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DETERMINATION OF DRY RUBBER CONTENT OF LATEX BY BUOYANCY METHOD*(1)

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Summary

Experiment was conducted to determine the pattern of variations between dry rubber content of latex and the specific gravity of dry rubbe produced by six varieties of rubber trees cultivated in the Hainan island. While the dry rubber content was within the range of 17 to 45 %, the dry rubber specific gravity was in the range of 0.915 to 0.909. That is, higher is the dry rubber content, lower is the specific gravity. When a sample of 10 grammes form a thickness of less than or equal to 2 millimetre to the new rubber slice, immerse it in water for 1.5 hours in order to remove the soluble nonrubber contents. The determination factor of this method and the degree of accuracy are compared with the weighing method. Special features of this method are: the buoyancy of the new rubber slice which is determined inside water and the buoyancy of dry rubber whose weight is already known are mutually compared, then the weight of dry rubber within it can be calculated. No electric power or oven is required and any basic level production unit can use this method. Result can be obtained within 2.5 hours after sampling; variation in analysis is about 0.5 %.

Introduction

Determination of dry rubber content in the latex is of great

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importance in the production of rubber as well as in scientific experiments. It not only commands and grasps the production as well as the quality of rubber trees, but also is the major basis for the rubber workers to get better rewards. At the same time, it is also one of the important means which influences the various factors related to the growth and production of rubber which the scientific research personnel have understood and on which research is conducted. Therefore, all along people attach great importance to this. During 1973, the Rubber Institute of Malaysia listed 15 types of analysing methods.*(2) These methods are divided into two major categories. No. 1 is the weight method and No. 2 is the hydrometer method. No. 1 method is accurate, but the analysing speed is considerably low. Though the second method is fast, variation is high. Since recent 30 years, the experts of our country have carried out lot of work in this aspect and there is development to certain extent. But, up till now, the method used by basic level production unit is simple, convenient and fast, but a basically accurate method has not yet been established. For this purpose, experiments were conducted based on Archimedes principle and this new method has been advanced to determine the dry rubber content in the rubber latex— the buoyancy method.

I. Principle

According to Archimedes' principle, when a body is immersed in a gas or liquid, that gas or liquid exerts a vertically upward thrust (buoyancy), the amount of this force is equal to the weight of the same volume of gas or liquid displaced by the body. Water is a kind of liquid, its specific gravity is taken as 1, the buoyancy which is received by the rubber slice is numerically equal to the volume (in

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cubic centimetre) of water displaced by it.

Suppose the weight in the air of new rubber slice containg water is X grams

Weight inside water of new rubber slice which contains water be Y grams

Then the volume of new rubber slice is X-Y cu.cm

Hence specific gravity of this rubber slice is $\frac{X}{X-Y}$ (1)

Again, suppose the dry rubber weight of this rubber slice is R grams

" suppose the specific gravity of pure rubber is d

Then the volume of dry rubber inside this rubber piece is $\frac{R}{d}$ cu. cm

Since the volume of water inside this rubber piece is X-R cu.cm

Hence the volume of this rubber piece also is $X-R+\frac{R}{d}$ cu.cm

Therefore the specific gravity of this rubber piece is $\frac{X}{X-R+\frac{R}{d}}$ (2)

By (1) and (2) we get the formula $Y=R.(\frac{d-1}{d})$ ... .(3)

Or $R = Y.(\frac{d}{d-1})$

From formula (3) it can be seen that (1) the weight Y of new rubber piece inside the water and the weight of dry rubber within the rubber piece become directly proportional, (2)

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change in specific gravity (d) of rubber resulted to change of $\frac{d-1}{d}$ effecting the analysis , (3) when the specific gravity of the weighed body is less than 1, the body floats, Y becomes negative. When the specific gravity of rubber is less than 1, Y becomes negative. (4) When the specific gravity of the weighed body is 1, Y=0. Specific gravity of water is 1, hence the water content in the rubber piece will not have any effect on the analysis. Therefore using suitable instruments by weighing the buoyancy of rubber piece having water content inside water, the dry rubber content in it can be obtained.

II. Testing equipments and Materials

1. Latex sample: Fresh latex having different rubber content from 6 varieties of rubber trees such as PR 107, PRIM 600, PB 86, GT1, Hai Ken 1, and Shi Sheng Shu produced by No. 5 Unit of Experimental Agricultural Farm of this Institute.

2. Equipments: Analytical balance, Open-sided torque balance of sensitivity 0.001 gram, table balance of sensitivity in the range of 0.05 to 0.1 gram, one each and Dry rubber analyser-1 (sketch 2 E) / table balance of sensitivity 0.01 gram

3. 3% Acetic acid.

III. Method of experiment and Result.

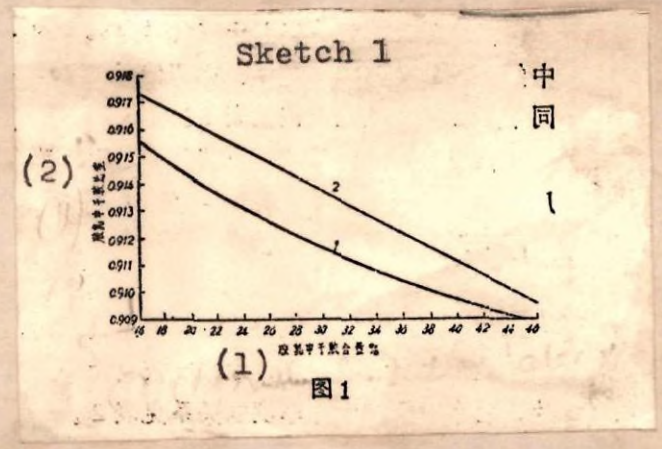
(A) Pattern of variation variations between dry rubber content of latex and dry rubber specific gravity.

The aim of conducting this experiment is to find out the effect on the result of analysis when ' d ' changes. Method of analysing the dry rubber content in the latex and the specific gravity of dry rubber are as follows:

Sampling of latex, solidifying, pressing and immersing in water are similar to Section 1, 2, and 3 of Section IV of this article, however, keep immersed in water overnight, dry the rubber piece inside oven at 70°C. Take the weight using Analytical Balance

and calculate the dry rubber content. Afterwards, take an open-sided Torque Balance having weighing capacity of 500 milligrams and sensitivity of 1 milligram; using a thin nylon thread , suspend a small wire hook at the lower end and the upper end to the arm hook of the balance, immerse the small wire hook in distilled water at 28°C(3). Adjust the total weight to 500 milligrams. Suspend each rubber piece on small wire hook, immerse them in water and determine the buoyancy. Afterwards calculate the specific gravity of each rubber piece using formula No. 1 of Section I.

Pattern of variations between the dry rubber content of different breeds (27 samples of each breed) and the specific gravity of dry rubber are shown in sketch 1.



Sketch 1.

Sketch No.1 shows the following :- In the latex where the dry rubber content is higher, its specific gravity is lower. In five breeds of PB 86, PR 107, RRIM 600, Hai Ken 1 and Shi Sheng Shu, the five curves showing the relationship between their dry rubber content and dry rubber specific gravity are fairly close, for this curve No.1 is drawn taking their average value. The curve of GT 1 is almost a straight line(curve 2) and its specific gravity is slightly higher than previous 5 breeds.

The dry rubber specific gravity is as good as the Malaysian rubber(4), when the dry rubber content is within the range of 25% to 45%, the variation in dry rubber specific gravity is in the range of 0.0006 to 0.0030. When the dry rubber content is below 25% , the variation is in the range of 0.0057 to 0.0119. The specific gravity of all dry rubber produced in Hainan island is a little lower.

According to sketch 1, calculation shows that the buoyancy of rubber piece with 32% dry rubber content is standard (specific gravity 0.9112, the buoyancy of each gram of dry rubber in water is 0.09745 gram), that is, the variation in analysis when No.1 type of standard rubber piece is used, (see 'C' of this section). Variations in analysis of different dry rubber contents are shown in Chart 1.

