WORK OF CEYLON RUBBER RESEARCH SCHEME DURING 1925.

J. MITCHELL, A.R.C.Sc.,

Organising Secretary of the Scheme.

The following account has been abstracted from the Reports which were presented at the Fourth Ordinary General Meeting of the Ceylon Rubber Research Scheme held at the Chamber of Commerce Rooms, Colombo, on April 16th, 1926:—

MEMBERSHIP.

At December 31st, 1925, there were 104 Rubber Growers' Association Members and 95 Rubber Research Scheme Members making a total of 199 Members in all as compared with 193 Members at December 31st, 1924.

BUILDINGS.

(a) *Laboratories.*—The laboratory buildings have been kept in good repair and the necessary additional equipment has been secured. The laboratories are now well equipped and provide adequate accommodation for the scientific staff, except for the chemical section which is becoming congested and it will be necessary to consider an extension of this section of the laboratories during the coming year.

(b) *Bungalows.*—The two staff bungalows on Heatherley and Culloden Estates were completed in March-April and are now occupied by the Chemist and Physiological Botanist respectively. The bungalow handed over by the Rubber Growers' Association at the inauguration of the Scheme on its present basis has been improved and is now occupied by the Mycologist. These bungalows have been equipped with the necessary heavy furniture that is usually supplied to bungalows on estates.

(c) *Water Services.*—Each bungalow has been equipped with the necessary water service and these are in satisfactory working order.

EXPERIMENT STATION.

Fifty acres of Crown land at Navitigalakele near Matugama in the Kalutara District has been secured and provision has been made in the 1926 estimates for the development of this land. Problems relating to seed selection, budding, cover plants, and contouring in relation to the prevention of soil erosion are to be specially investigated on this Experiment Station.

SPRAYING OF RUBBER.

In view of the annual occurrence of secondary leaf-fall, arrangements have been made for the Mycologist (Mr. R. H. Stoughton-Harris) to visit South India during March, 1926, prior to commencing experiments in Ceylon in order to acquaint himself with the work already carried out on estates in South India under the guidance of Mr. Ashplant. Several Ceylon estates will commence spraying rubber this year, but it is necessary for the Scheme thoroughly to test machines under Ceylon conditions and to ascertain the cost of the operations before making definite recommendations.

CO-OPERATION OF RESEARCH STAFFS.

The arrangements for an exchange of Technical Reports between the Research Staff of the Rubber Research Scheme and the Research Staff of the Rubber Growers' Association working in Malaya and South India have proved satisfactory and will be continued during 1926.

DISTRICT MEETINGS.

Officers of the Research Scheme have addressed Meetings of planters in the Ratnapura and Kalutara Districts. These Meetings were largely attended and discussions took place on questions of diseases and disease control, budding and selection, manuring, hydrometers for latex, the use of Formic Acid as a coagulant and paranitrophenol as a preventive of mould. These Meetings were highly successful and it is proposed to continue them.

PROGRESS OF WORK.

A.—ORGANISING SECRETARY.

Mr. J. Mitchell has continued his duties as General Secretary of the Research Scheme and as Secretary of the Executive and Technical Committees and a considerable volume of correspondence has been dealt with.

In addition Mr. Mitchell visited 55 estates and issued reports thereon to the Agents and Superintendents of the estates visited. The following notes are taken from Mr. Mitchell's Annual Report and represent the writer's view of general conditions on Ceylon estates at the present time.

(a) *Root Diseases.*—With regard to root diseases there has been a steady improvement, but the disease caused by *Ustulina zonata* will call for much attention during the next few years. This disease is becoming more prevalent on the older properties and attention is drawn to the need for early diagnosis at which time treatment can be carried out with every hope of success. A method of filling the cavities produced by this disease is illustrated and described in the 4th Quarterly Circular for 1925. *Fomes lignosus*, *Poria hypobrunnea and Fomes lamaoensis* have been noted on most estates visited but with a few exceptions are not causing serious loss. *Sphaeorostilbe repens* has not been as much in evidence as it was during 1924.

(b) *Stem Diseases.*—With regard to stem diseases there has been a marked improvement in connection with both *Bark Rot and Patch Canker.* The systematic preventive painting of the tapping cut with disinfectants has proved very successful and with a more universal adoption of the practice of disinfectant painting, *after every tapping*, there is reason to anticipate that the worst of the bark diseases in Ceylon will be kept completely under control. It is considered that a reduction in the amount of Patch Canker has been brought about by the greater care taken in scraping and as a result of employing more intelligent coolies to carry out the operations.

There does not appear to have been any marked increase in the prevalence of Brown Bast during 1925, but it is to be expected that on resumption of full tapping this disease will again become more prevalent. On most estates which have been re-visited it was noted that the work on this disease has been carried out satisfactorily and there are indications that the majority of the trees treated will be tappable within the next two to three years. A combination of the usual scraping methods and the " isolation " method advised by Keuchenius is now being adopted.

Corticium Salmonicolor (Pink Disease) has been noted on young trees, but has not proved serious on any estate. Die-back has given very little trouble during the year.

(c) *Leaf Diseases.*—A leaf-fall caused by a species of *Oidium* appeared in most districts of the Island in March and April (see 1st Quarterly Circular, 1925) and the possible further development of this disease is being carefully watched.

