this case the conditions of environment differ considerably, this factor is eliminated if we compare the high class Sumatra seedlings with the common ones; both are grown under entirely similar conditions. We find, that for the high class plants the tube width is 17·3 microns, only 0·7 microns more than for the common plants, while the yield is 27·6 grams versus 6·9 grams, exactly 4 times the one of common plants.

There again our comparison does not confirm Mr. Ashplant's theory. We find that a large difference in diameter of latex tubes does not correspond with a higher yield, and in the other case, that a very considerable difference in yield does not correspond with a large difference in the average latex tube width.

On the other side, we can compare the average yields of the three classes of seedlings with those of the popular AVROS-Clones. Table VII gives the figures, obtained by Dr. Heusser, in a set of experimental plots now about 10 years under observation.

Table VII

Yield of AVROS-Clones per tapping.

		Seventh year	Eighth year	Ninth year	
AVROS	33	27·6	29·9	31·8	grams
	36	24·8	33·2	41·4	,,
	49	32·5	35·8	34·5	,,
	50	34·0	29·5	31·1	,,
	80	25·7	27·8	35·7	,,

If we compare these yields with the averages for common seedlings and for the ones selected on tube width, we see, that if the latter figures show some improvement, they still remain far behind the averages for the popular clones. Only the high class seedlings come near to these clones in yield, but on this set of trees the tube width selection was a complete failure and further seeds of this high quality are not available.

Apart from the yield there are other characters, like vigour and resistance against diseases, which count, if we want to judge the value of our planting material.

According to Mr. Ashplant (R.G.A., p. 802) he has discovered a number of snags with budding: weak growth, weak renewal, possibly greater susceptibility to disease, undoubtedly greater susceptibility to Brown Bast. Those, who are familiar with our present clones will not share this opinion. On the contrary, we have clones which in vigour and resistance against diseases surpass our common seedlings. There is a special point in favour of budgrafting, compared to seedling selection and that is the great uniformity in special characters.

With seedlings grown from the best selected, clonal seeds, even if they are obtained by self-fecundation, such a uniformity will never be reached with our present material. There is a good chance, that some of our clones now popular among planters in Java and Sumatra will show special advantages, for instance a greater resistance against secondary leaf-fall or against drought. If such a clone is found we are certain, that it will repeat this character in all its buddings, while with seedlings we are never sure we will always find variations in the degree of resistance.

In many circles there is still a prejudice against budgrafting, a lack of faith in the results obtainable by this process.

Instead of arguing with yield figures, I will cite statistical data for Sumatra, where in 1929 practically all extensions were planted with budgrafts, pure and mixed with seedlings.

The Extension with Buddings in Sumatra.—Since 1920 buddings are planted on a fairly large scale in Sumatra. In the first year after 1920 generally mixtures of buddings and seedlings were planted with the idea that if the buddings turned out to be less satisfactory, the seedlings only could be kept. Also a fair percentage of the extensions were planted with seedlings, grown from selected seeds, in former years mostly seeds taken from high-yielding trees in common plantations.

At present seeds from clonal plantations become available and possibly selected seeds are now mostly clonal seeds. In the first year only part of the extensions were planted with improved material.

In table VIII we have put together the figures, calculated in acres, for the total extensions of each year and for the average under buddings, under buddings mixed with seedlings and under selected seedlings. From these figures the percentage figures are calculated. They give the percentage of the group of the total extension, the percentage of the total extension with improved material, total of per cent figures column 1, 2, and 3, and the percentage with buddings mixed with seedlings, column 1 + 2.

From these last figures we may conclude, that planters in Sumatra have abandoned entirely the planting of common seedlings; column 4 shows that in the last two years all extensions were planted with improved material. The table shows further, that there is a tendency to turn more to buddings. Column 5 shows a gradual increase in the percentage of the fields planted entirely and partially with buddings. We see further, that there is a growing confidence in buddings. The percentage of the extension with pure buddings, see column 1 becomes larger every year.

Table VIII

Figures on extensions with improved material in Sumatra (in acres).

Year	Total extension	1 Pure buddings	2 Budding a seedlings	3 Selected seedlings	4 Improved material	5 Budding a mixture.
1924	22·252	2·580	5·975	4·215		
		11·6%	26·9%	18·9%	57·4%	38·5%
1925	20·630	1·350	11·338	1·732		
		6.5%	55·0%	8·4%	69·9%	61·5%
1926	34·182	8·648	16·432	7·070		
		25·3%	48·1%	20·7%	94·1%	73·4%
1927	40·507	9·758	21·345	9·040		
		24·1%	52·8%	22·3%	99·2%	76·9%
1928	44·257	13·782	23·937	6·537		
		31·1%	54·1%	14·8%	100%	85·2%
1929	32·960	19·340	12·310	1·310		
		58·7%	37·4%	4%	100%	96·0%

Conclusions.—From the figures and comparisons resumed above may be concluded, that the selection average tube diameter in the leafstalk has no value for improving the yields per acre. If we study it from various angles we find that yield and tube width are not so well correlated as Mr. Ashplant thought them to be. In this respect we may cite Dr. Frey-Wyssling's conclusion, that trees with narrow tubes are poor yielders, but trees with wide tubes are by no means always good yielders of rubber. This is a serious drawback against practical application of the method. It is more important for the efficiency of our selection, that we exclude all poor yielders, than that we include all high yielders and it is just on this point that the method fails.

If we apply the method on the three sets of trees, for which yield and tube diameter has been studied, we find that in the two cases, where some improvement was reached, with common seedlings the improved yield remained still far behind the yield which may be obtained with the popular clones.

From this we may conclude, that at present the best way to raise our crop per acre is to plant the best clones now available. That is, what planters in Sumatra have started to do some years ago; from the statistics may be concluded, that they have more and more confidence in buddings. The safest policy for planters in other rubber-producing centres of the world is to follow their example, till perhaps in a further state of the technique of rubber-growing new methods are found, easy to apply, efficient and reliable. I do not think, that the selection on tube diameter responds to those three demands.