Chart 1

Dry Rubber Content %	Dry Rubber Specific Gravity	Variation In Analysis %	Dry Rubber Content %	Dry Rubber Specific Gravity	Variation In Analysis %	Dry Rubber Content %	Dry Rubber Specific Gravity	Variation In Analysis %
16	0.9154	-0.83	26	0.9126	-0.45	36	0.9104	+0.36
17	0.9151	-0.82	27	0.9123	-0.36	37	0.9102	+0.46
18	0.9148	-0.80	28	0.9121	-0.31	38	0.9101	+0.52
19	0.9145	-0.77	29	0.9119	-0.25	39	0.9099	+0.63
20	0.9142	-0.74	30	0.9117	-0.19	40	0.9097	+0.74
21	0.9139	-0.70	31	0.9114	-0.08	42	0.9094	+0.94
22	0.9136	-0.65	32	0.9112	0	44	0.9092	+1.09
23	0.9134	-0.62	33	0.9110	+0.08	46	0.9090	+1.26
24	0.9131	-0.56	34	0.9108	+0.17	48	0.9088	+1.43
25	0.9129	-0.52	35	0.9106	+0.26	50	0.9080	+1.61

Notes: 1. The analysis variation between two dry rubber contents can be obtained by using the method of substitution of variation.

2. The use of curve showing analysis variation drawn out of dry rubber content and corresponding variation is more convenient.

Example of correction of analysis result:-Suppose the dry rubber content of certain latex is 30%. Referring chart 1, the variation is 0.19. Hence the analysis result after correction is 30+0.19=30.19%.

(B) Testing by immersing rubber piece in water

Immersion of newly formed rubber piece in water is called immersion of rubber piece. The aim is to remove the non-rubber components in the water inside the rubber piece so that the purity of rubber will be increased. If the duration of immersion of rubber piece is not enough, the specific gravity of rubber piece will be slightly higher which will cause to lower the result of analysis.

Take one cup of well distrubted latex , take 10 grams of latex as a sample. According to method explained in Section(IV), form rubber pieces of varying thickness, the relation between immersion time and thickness of rubber piece is shown in Chart 2.

Chart 2.

Immersion time of rubber piece(in hours) / Buoyancy reading (in millimetres) / Thickness of rubber piece (in millimetres)	0.5	1	1.5	2	3	4	12	24
3.5	61	68	69	69.5	72	73	73	73
2.9	62.5	69	69	70	72	73	73	73
2.0	69	72	73	73	73	73	73	73
1.3	71.5	72	73	73	73	73	73	73
1.1	72	72	73	73	73	73	73	73
1.0	72.5	72.5	73	73	73	73	73	73

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Result given in Chart 2 shows: when the thickness of rubber piece is less than or equal to 2 millimetres, the immersion time in water has already crossed 1.5 hours.When the thickness of rubber piece is between 2.0 and 3.5 millimetres, for every 1 millimetre thickness , the immersion time is to be correspondingly increased by 1.5 hours.

(C) Standard Rubber Piece and Standard Curve

1. Standard Rubber Piece: A rubber piece whose weight as well as the dry rubber content of the latex forming the rubber piece are known is called standard rubber piece.

(i) No.1 type of standard rubber piece: Take 10 to 15 latex samples having approximately 32% of dry rubber content, each sample being 10 grams; make rubber piece by using method given in Section IV, keep them immersed in water for overnight. Afterwards allow them to to dry up in the oven at 70°C, weigh and calculate the dry rubber content. Select three rubber pieces having 32% ($\pm_0$.5 %) of dry rubber content. In the centre, pierce round holes of diameter 2 to 3 millimetres. With the round holes as the centre, cut pieces of weight 1,2and 3 grams respectively. They can be grouped into different weights in the range of 1 to 6 grams, that is to say, dry rubber weight corrosponding to 10 grams of latex whose dry rubber content is in the range of 10 to 60%.

(ii) NO. 2 type of standard rubber piece: Before the extraction of rubber latex bebins, depending on trunk of the trees, select from the rubber grove section 10 latex samples of different dry rubber contents in rubber cups. Take 10 grams of each sample and make rubber pieces according to method given in Section IV; immerse them in water overnight, pierce holes in the middle. Then by using Dry Rubber Analyser , take the true buoyancy reading of each rubber piece (See Section IV). After drying the rubber pieces by placing them in the oven at 70°C, take their weights and calculate the dry rubber contents. These rubber pieces can be preserved properly and used as standard rubber pieces.in one to two months.

Out of the two types of standard rubber pieces, select only one for use.

2. Standard Curve: By using the method given in Section IV, the true buoyancy reading of each standard rubber piece is determined. Standard curve is drawn with dry rubber content as abscissa and true buoyancy reading as ordinate(Sketch 2). When No.1 type of standard rubber piece is used, the analysis result obtained from the curve must be corrected according to chart 1. When using No.2 type of standard rubber piece, the standard curve already contains

Sketch 2

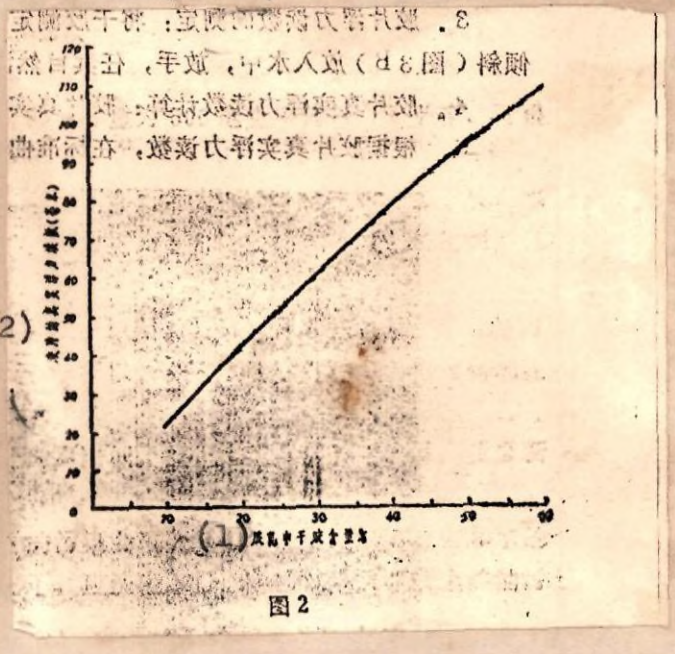


图 2

$\frac{d-1}{d}$ factor in it, the variation in analysis is automatically removed, therefore the result obtained does not require any correction.

(D). Comparison of analysing conditions and accuracy with d. weight method.

1. Conditions: Weight method requires balances, electric power and oven. The result can be obtained only after 30 to 48 hours of sampling. But buoyancy method requires only balance(or absorption tube) and dry rubber analyser (Sketch 3 D. E). Electric power and oven are not required, result of sample can be obtained after 2.5 hours.