Secondary leaf-fall and pod disease (*Phytophthora* sp.) has again been prevalent in the Kalutara District, but much less so in the other districts of the Island. The manuring experiments which have been in progress on Gallawatte Estate for the past three years have given indications that a considerable improvement in the foliage cover can be secured by manuring (see 3rd Quarterly Circular, 1925) and the Gallawatte Company has kindly agreed to continue these experiments during 1926.

(d) *Manufacture.*—With regard to manufacture, fewer complaints have been received during 1925 than in any previous year and the problems of " spotting " of crepe and " rust " on sheet appear to have been satisfactorily solved. With the introduction of paranitrophenol it is believed that the problem of mould on sheet (the most prevalent trouble at the present time) will also be settled.

The introduction of Formic Acid to replace Acetic Acid as a coagulant is the only change in the methods of manufacture of crepe or sheet to record during the year.

The following notes are taken from Mr. T. E. H. O'Brien's Annual Report :—

B.—CHEMIST.

(a) *Smoking Experiments.*—The series of experiments to study the effect on mould growth of varying conditions of smoking is now nearing completion.

During the past year a comparison has been made between " combusted " smoke and " uncombusted " smoke. It is found that by varying the amount of ventilation of the fire the character of the smoke can be markedly altered. " Combusted " smoke produced when the wood glows and burns, has an acrid smell and irritates the nose and eyes. " Uncombusted " smoke, produced when the wood is only allowed to smoulder, has a soft tarry smell and little effect on the eyes. When sheet smoked with these two types of smoke are tested for resistance to mould, it is found that " uncombusted " smoke is considerably more effective in preventing mould than "combusted " smoke.

It has also been established that heavily smoked sheet is more resistant to mould than lightly smoked sheet.

The full results will shortly be published in a bulletin.

(b) *Paranitrophenol.*—One of the chief conclusions reached from the smoking experiments is that whilst liability to mould growth can be minimised by attention to various points during manufacture, sheet cannot be made entirely immune to mould by such means. This can probably only be effected by the addition of some disinfectant substance to the rubber. The Staff of the Rubber Growers' Association have worked on this subject and have introduced paranitrophenol as a suitable substance for the purpose. This has been tested by the Research Scheme and the results recorded by the Rubber Growers' Association have been confirmed.

Paranitrophenol is cheap, effective in small quantities, and has no detrimental effect on the rubber. Under Ceylon conditions the best method of use consists of soaking the freshly rolled sheets, after washing, in a 0 1 per cent. solution of the chemical. This treatment is now recommended to Members of the Research Scheme and paranitrophenol can now be obtained from the Colombo Commercial Co., Ltd., Colombo.

Paranitrophenol is also of value as a preventive of spots on crepe, being used in the same way as for prevention of mould on sheet.

(c) *Formic Acid as Coagulant.*—Further tests were carried out to decide on the amount of formic acid required for coagulation. It was found that the amount of 90 per cent. (full strength) formic acid required is just half the quantity of acetic acid, thus permitting a saving of slightly over 50 per cent. on coagulating costs. Tests carried out by various Research Institutes show that formic acid has no ill effects on the vulcanising properties of the rubber, and its use is therefore recommended to Members of the Research Scheme.

(d) *Glass Hydrometers for Latex.*—A number of hydrometers made to the pattern developed last year were obtained from England, and have been distributed to estates for tests. The results have been satisfactory, showing that glass hydrometers can be used under estate conditions without undue fear of breakage, and that with care reliable crop estimates can be obtained from hydometer readings. It is expected that a supply of these instruments will be available during 1926.

(e) *Mineral Constituents of Latex.*—An investigation is in progress on the effect of heavy tapping on the mineral constituents of latex. A full report on these experiments will be issued shortly.

(f) *Effect of Bordeaux Mixture on Rubber.*—Experiments were carried out to ascertain if Bordeaux Mixture could be used as a preventive of bark rot. The stems and tapping cuts were sprayed with this mixture. Tests at the Imperial Institute on rubber have indicated that traces of Bordeaux Mixture in the latex have an appreciable effect on the ageing properties and plasticity of rubber. Further samples have been prepared and despatched to the Imperial Institute so that the study of this subject can be continued.

(g) *Variability of Ceylon Rubber.*—A number of samples of smoked sheet and crepe have been obtained from various estates and forwarded to the Imperial Institute for tests to determine whether the standard of uniformity of Ceylon rubber is equal to that of other countries.

The following notes are taken from Mr. R. A. Taylor's Annual Report:—

C.—PHYSIOLOGICAL BOTANIST.

(a) *Budding and Selection.*—In this connection 18 estates are keeping records of their best yielding trees and from 130 to 140 trees are being kept under careful observation. The best of these are to be used as "Mother trees" for budgrafts. In addition, seeds from trees of known parentage at Peradeniya and Heneratgoda have been planted at Peradeniya to provide the stocks on which these buds are to be grafted. A further detailed study of 161 trees of known parentage growing at Peradeniya Experiment Station is being made with a view to finding the relationship which exists between the various characters of the trees.

(b) *Brown Bast.*—The study of this disease has been continued both in the laboratory and in the field, but up to the present time it has not been possible to discover any new facts of importance. Comparative experiments are in progress in connection with the "scraping" and "isolation" methods

of treatment, but these are not yet sufficiently advanced to allow any conclusions to be drawn on the relative merits of the two systems.