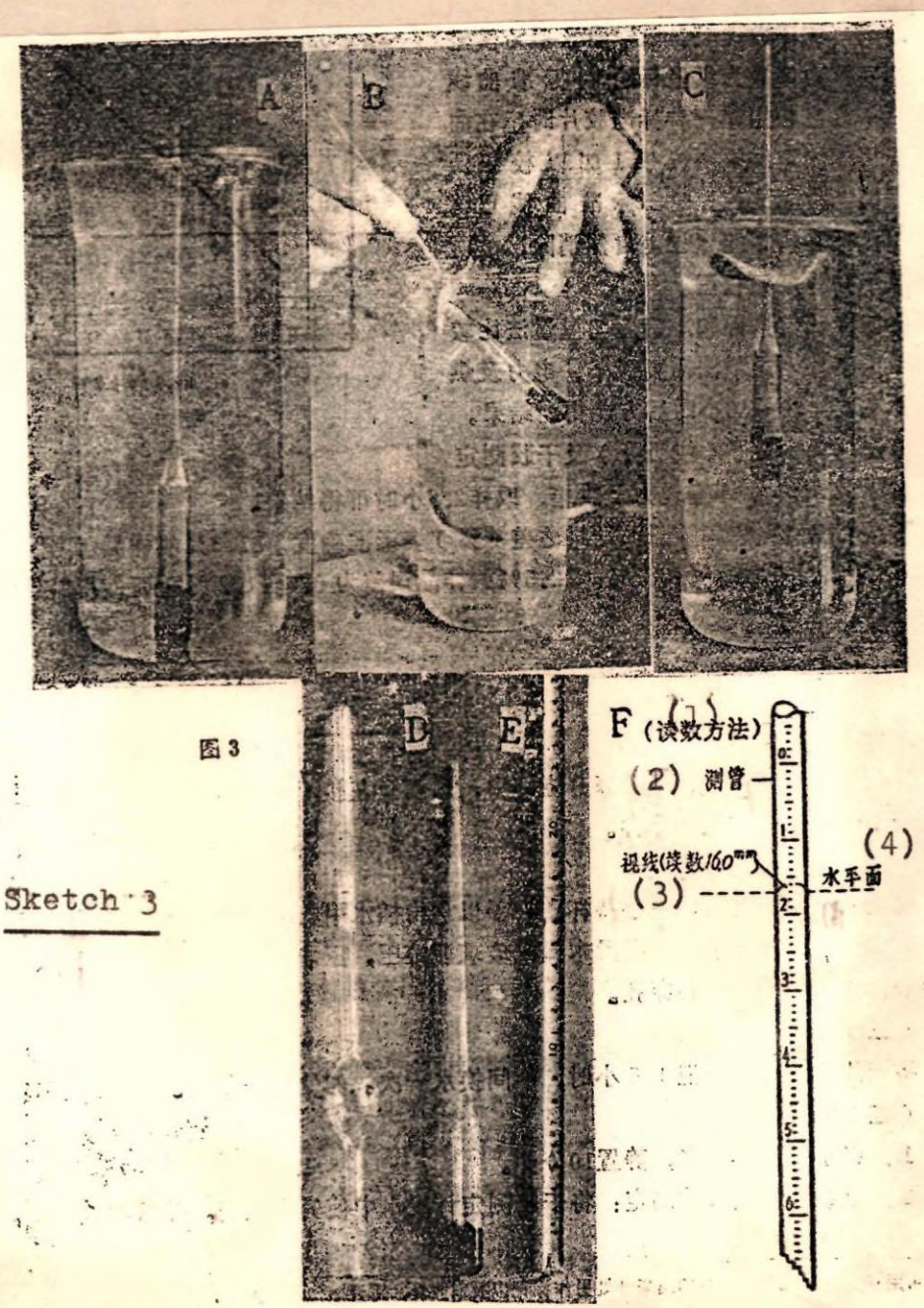


图 3

Sketch 3

2. Degree of accuracy: The percentage of variation in the result using weight method shows the degree of accuracy. Sample variation in 81.5% is less than 0.5%, in 6.2% is 0.5 to 0.7% and in 12.5% it is between 0.7 to 1.2%. But when using No.2 type of standard rubber piece, the degree of accuracy is slightly higher.

IV. Method of Analysis

(A) Sampling and Solidifying

Using balance,* (5) weigh 10 grams of latex in 50 millilitre beaker, spread 1 millilitre of 3% acetic acid close to the surface of latex, gently shake and distribute it evenly and keep it quiet for 40 minutes.

(B) Pressing the piece

Fill a rubber cup with clear water, hold the rubber cup with with left hand, put the index finger of the right hand inside water, roll down the rubber coating on the wall of the cup and press on the rubber piece. Take out the rubber piece , place it on a smooth surface, press it by smooth and evasive woodden stick or glass bottle until the thickness of the rubber piece becomes less than or equal to 2 millimetres. Afterwards put marking on the rubber piece and pierce hole in it at the centre with pointed owl.

(C) Immersion of rubber piece in water

Keep the rubber piece immersed in water for 1.5 hours, change the water once in the middle. Donnot allow the rubber piece to overlap or fold.

(D) Analysing

(i)Fill a bucket with clear water, keep it quiet for 10 minutes

(ii) Determination of buoyancy reading of air; Immerse the dry rubber analyser in water so that it becomes fully damp, afterwards place it vertically in water; when the water is steady , take the buoyancy reading 'A' of the air (See Sketch 3 A.)

(iii) Determination of buoyancy reading of rubber piece: Insert the thin end of the dry rubber analyser in the hole of the rubber piece, then move it to the lower part of the analyser tube inclined at 45 degrees (Sketch 3 B), let it go inside the water , leave the hand and allow it to sink or float; after it is steady take the buoyancy reading 'B' (See skrtch 3 C).

(iv)Calculation of true buoyancy reading of rubber piece:

The true buoyancy reading of rubber piece = B-A.

(v) Based on true buoyancy reading of rubber piece, the dry rubber content of each latex can be found out from the standard curve.

V. Discussing the problems

1. Instruments for determination of the buoyancy of rubber piece are, extremely sensitive spring balance, open-sided torque balance which has a weighing capacity of 500 milligrams etc. can be selected and used depending on conditions. The more precise is the instrument, the higher will be the accuracy.
2. Sensitivity of the dry rubber analyser: Normally the buoyancy of each gram of dry rubber in water is nearly 0.098 gram . This means that in water each gram of dry rubber will cause to float a section of its weight which is nearly 0.098 gram on the analyser, measuring tube must be thin and small. Dry rubber with sensitivity of 0.5 gram per millimetre is suitable.
3. Mixing up of air bubbles with the rubber piece is the main reason for producing high analysis result. The buoyancy offered by 0.01 millilitre of air bubbles and the buoyancy of 0.01 ounce of rubber is the same. This can lead to a variation of $\pm$ 1%. Therefore during the entire period of analysis, maximum attention is to be given to prevent production of gas bubbles.
4. The buoyancy reading by using dry rubber analyser with air inside goes up and down along with the water temperature. Hence, when there is considerable change in water temperature the analysis should be repeated in order to get accurate true buoyancy reading.
5. Do not allow greasy dirt to remain on the surface of water because the pollusion of measuring tube by greasy dirt will change the adhesive force between measuring tube and water as well as the surface tension of water; more-over it will cause irregular drift in the readings, Under this circumstances, wash and clean the bucket and replace the water. The greasy dirt over the measuring tube can be removed by gently rubbing with cotton dipped in ethil alcohol.

References

This article was received on 4 June 1981.

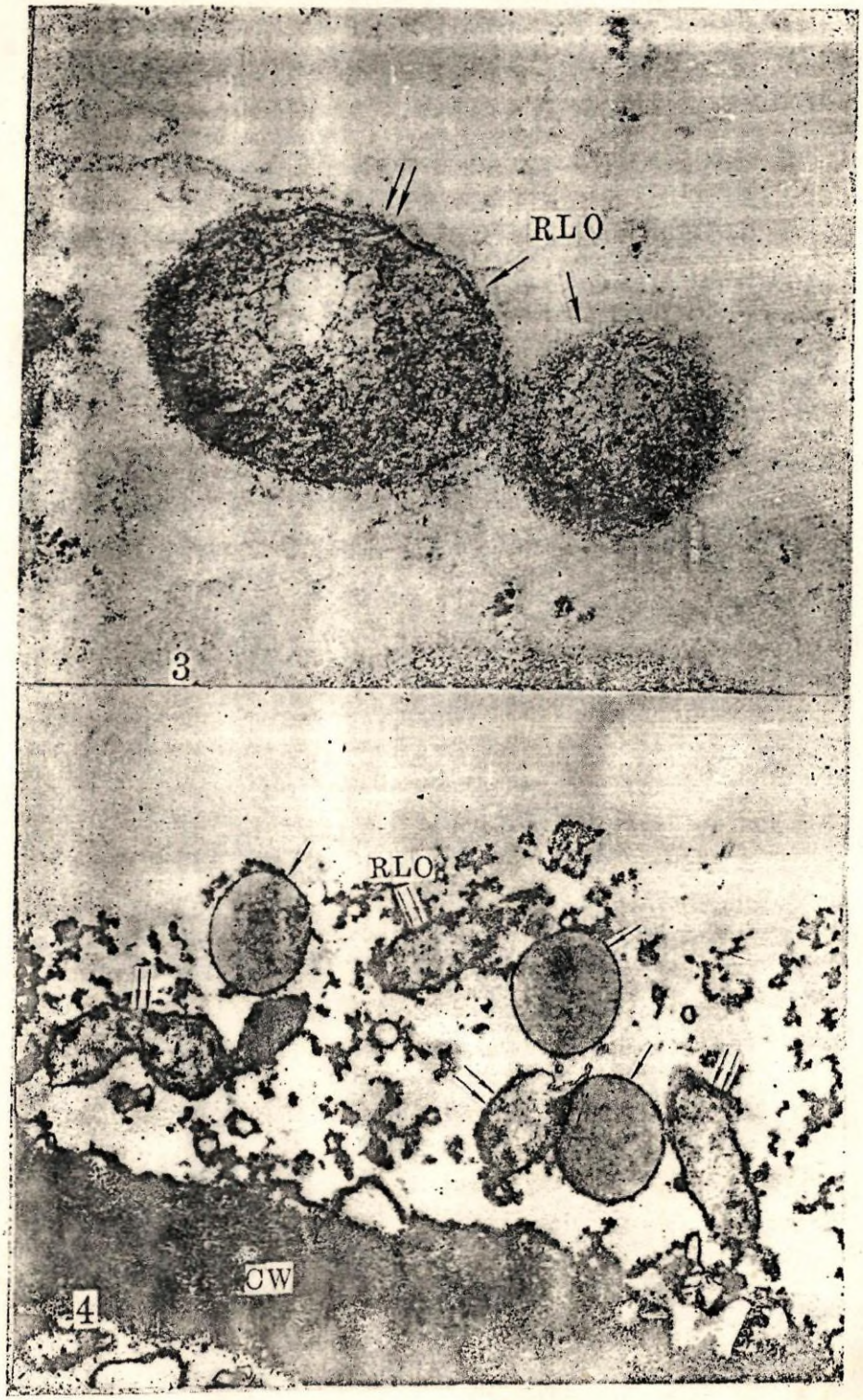
*(1) on page 1: The analysing principle advanced by this article is the method used in the early days for determination of dry rubber content by weighing the buoyancy in water of rubber piece containing water by extremely sensitive spring balance , (Zhen Yu San): (A new method to determine the dry rubber content) (Scientific and Technicial News of Tropical Corps, Issue No. 3 of 1977). Later Comrade Fang Zhong Gen advanced a method for speedy determination of dry rubber content of latex by using open-sided torque balance, (Scientific and Technical News of Tropical Corps, Issue No. 4 of 1977). Comrade Li Shi Sen also advanced a new method to determine the dry rubber content of latex ---- the method of determination by Specific Gravity Meter) (Scientific and Technical News on Tropical Corps, Issue No. 5 of 1977). Considering the high cost of analyser and also with the object of gaining easy popularity, this article selected a comparatively simpler equipment --- the Specific Gravity Meter which enabled to increase the sensitivity by two to three times. In order to determine the buoyancy of rubber piece and to differentiate the concept of buoyancy of rubber piece and the specific gravity of liquid, the Specific Gravity Meter was renamed as Dry Rubber Analyser.

*(2) in Page 2:

RRIM Planters Bulletin : Methods for analysing the rubber content of field latex, 124 (1973) .