(c) *Manuring Experiments.*—All the preliminary preparations for a manuring experiment to be carried out during 1926 have been made.

(d) *Tapping Systems and Bark Renewal.*—The change-over tapping experiment has been continued and yield records kept. Measurements of the rate of bark renewal under the two systems " change-over " and " non-change-over " are to be made during 1926.

The following notes are taken from Mr. R. H. Stoughton-Harris' Annual Report :—

D.—MYCOLOGIST.

(a) *Secondary Leaf-fall & Pod Disease.*—A study has been made of the causal organism (*Phytophthora* sp.) and of the interaction between the organism and the medium on which it grows. Certain interesting facts which may have an important bearing on the control of the disease have been observed and are referred to in the Mycologist's report. In addition, the manuring experiments being carried out on Gallawatte Estate to test the efficacy of Nitrate of Soda for the prevention or reduction in secondary leaf-fall have been supervised. Facts in connection with this experiment are recorded in the 3rd Quarterly Circular for 1925.

(b) *Bark Rot.*—A thorough study of this disease has been in progress throughout the year and a series of experiments to test the efficacy of various disinfectants on the growth of the causal organism (*Phytophthora* sp.) have been made. In addition to certain special substances all the well known proprietary disinfectants have been tested and on conclusion of the experiments the results will be issued as a Research Scheme Bulletin.

In addition, field experiments have been carried out to test the efficacy of different disinfectants on the tapping cut. It is proposed to repeat these during 1926.

(c) *Patch Canker.*—Experiments in connection with this disease have confirmed the previous conclusions that *Phytophthora Faberi* (Maublanc) is the causal organism.

(d) *Pollarding Experiment.*—The experiment to determine if pollarding of trees provides a check against secondary leaf-fall has been carried out and the opportunity is being taken to determine if a reduction in yield results from such treatment and to determine the rate of healing of large wounds.

(e) *Oidium Leaf-fall.*—A serious outbreak of this disease, particularly in the Kalutara District, has necessitated a study of the causal organism, its nature, and occurrence. An account of this disease is given in the 1st Quarterly Circular for 1925 and a further study of it will be made in 1926 should a recurrence take place.

(f) *Tree Surgery.*—A good deal of work has been carried out to determine the best methods of filling cavities in trees caused by decay, particularly that caused by *Ustulina zonata.* An account of the progress of this investigation is given in the 4th Quarterly Circular for 1925.

RESEARCH WORK AT THE IMPERIAL INSTITUTE.

The following notes are taken from the Annual Report of the London Advisory Committee:—

1. *Wet Rubbers.*—In continuation of previous investigations of wet rubbers, a study was made of the vulcanising and mechanical properties of crepe and unsmoked sheet kept in a wet condition, chiefly with a view to determining the effect of different amounts of moisture. The samples were prepared on four different estates and each set consisted of (*a*) air-dried crepe and crepe blocked immediately and 1, 2, 4 and 8 days after machining; (*b*) air-dried unsmoked sheet and sheet rolled up immediately and 1, 2, 4 and 8 days after machining. In the case of the crepe samples, with one exception, only those blocked immediately after machining contained more than 1·0 per cent. of moisture on arrival at the Imperial Institute; most of the rolled sheets however contained appreciable amounts of moisture, viz., from 1·8 to 8·50 per cent.

The samples were submitted to vulcanising and mechanical tests in a rubber-sulphur mixing (90: 10) at a less advanced state of cure than that formerly used, chiefly with a view to carrying out ageing tests on the same specimens. They were also examined in the following mixing—90 rubber, 5 zinc oxide, 5 sulphur, 1 diphenyl guanadine—in continuation of the study of the behaviour of plantation rubber in different technical mixings.

A report giving details of the results obtained has been published in Research Scheme Bulletin No. 40.

It was found that in the rubber-sulphur mixing:

(*a*) The wet blocked crepes were more variable in time of vulcanisation than the controls, whereas the wet rolled sheets were slightly more uniform.

(*b*) On the average, samples containing the most moisture had the shortest time of vulcanisation, but the effect of the moisture was more pronounced in the case of one estate than in the others.

(*c*) The tensile strengths of the wet samples did not differ from those of the corresponding controls to any marked extent.

All the samples gave similar tensile strengths and elongations when vulcanised for a fixed period in the accelerator-zinc oxide mixing.

This investigation, in conjunction with those previously carried out on wet rubbers, indicates that on the whole crepe blocked wet and unsmoked sheet rolled up wet possess no important advantages over dry crepe and sheet either as regards tensile strength or uniformity in time of vulcanisation.

2. *Plasticity of raw rubber.*—The investigation of the plasticity of plantation rubber has been continued.

A large number of experiments have been carried out chiefly on the lines indicated in the last annual report, viz.:—(*a*) measurement of the amount of power consumed during mastication and mixing; (*b*) determination of the rate at which masticated and mixed rubber can be forced through a small orifice under a constant load at constant temperature; (*c*) determination of the viscosity of solutions of masticated rubbers in benzene at a constant temperature.

The results of preliminary experiments made with the wet rubbers

referred to in section (1) indicated that:

(*a*) Air dried crepe was more plastic than air-dried unsmoked sheet, (*b*) blocking the crepe and rolling up the sheet had no effect on plasticity, (*c*) keeping the blocked crepe and rolled sheet in a wet condition for a considerable period had also no effect.