References continued on page -28-

1. 橡胶树褐皮病韧皮部筛管细胞中的RLO病原. 15000×
2. 橡胶树褐皮病韧皮部筛管细胞中的RLO病原. CW示细胞壁. 15000×

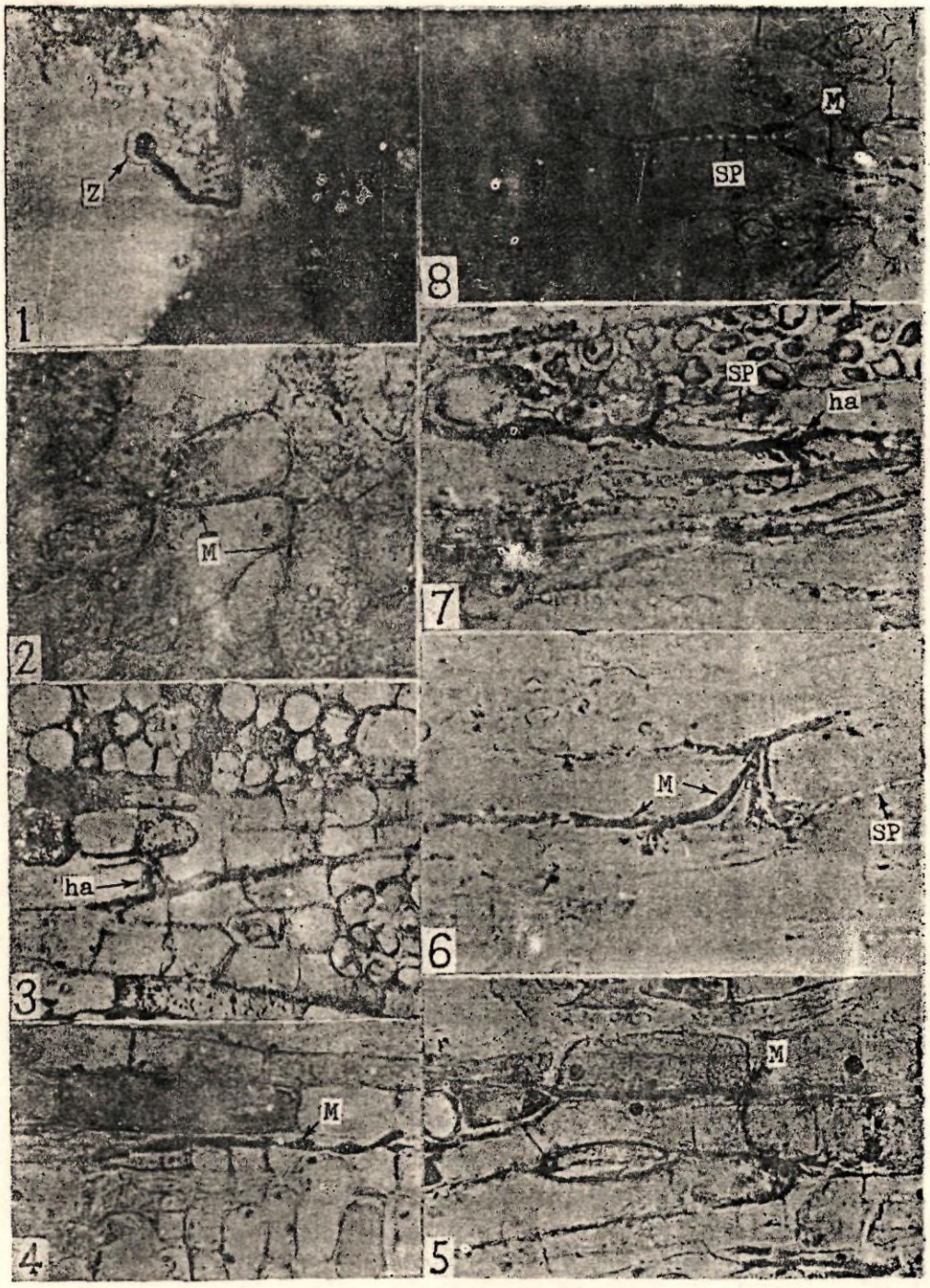


3．橡胶树褐皮病的RLO病原．49800×

4．橡胶树褐皮病乳管细胞中的RLO病原(双箭头所示)，乳胶粒子(单箭头所示)．20000×

5. 橡胶健康树乳管细胞中的乳胶粒子(箭头所示)。15000×
6. 橡胶健康树韧皮部筛管细胞，CW示细胞壁，N示细胞核。16600×

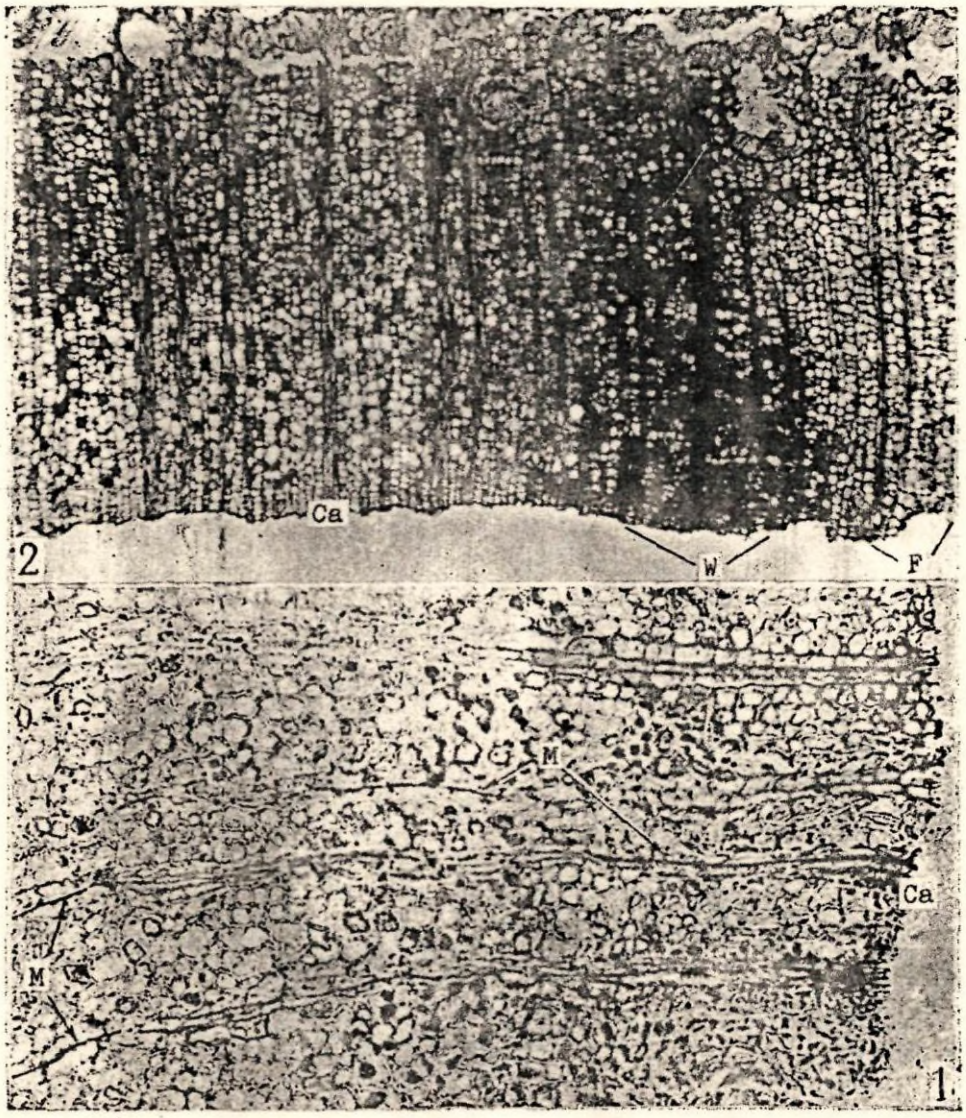
(I) 吴继林等：巴西橡胶树条溃疡病的病理解剖学研究 图版 I



.游动孢子侵入树皮切片的情形。×400 2.砂皮中的菌丝。 3.黄皮的切向切面，示薄壁细胞中形成的吸器。 4.黄皮中的菌丝(M)，它不伸向含有单宁物质的细胞(深色)。 5.黄皮中的菌丝。 6.筛管中分枝的菌丝。 7.筛管中菌丝形成的吸器。 8.筛管中菌丝穿过筛板。 2—8：×300 (M菌丝 ha吸器 Z萌发的游动孢子 SP筛板)