As a result of the experience gained in these tests, a number of important modifications in the apparatus have recently been made. In addition the scheme of testing is being extended to include comparative tests with an Ira Williams' type of plastometer which was obtained towards the close of the year. In this apparatus a small ball of rubber of standard weight is submitted to constant pressure at constant temperature for a definite time, and the relative plasticity of the rubber is indicated by the decrease in the thickness of the ball. This method of determining plasticity, which is used by a number of other investigators, has the particular advantage that it can be utilised for tests on raw unmasticated rubber as well as on masticated and mixed rubber.

An investigation is now in progress with a view to determining the extent and cause of variability in the plasticity of Ceylon estate grades.

3. *Ageing Tests.*—Although vulcanised articles always deteriorate eventually on keeping, few experiments have been made to determine the effect of the method of preparation of rubber on the ageing properties of the vulcanised product. In view of the importance of the subject it is proposed to make a detailed study of the behaviour of plantation rubber on ageing and to compare the results obtained with those given by fine hard Para. For the first set of experiments the wet rubbers referred to in paragraph 1 have been submitted to artificial ageing tests at 70° C after vulcanisation. The results showed that the unsmoked sheet samples were superior to the crepe, as they were stronger, had a longer life when vulcanised to the same standard and also a greater latitude of cure. It was found that the wet blocked crepe and the wet rolled sheet did not differ in ageing properties from the corresponding samples of dry crepe and sheet.

Experiments are now in progress with smoked sheet and fine hard Para. The examination of fine hard Para should be of special interest, as one of the reasons suggested for the preference for this rubber in the manufacture of golf ball tape and elastic thread is that it has better ageing properties than plantation rubber in a rubber-sulphur mixing.

Reference was made in the last annual report to the poor ageing properties of crepe prepared from ammonia-preserved latex by coagulation with acetic acid. This subject has been further investigated and in recent experiments glue was added to the latex before coagulation with acetic acid, but no improvement in the ageing properties of the rubber was produced. On the other hand rubber obtained by the evaporation of the preserved latex possesses excellent ageing properties.

In this connection it has been found that dilute ammonia solution extracts about two per cent. of organic and mineral matter from unsmoked sheet, and that the extracted rubber has poor ageing properties.

Further work on this subject is in progress.

4. *Bordeaux mixture.*—A series of experiments was arranged by the Ceylon Technical Committee with a view to obtaining definite information as to the effect on the vulcanised rubbers of spraying trees with Bordeaux mixture. As the result of tests carried out at the Imperial Institute on samples prepared in Ceylon, it was found that the latex obtained from trees within two days of spraying was contaminated with traces of copper, but that latex obtained a few days later after heavy rain was free from copper. The samples containing copper did not become tacky on storage for 12 months, but on exposure to the sun they became tackier than the others. Moreover on

masticating and mixing, a more plastic product was obtained in the case of the samples containing copper. The presence of copper had no effect on the rate of vulcanisation, but it resulted in a lower tensile strength and a more rapid deterioration on ageing.

Further experiments have been made in Ceylon, in which known quantities of Bordeaux mixture were added to latex and these samples will be examined in due course.

5. *Smoking experiments.*—In connection with the study which is being made in Ceylon of different conditions of smoking, two sets of smoked sheet rubbers, one prepared with del wood and the other with rubber wood as fuel, were examined with regard to (*a*) the time taken in a humid atmosphere for visible mould to develop after inoculation, and (*b*) the time of vulcanisation in a rubber-sulphur mixing.

Comparative tests showed that the heavily smoked samples were more resistant to mould than medium and lightly smoked; and also that the samples smoked with del wood were more resistant than those smoked with rubber wood. There was no marked difference in time of vulcanisation between the lightly, moderately and heavily smoked samples, nor between those smoked with del and rubber wood.

6. *Other Investigations.*—Work on the following subjects has also been carried out during the year and is being continued:—

(1) The effect of low temperature on the physical properties of raw rubber;

(2) The effect of adding glue to latex when used in the manufacture of paper and;

(3) Duplicate experiments in conjunction with other investigators in connection with the standardisation of methods of testing rubber.

The following papers were published by members of the Staff in London:

(*a*) "The function of rubber 'resin' in the vulcanisation of mixings containing accelerator and zinc oxide," by G. Martin, B.Sc., A.I.C., and W. S. Davey, B.Sc., A.I.C., Journal of the Society of Chemical Industry, XLIV, 1925, p. 317T.

(*b*) "Notes on recent developments in the preparation of raw rubber," by W. S. Davey, B.Sc., A.I.C., Institution of Rubber Industry, Birmingham Section, October 15th, 1925.

PUBLICATIONS.

Rubber Research Scheme Bulletins.—Research Scheme Bulletins Nos. 37, 38 and 39 have been published and distributed to all Members of the Research Scheme and to Scientific Organisations in the various Rubber-growing countries. These deal with investigations carried out at the Imperial Institute on samples of rubber prepared in Ceylon and a full summary with conclusions is given in Bulletin No. 39.

Rubber Research Scheme Quarterly Circulars.—Circulars dealing with questions of current interest to the Rubber Planting Industry have been published at quarterly intervals and from the expressions of appreciation received it would appear that they are well serving the desired purpose of establishing a closer link between the Research Scheme and the Rubber Industry of the Island.

Rubber Growers' Association Bulletins.—All the Bulletins issued by the Rubber Growers' Association during 1925 have been received and distributed to those estates which do not receive them direct from London. In addition, the Research Scheme has distributed to all Subscribers the booklets "Recent Developments in the Rubber Planting Industry," by Mr. Herbert Ashplant and "Rubber on the Market and in the Factory," by Dr. O. de Vries, which were received from the Rubber Growers' Association.

REPORTS.

The London Advisory Committee forwarded the following reports:—

(*a*) Variability of Rubber from different districts (Series I.).
  (1) 6th Interim Report (R. S. Bulletin No. 38).
  (2) Final Report (R. S. ,, ,, 39).

(*b*) Wet Rubber (Series II.).
  (1) Vulcanising and Mechanical Tests (R. S. Bulletin No. 40).

(*c*) 1st Interim Report on Ageing Tests on Plantation Rubber (R. S. Bulletin No. 41).

(*d*) Ageing properties of Rubber prepared from latex preserved with Ammonia (Research Scheme Quarterly Circular No. 1, 1925).

(*e*) The Ageing properties of Rubber extracted with dilute Ammonia (Research Scheme Quarterly Circular No. 4, 1925).

(*f*) Plasticity of Raw Rubber (Research Scheme Quarterly Circular No. 3, 1925).

(*g*) Effect of different conditions of smoking on liability of sheets to become mouldy (2nd Report).

(*h*) Effect produced on Rubber by spraying trees with Bordeaux Mixture.

(*i*) Investigation of samples of Rubber prepared by a special process.

THE APPLICATION OF DISINFECTANTS USED IN THE CULTIVATION OF RUBBER.

Dr. A. STEINMANN and Dr. J. J. B. DEUSS.

SUMMARY.

There are a great many kinds of tar and tar preparations in use in the cultivation of rubber as disinfectants, which, as far as their suitability as preservatives against infectious diseases are concerned, differ considerably.

These disinfectants can be classified as follows: A. Species of tar; B. All tar preparations not miscible with water; and C. Mixtures of tar or tar preparations with oil, resin, wax or paraffin with the addition of benzine or spirit.

A. TAR.

1. Swedish Tar or Wood Tar is entirely unsuitable on the tapping surface, since its power of penetration is far too great and it contains damaging ingredients.

Wood tar is almost completely soluble in alcohol, contains in contrast to coal-tar little or no free carbon, but much phenol and acetic acid. If one is dealing with the so called "blasentar," this then contains as much as 8 per cent. acid. Also species of tar obtained by other processes of wood distillation can contain 5 per cent. acetic acid; tar from resinous wood as much as 12 per cent.; this latter being the kind usually known as Swedish tar.

On account of its high percentage of creosote, wood-tar is an excellent preservative for dead wood.

It appears that this tar can be used in the form of a mixture with fine sand or with boiled waste rubber for combating the attacks of insects (vide A. Steinmann, De ziekten en plagen van *Hevea brasiliensis*, p. 124). The entrance of boring beetles is prevented by the viscous lump which is formed.

2. Coal Tar if of a good quality, can be applied cold to the tapping surface as a preservative, provided that a strip of about 1 cm. is left free above the tapping cut, in order not to foul the scraps with tar.

The objection must also be pointed out (vide Handbook v/d. Rubber-cultuur, 1921, p. 184) that once coal-tar has become mixed with rubber, it cannot be washed out.

The application of tar has the great disadvantage of concealing every thing from view, covering up the surfaces and the tapping wounds and consequently preventing proper control. Furthermore, when tar is used, it is not easy to ascertain whether the tapping surfaces are receiving regular treatment.

The various methods of composing coal-tar differ greatly and depend principally on the origin of the tar.

The fact that about 210 different chemical ingredients are to be found in such a substance shows how complicated the work of analysis becomes.

Water-Gas Tar is something quite different and the composition very variable. The tar is a thin fluid and, since it penetrates to a great depth, can be used with success instead of carbolineum to prevent wood rot.

Water-Gas Tar is easily distinguished from carbolineum by the smell and also by the fact of the former being a thinner liquid.

Creosote, such as is used for disinfecting, is one of the heavier fractions of the dry distillation of coal, wood, etc. If used for disinfectant purposes (such as direct application to dead wood or as a mixture) it must comply with the following demands:

1. It must be free from naphtaline and homologen, as these prevent a good emulsion (this also applies to carbolineum.)

2. For the preservation of dead wood it must contain from 3-20 per cent. phenols. The percentage in every species (also in carbolineum) must be known in order to be able to dilute it to the required grade.

3. The specific gravity must be nearly the same as that of water. The lighter it is, the better it emulsifies. 1·015 at 38°C is good, not higher however than 1·07.

If it is desired to make the creosote a better emulsion, soap should be added—to the cheaper qualities resin soap, and to the better qualities resin soap mixed with vegetable oil soap or merely the latter alone.

There must be no over-measurement of alcali, as this obstructs the disinfectant working of the phenols.

An example of one of these good emulsifying creosotes is:

Resin-soap	26%	
Light creosote	61%	(specific gravity 10·25, 18% phenols)
Petroleum	3%	(s.g. 0·815)
Caustic soda	2·5%	
Water	7·5%	

There are also varnishes made of creosote with pitch or bituminous matters. Some are slow-drying, but in general these varnishes quickly crack on becoming dry as a result of the light, whereby an auto-oxidation probably takes place. Tars containing pitch or asphalt also form quick-cracking varnishes. When analysing a tar, this point must therefore also be kept in mind.