Plate II

(I) 吴继林等：巴西橡胶树条溃疡病的病理解剖学研究 图版 II



1．受侵染树皮横切面，表示菌丝从射线侵入，×58

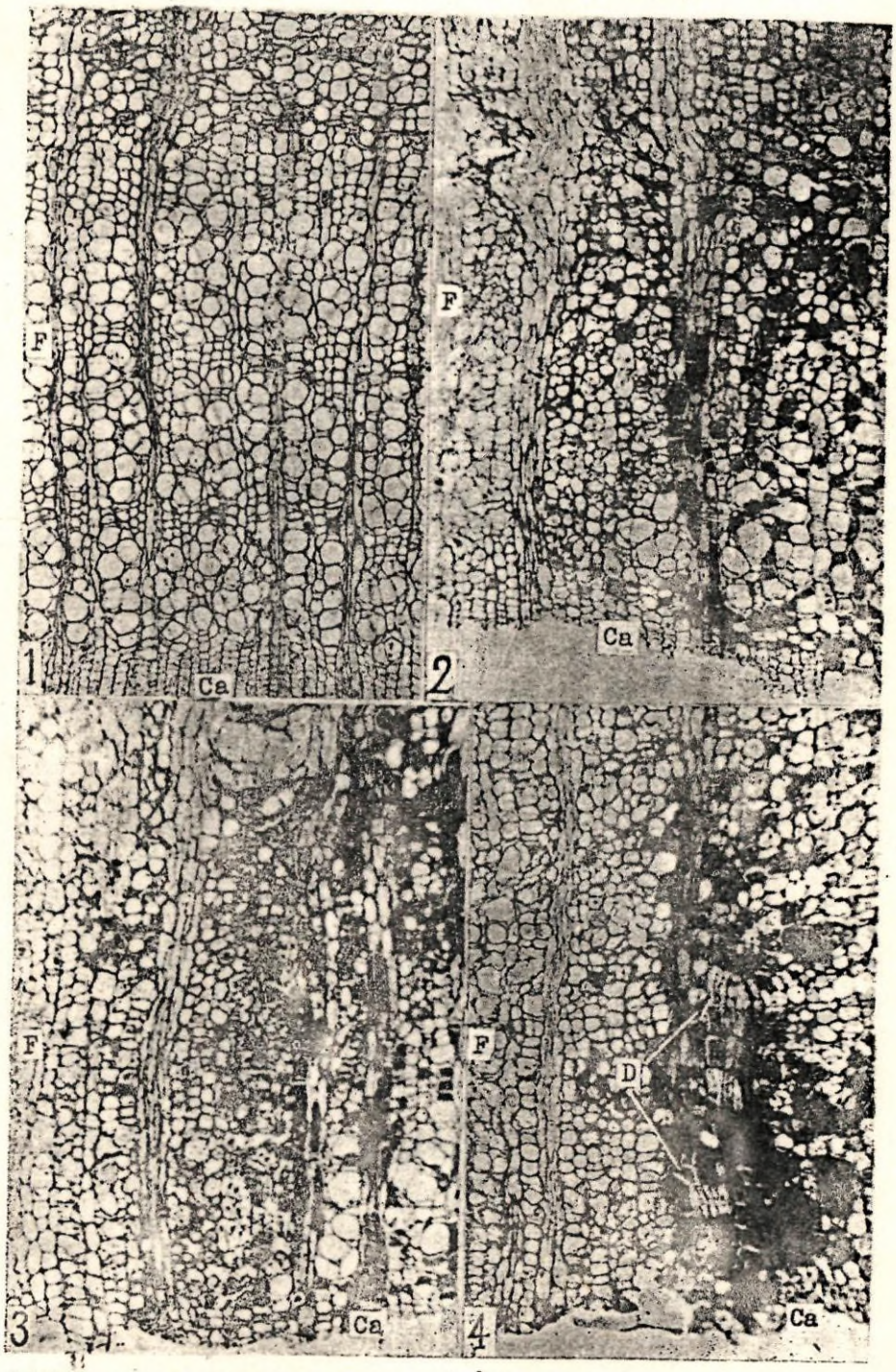
2．树皮病斑横切面，表示褐变层，×40

（Ca形成层，F受侵染的组织，M菌丝，W褐变层）

Picture 6 Page -19

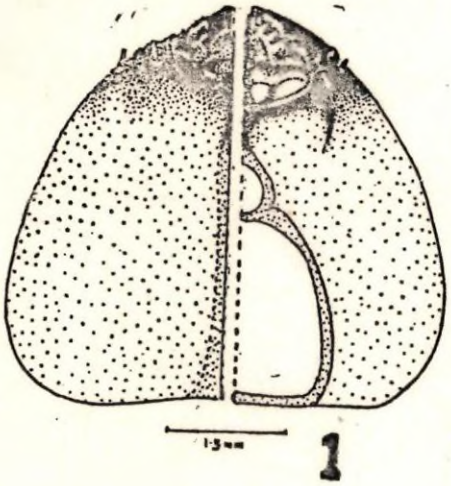
Plate III

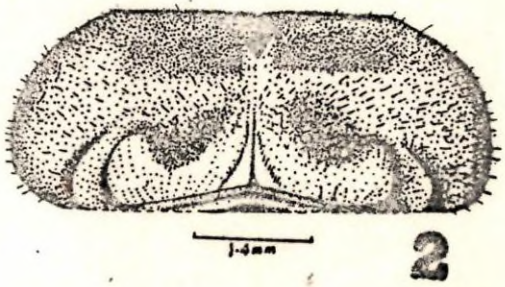
(I) 吴继林等：巴西橡胶树条溃疡病的病理解剖学研究 图版 III

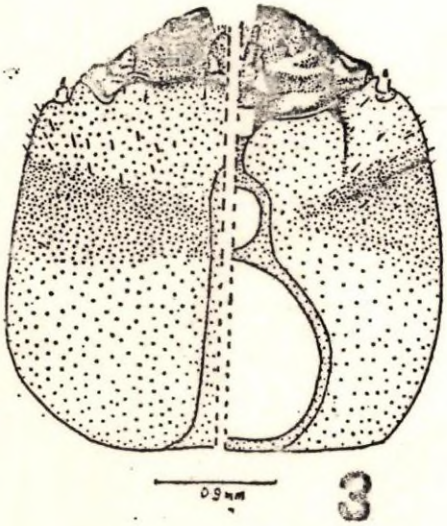


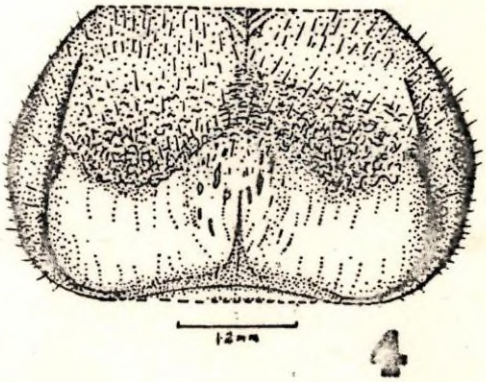
的发生和变化：1．侵染初期，在受侵染组织附近形成的少数褐变细胞（右面深色的细胞）．2．褐变细胞增多，
层形成．4．褐变细胞分裂，以后形成新的周皮．1—4：×55 （Ca形成层，F受侵染的组织，D正在分裂的褐
胞）

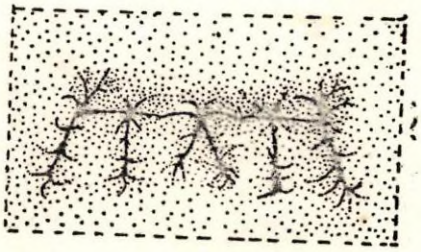
(I) 钱庭玉：咖啡、可可天牛类害虫幼虫记述 图版 I

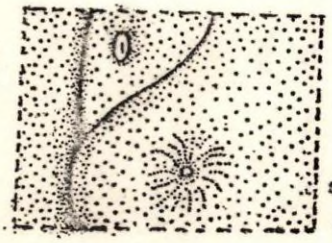


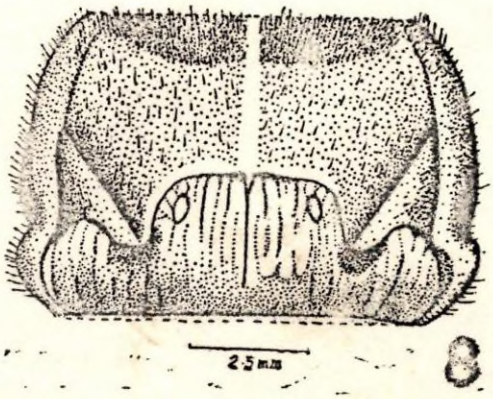






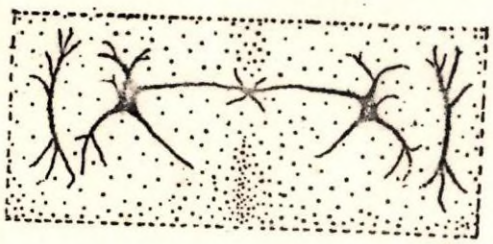






1．咖啡飞字虎天牛幼虫头部 左、背面；右、腹面；左、背面；右、腹面 2．咖啡灭字虎天牛幼虫前胸背板 3．艳虎天牛幼虫头部 4．艳虎天牛幼虫前胸背板 5．艳虎天牛幼虫第3腹节背面步泡突 6．艳虎天牛幼虫额区前缘 7．艳虎天牛幼虫第2腹节侧疣 8．龟背天牛幼虫前胸背板

(I) 钱庭玉：咖啡、可可天牛类害虫幼虫记述 图版 II



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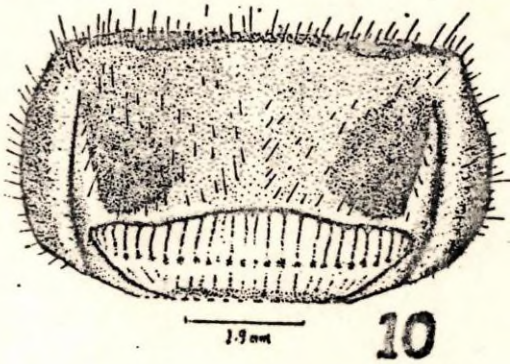

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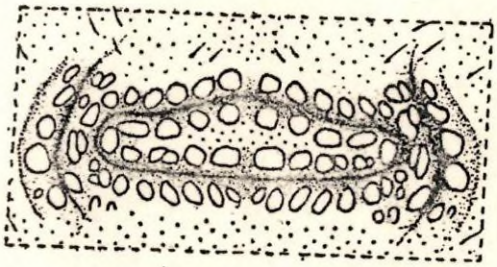

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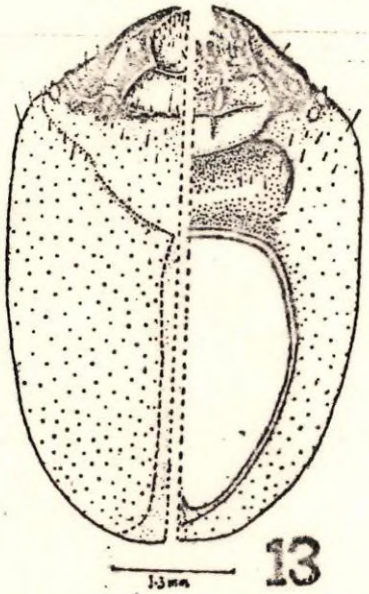