Schmitz and Zeller (Journ. Ind. Eng. Chem. **1921, 13,621-623**), concluded that the creosote fraction of 270-315°C., is the fraction with which the most rapid killing of fungi is effected. Above 355° C. distilling material is valueless.

What then are the demands that can be laid down for a good tar?

According to the maxims for Indian purchases coal-tar must be a pure product of coal; it must be of the best quality, unadulterated, and free from foreign ingredients, similarly from an excess of ammoniac-water, it must be about 50 per cent. soluble in benzol; the residue after evaporation of the benzol must be firm. Coal-tar must be homogeneous and must contain no " gall " that could spoil the perfect smoothness; it must be free from acids. Coal-tar must be practically free from water; the proportion of water must not be more than 3 per cent. (the danger exists with coal-tar, which has too high a percentage of water, that on becoming dry no compact and unbroken layer of tar is formed). Coal-tar must be sufficiently viscous to cover the objects treated completely.

Two samples of tar, that showed a viscosity of resp. 57'7°E and 120'7°E at 50°C. and of 5'0°E and 5'6°E at 100°C. were quite satisfactory for the pruning wounds of tea. The limits in this connection are therefore comparatively wide.

It is marketed in barrels of 200 litres =216 KG net.

A margin of 2 per cent. per barrel is allowed when buying or selling, so that the price may not be increased or decreased if the quantity received per barrel remains within these bounds.

As we have repeatedly noticed, the quality of *sundry* deliveries of coal-tar by the *same* Company or Gas Company can vary considerably. It does not follow that because one parcel is satisfactory the next delivery will be of the same quality.

When inspecting tar, with a view to using it on live trees, it is always sufficient to assay the efficiency by biological methods. By these methods, which are also put into practice on the English side, it is possible to form an idea of the serviceableness of the different preparations.

The test is easy to make and every planter can carry it out himself. A healthy tree is shaved in two places; in the one place sufficiently deep for the so called hard stone-cell-containing-bark to be visible, in the other place deeper—through the bark, until the soft latex-vessels-containing-bark is laid bare. One must be careful that a layer of bark at least 1mM thick remains. One waits until the latex, which exudes, has coagulated and then, after removing the rubber, one smears on some of the trial-sample tar. After ten days a piece of the bark is removed (with an ordinary bark-drill such as is commonly used for taking bark samples), is cut through, and with the help of a magnifying glass the thickness of the discoloured bark is measured. If on the sample the discolouring has penetrated to the wood then this quality of tar is unsuitable.

If a stricter test is required, one can determine by examination under a microscope how far the preparation has sunk into the tissues. It is always able to sink further into the stone-cell-containing, *i.e.* the hard, bark which is exceptionally porous, than into the soft inner-bark.

From the undermentioned results of the biological examination of a few tar samples, which were sent to us during the last few years, it is most clearly illustrated how extensively the tars in use on the estate vary in quality.

	Penetrating Power		
	Hard	Soft	
Woodtar	2.0 mM	2.0 mM	
Tar L. T.	2.0-3.0 „	2.0 „	
„ 3 N.	3.0 „	2.0 „	
„ 2 N.	1.0-1.5 „	1.0 „	Of these various sorts of tar,
„ 1 N	1.5 „	1.0 „	therefore, only the latter 5 were
„ W.	2.0 „	1.0 „	suitable.
„ Tjr.	0.8-1.0 „	0.6 „	
„ Tjp.	1.0 „	0 7 „	
„ V.	0.7 „	0.7 „	
„ B.	0.7 „	0.7 „	
Cambisan	0.7 „	0.5 „	

Cambisan is a neutral-tar, which gives rise to no burning pehnomena on the bark (Vide Gandrup, Rubberarchief, 1921, p.558). It is, as a matter of fact, more expensive than ordinary tar, and also difficult to work with in a cold state on account of its thick fluidity, to which point Gandrup has drawn attention.

An experiment was made of adding to cambisan-tar the ingredients, in the same quantities, contained in normal tar.

20. XI.	Penetrating power		Quantities corresponding with those in normal tar
	Soft mM	Hard mM	
1. cambisan	½	½—¾	—
2 cambisan 600 gr. phenol 12 „	½—1	—	2% phenol
3. cambisan 730 gr. pyridine 3 „	up to 1	—	¼ % pyridine
4. cambisan 760 gr. anthracene 15 „	1—1¼		2 % anthracene
5. cambisan 530 gr. phenol 6 „	up to 1		1 % phenol
6. tar oil and caustic potassium	¾	¼	—

The penetrating-power proved to be *too* great.

A watery latex was only observed to exude from No. 4 (760 gr. cambisan * 15 gr. anthracene).

Further experiments were made to determine whether perhaps the quantity of soda, necessary for emulsifying tar preparations, could be the cause of burning.

* Test 2 is the average of the results on 4 trees

The first series of tests were made on only one tree, whilst at the repetition each mixture was tried on four trees so that the figures show the average powers of penetration of the trial samples.