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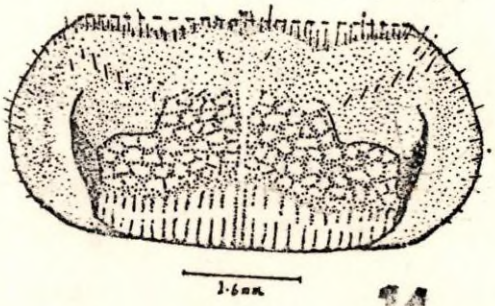

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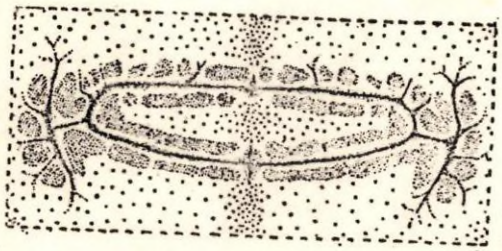

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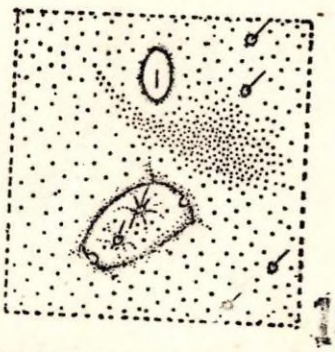
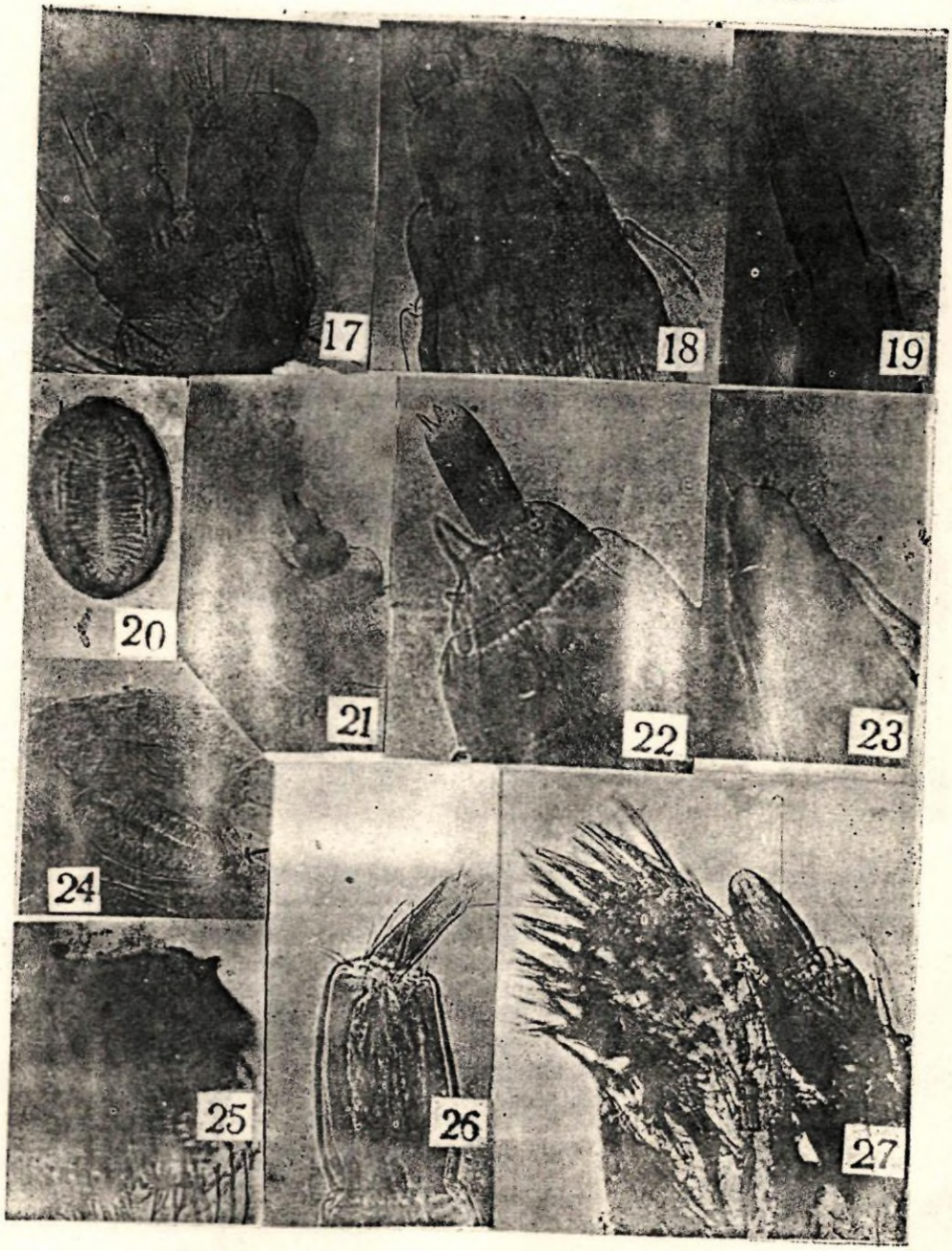


16

9. 龟背天牛幼虫第3腹节步泡突
11. 龟背天牛幼虫前胸主腹片
13. 海南灰天牛幼虫头部 左、背面；右、腹面
15. 旋皮锯天牛幼虫第3腹节步泡突

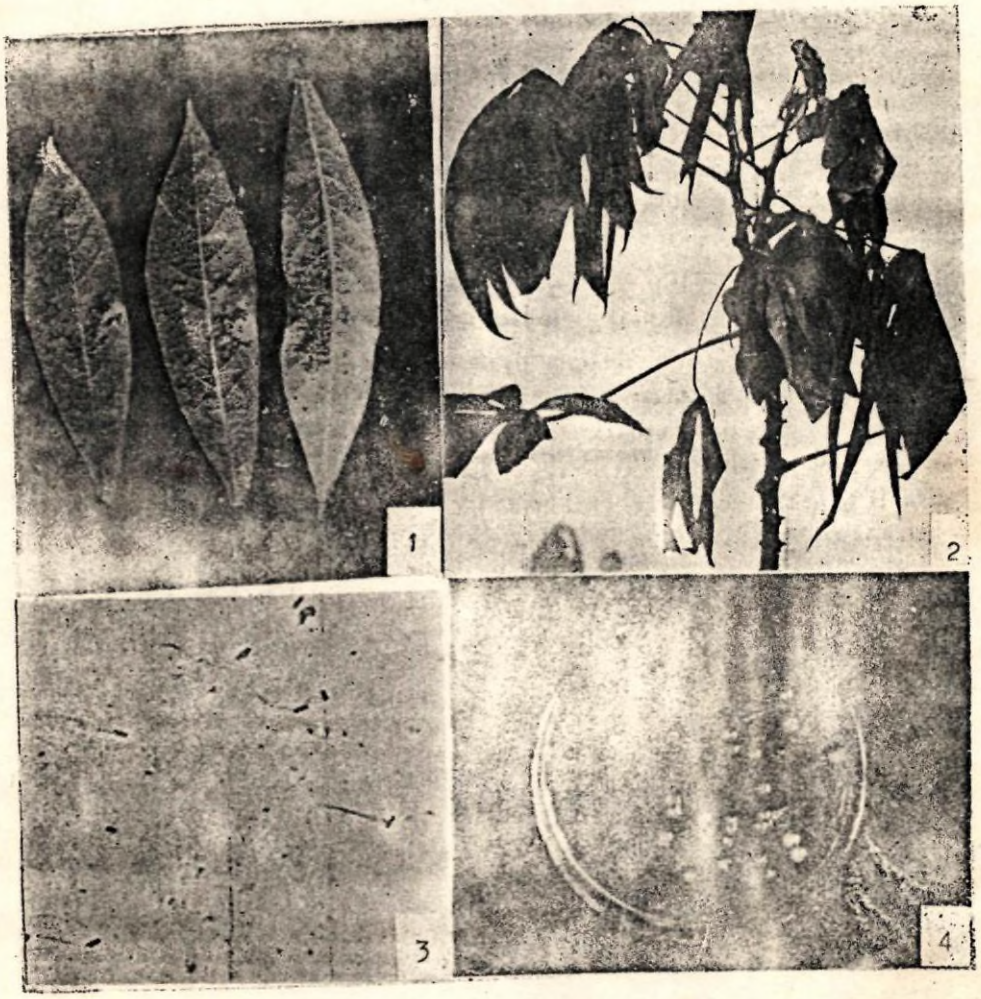
10. 海南灰天牛幼虫前胸背板
12. 海南灰天牛幼虫第3腹节背面步泡突
14. 旋皮锯天牛幼虫前胸背板
16. 旋皮锯天牛幼虫第3腹节侧盘