	Penetration			
	Hard		Soft	
	Test 1	Test 2 *	Test 1	Test 2 *
A. Mixture of 250 gr. taroil (2% phenol), 600 gr. water and 6 gr. soda	1·0 mM	1·0 mM	0·75 mM	1·0 mM
B. Mixture of 260 gr. taroil, 600 gr. water & 4·5 gr. caustic soda.	1·0 „	1·2 „	0·5 „	0·8 „
C. „ of tar (2% phenol), water and caustic soda.	1·0 „	—	0·5 „	0·7 „
D. „ similar to C. but 3 times diluted.	1·25 „	1·5 „	0·75 „	0·8 „
E. „ of tar, water and soda.	1-1·25	—	0·5 „	—

It appeared that this is not the case. The addition of soda in the quantities used in these instances had no abnormally high effect on the powers of penetration, except with A, where the penetrating power of the sample being 1mM. was in test 2 too great.

Finally we made a series of tests by applying the various ingredients of tar, which were obtained by fractional distillation, to a tree and inspecting their penetrating powers on the bark.

In this instance tar of the Gas Company, Buitenzorg, was used for distillation. The various items were brought to an emulsion with common soap.

Concentration.	Ingredient of the Tar.	Penetration Power.	
		Hard	Soft
1%	Lowest fraction taroil	1·0 mM	1·0 mM
2%	„ „ „	1·5 „	0·75 „
5%	„ „ „	1·5 „	1·0 „
	Residue taroil	1·5 „	1·0 „
1%	fraction 200°C.—210°C. taroil	3·0 „	dead
2%	„ 210°C „	2·0 „	Not determ.
5%	„ 200°—210°C „	2·0 „	„ „

As the above table shows, the low-boiling fractions of the tar (up to 200°C—210°C) are not suitable for treatment of the tapping surface; they soak far too deep into the bark, which for that reason becomes burnt.

It is therefore probably principally the elements present in these fractions, which give rise to the burning phenomena in tar of poor quality.

In view of the fact that the composition of the kinds of tar, available on the market differs so widely, and that we have often had occasion, when using tar as fungicide on tapping surfaces, to see dead places and wood-wounds occur from being burnt, cases of which are also frequently recorded elsewhere. We prefer for this puspose other preparations, for example a diluted tar preparation or mixture of resin and spirits.

Besides for disinfecting tapping surfaces, coal-tar is, in the cultivation of rubber, also used:

1. On the tapping surface for covering over tapping wounds:
2. For the treatment of branches attacked by djamoer œpas and divers root diseases, in particular by dry collar rot.
3. For covering stumps of branches and other large wood-wounds on the trunk.

We would mention here the results of several tests we made a few years ago in connection with the use of coal-tar for the treatment of tapping wounds.

On 10 trees in the agricultural garden at Tjikeumeuh, which had previously been tapped from two cuts, one above the other, of about $\frac{1}{4}$ of the circumference, but which at the time of the tests had not been tapped for about $2\frac{1}{2}$ months—we made on the tapping surfaces a number of large round wounds (from 2 cm. diameter) right through to the wood. These wounds were made with a hollow pipe, such as is used for taking bark samples.

The next day, after removal of the coagulated latex which had oozed out of the wounds, these, by then dry, were subjected to various treatments. One wound was tarred cold (A tar was used which was ascertained by chemical analysis to be well qualified for the purpose), another was painted with a paraffin which had a boiling point of 60° C. and which had been heated just enough to make it liquid; while yet another was left untouched and thus acted as a control.

After a period of about $2\frac{1}{2}$ months the distances between the closing edges of the callus tissues of all the wounds were measured.

It is a recognised fact, that the speed, with which the tissues regenerate, is different for every tree in relation to its age and the external circumstances to which it is subjected, etc., etc., and must be judged separately.

Therefore for comparison it is necessary to show the results of each tree treated with the various preparations separately.

In total 86 test-wounds were made, distributed over the upper and lower tapping surfaces, of which 21 were for control, 37 for tar and 28 for paraffin treatment.

In many cases, according to the circumstances, more than 3 wounds per tree were made, sometimes as many as 5 or 6.

No. of tree	Distance between closing tissues in mM.			No. of tree	Distance between closing tissues in mM.		
	Control	Tar	Paraffin		Control	Tar	Paraffin
Upper surface 62	5	10	—	75	11	10 | 14	10
Lower surface	4	10 | 7	—		10	8 | 10	11 | 12
Upper surface 63	10	10 | 12	10	76	—	18	11 | 14
Lower surface	1	7 | 9	8		9	11 | 12	12 | 15
Upper surface 70	11	—	10	85	6	9 | 10	8 | 8 | 9
Lower surface	13	14	—		7	8 | 8 | 9	8 | 9
Upper surface 72	4	5 | 6	1 | 3	86	9	5 | 9	2
Lower surface	5	7	—		4	7	4 | 4
Upper surface 73	5	9 | 12	—	84	11	12 | 15	11
Lower surface	4	10	—		—	15	11 | 12
Upper surface 74	7	9	10	28	12	12 | 15 | 15	8 | 13
Lower surface	9	—	5 | 8				

From these statistics it is apparent that the tar, although of a good quality, that is to say with a small power of penetration (0·3—0·5 mM.). exercised a *detractory* effect on the healing of the callus wounds.

In most cases the distance between the edges of the closing callus-tissues of the wounds treated with tar was much greater than that between the tissues of the control wounds, while the figures for the paraffin treated wounds differed so much that no definite conclusion could be drawn from them.