(I) 钱庭玉：咖啡、可可天牛类害虫幼虫记述 图版Ⅲ



17. 咖啡灭字虎天牛幼虫左下颚
18. 龟背天牛幼虫触角端部
19. 咖啡灭字虎天牛幼虫触角端部
20. 旋皮锦天牛幼虫中胸气门
21. 艳虎天牛幼虫右下颚
22. 海南灰天牛幼虫触角端部
23. 旋皮锦天牛幼虫触角端部
24. 艳虎天牛幼虫中胸气门
25. 海南灰天牛幼虫上唇
25. 艳虎天牛幼虫触角端节
27. 龟背天牛幼虫右下颚

(I) 文衍堂等：木薯细菌性疫病病原菌鉴定 图版 I



1．喷雾接种的叶片表现典型的水渍状角形病斑。
2．嫩茎针刺接种后，枝条和叶片表现萎蔫症状。
3．病原菌形态。
4．菌落形态。

Insertions in Sketches / Pictures

Sketch 1 , Page 5.

(1) Dry rubber content of latex (%)

(2) Specific gravity of dry rubber in the latex

Sketch 2, Page 9.

(1) Dry rubber content of latex (%)

(2) True buoyancy reading of rubber piece

Sketch 3, Page 10

(1) Method of reading

(2) Measuring tube

(3) Line of sight(Reading 16.0 mm)

(4) Level surface

Picture (1), Page- 14

(I) Zheng Guan Biao and others: Plate No.1

Preliminary report of research conducted on the cause of contagious disease in the bark of rubber trees.

(1) The cause of RLO disease to the cells of sieve tube on the phloem of rubber trees. 15000X

(2) The cause of RLO disease in the cells of sieve tube on the phloem of rubber tree. CW indicates cell wall. 15000X

Picture(2) , Page-15

(I) Zheng Guan Biao and Others : Plate II

Preliminary report on the research conducted on the cause of contagious disease to the bark of rubber trees.

(3) Cause of RLO disease to he bark of rubber trees. 49800x

(4) Cause of RLO disease to the latex cell in the bark of rubber trees,(all double arrows show)latex particles (all single arrows show) 20000x

Picture (3), Page 16

(I) Zheng Guan Biao and others : Plate III
Preliminary report of the research conducted on the cause of contagious disease to the bark of rubber trees.

(5) Latex particles in the latex tube cell of a healthy tree (arrows show)

(6) Cell of the sieve tube in the pholem of a healthy rubber tree, CW shows wall of the cell , N shows the cell nucleus . 16600x

Picture (4), Page 17

(I) Wu Ji Lin and others : Plate I
Pathological Research on ulcer of Brazilian rubber tree.

(1) Condition of the section of a bark inficted by mobile spores. x400

(2) Hypa on the outer layer of the bark.

(3) Section of the yellow bark shows the sucking organs formed in the thin wall cell.

(4) Hypa on the yellow bark(M). They do not spread to the cells containing tannic substances (deep colour)

(5) The hypa in the yellow bark.

(6) The hypa that has spread in the sieve tube.

(7) The sucking organs formed by hypa in the sieve tube.

(8) The hypa has pierced the sieve plate in the sieve tube. 2-8x:300
(M Hypa, ha Sucking organ , Z - Germinating mobile spores.

Picture (5), Page 18

(I) Wu Ji Lin and others : Plate II
Pathological research conducted on ulcer of Brazilian rubber tree.

(1) The horizontal section of the bark infected by disease shows the hypa attacking from the ray. x58

(2) Horizontal section of the diseased bark shows that the colour Of the layer has changed into brown. x40
(Ca formation of layer, F the group attacked by disease, M the hypa, W the layer which has turned into brown)

Picture (6) , Page 19

(I) Wu Ji Lin and others : Plate III
Pathological research conducted on ulcer of the branches of Brazilian rubber tree.

The occurrence of changing the layer into brown and the change:

(1) Initial stage of attack by disease and the small number of cells turning into brown near the group attacked by disease. (cells in deep colour on the right side)
(2) The cells turning into brown are on the increase.
(3) Formation of layer changing into brown breaks up, afterwards new peripheral bark is formed. 1-4 : x55 (Ca formation of layer, F the group infected by disease, D layer of cells changing into brown in the process of breaking up)

Picture(7), Page 20

(I) Qian Ting Yu : Plate I
An accountant of the larva of longicorn who destroys coffee and cocoa.

(1) Head of the larva of Mie Zi Hu longicorn which destroys coffee, the back portion at the left and the stomach at the right.
(2) Front thorax of the larva of Mie Zi Hu longicorn which destroys coffee.
(3) Head of the larva of Yan Hu longicorn , back side on the left and abdomen on the right.
(4) Back block of the thorax of larva of Yan Hu longicorn.
(5) Stages of spongy projections of back of third section of stomach of Yan Hu longicorn.
(6) Front edge of the forehead of the Yan Hu longicorn .
(7) Side wart of No.2 stomach section of larva of Yan Hu longicorn.

(8) Back block of the front section of the thorax of Gui Bei longicorn.

Picture(8) Page 21

Qian Ting Yu : An account of the larva of longicorn which destroys coffee and cocoa. Plate II

(9) Stages of spongy projection of third section of the abdomen of Gui Bei longicorn.

(10) Back block of front thorax of larva of Hai Nan grey longicorn.

(11) Main stomach section of front thorax of larva of Gui Bei longicorn.

(12) Stages of spongy projection of back of third section of stomach of larva of Hainan grey longicorn.

(13) Main part of larva of Hainan grey longicorn, left is the back side and at the right is the stomach side.

(14) Back section of front thorax of larva of Lu Pi Jin longicorn.

(15) Stages of spongy projection of third section of stomach of larva of Lu Pi Jin longicorn.

(16) Side plate of No. 3 section of stomach of larva of Lu Pi Jin longicorn.

Picture (9) , Page 22

Plate III

Qian Ting Yu : An account of the larva of longicorn which destroys coffee and cocoa.

(17) Left lower jaw of Mie Zi Hu longicorn which destroys coffee.

(18) End portion of feeler of larva of Gui Bei longicorn.

(19) End part of the feeler of larva of Mie Zi Hu longicorn which destroys coffee.

(20) Spiracle at the thorax of the larva of Lu Pi Jin longicorn.

(21) Right lower jaw of larva of Yan Hu longicorn.

(22) End part of the feeler of larva of Hainan grey longocorn.

(23) End part of the feeler of larva of Lu Pi Jin longicorn.

(24) Spiracle at the thorax of larva of Hainan grey longicorn.

(25) Upper lip of larva of Hainan grey longicorn.

(26) End of the feeler of larva of Yan Hu longicorn.

(27) Right lower jaw of larva of Gui Bei longicorn.