The same experiment was repeated on the Estate Kedong-Alang on seven trees, which were tapped in the normal way, with a cut over ½ the circumference, during the period of the test. After 3 months the wounds were examined and measured; the following table shows that during that period several of the control wounds had already become closed, as also had some of the wounds treated with paraffin, whilst the tarred wound, with the exception of tree No. 26, in comparison with the others were behindhand.

No. of Tree	Distance between callus-tissues in mM					
	Control	Tar		Paraffin		
26	2	0 5		closed		
40	closed	0'5		closed		
66	closed	4		closed		
68	2	3—4		1	2—3	
70	1	2	4	closed	3	
43	1	6		1		
77	closed	1	1	closed		

As Vischer* has already advised, it is superfluous to tar tapping-wounds since they are, in any case, provided that the tapping surface is treated, also disinfected.

On the other hand in the case of tea as a result of pruning, although burning of the live tissues has also been recorded and as Bernard showed, the tissues become wounded *under* the cell-layers, where the tar has penetrated, this disadvantage is of less import than it is in the case of a tapping surface since it is heavily outweighed by the advantages which are connected with the treatment, namely: the prevention of rot and of the entrance of white ants, etc., the same can also be said of the treatment of djamoer œpas. and certain root-diseases of tea and rubber, and furthermore of the closing-over of branch stumps: coal-tar can in these instances also be used to a good purpose, provided that it fulfils the maxims laid down on page 16.

B. TAR PREPARATIONS.

In the cultivation of rubber these, besides being used for disinfecting roots and also canker attacks on the trunk, are principally used for the treatment of the tapping surface against mould-diseases such as mouldy-rot and stripe canker.

There are a great many of these preparations on the market. Some of which, such as carbolineum, solignum, agrisol and izal, are in general use, whilst we have insufficient experience of others, such as dougalite, noxonia, Jeyes fluid, jodelite, etc., which are less commonly used.

* W. Vischer, Het een en ander over de genezing van tapwonden (Rubberarchief) 1922, p.49.

Tar preparations are nothing other than the products of tar distillation, which have been dissolved by means of soap, alkali, etc. Sometimes in certain kinds special disinfectants are added (vide paragraph dealing with creosote). Izal, on the other hand, is most probably a carbolic acid solution with lime or resin-soap and is already obtainable on the market in a milky-white emulsified condition; the homogeneous liquid obtained by diluting it with water is ready for immediate use.

Trees were experimented upon with mixtures of 2 per cent. phenol and the relative natrium hydroxide, natrium carbonate, etc., and the following results were obtained.

	Penetration		
	Hard	Soft	
1. Phenolsoda	1·0-1·7	0·50-0·7	
2. Phenolnatron and chalk	1·0-2·0	0·50-1·0	
3. Phenol-lime	1·2-2·0	0·75-1·0	Average of two measurements on different trees
4. Phenol chalk	1·0-1·5	0·70-1·0	
5. Phenol and NaOH	1·0-1·5	0·50-1·0	
6. Phenolsoda and chalk	1·0-1·5	0·50-1·0	

Although in the cases of Nos. 2 (phenolnatron and chalk) and 5 (phenol and NaOH) the bark was partly dried and coloured, it is apparent that the powers of penetration are on the whole not very great. On the other hand the disinfectant powers proved to be very small, as all the treated strips of bark were mouldy.

The experiment took place during the wet season and in exceptionally damp weather; in view of the fact that a mould growth appeared on the pieces of bark treated with the disinfectant preparations, it is obvious that watery solutions of phenol are of no great value as preventatives of mould, at any rate on trees.

Carbolineum is principally obtained from the heavy tar oils, from coals, which over distil between 240° and 260° or from the so-called vegetable oil or filtered anthracene oil. It has already been mentioned what this contains. For the manufacture of carbolineum some of the heavy tar-oil is often mixed with medium oil. There are many very different species of carbolineum—for instance: the kinds for impregnating wood, for disinfectant washes (or paints), for use on fruit-trees, etc.

There are also certain specific manufactures, such as the carbolineum "Avenarius," which is made from the ordinary market product by the introduction of chlorine. In manufactures, that are used for impregnating wood, chloride of zinc or common resin is often added. Resin soaps make ordinary carbolineum emulsive in water.

Various sorts of carbolineum or liquids, which we have analysed and which appear on the market under fantastic names, contain soda and lime, elements which are sometimes apparently necessary for the process of emulsifying.

A method, by which one can determine the efficiency and harmlessness of a quality of carbolineum, remains to be discovered.

For that reason there are absolutely no definite maxims known for carbolineum. The main stipulations that are usually insisted upon for a good quality are: that carbolineum should emulsify *entirely* in water * and that it should form a milky liquid,† furthermore that it should not soak deeper into the bark than 0·75 mm. (Petch).

Several writers state that: carbolineum has a specific gravity not lower than 1·12, does not begin to boil at a lower temperature than 230° C, has a very great viscosity a flash point above 120° C, and is free from naphthaline and other firm excretions. So one can determine what quantity of carbolineum evaporates, by pouring a known weight on to a piece of filter paper and then ascertaining the weight evaporated. This must be carried out as accurately as possible. The demands laid down above for creosote, can also be partly applied to carbolineum.

For particulars in connection with the analysis of tar preparations we would refer to the appendix, wherein the methods which should be followed for analysing are given.

Finally we would mention that every year new preparations are placed on the market; the majority of these are, in reality, old makes under a new cloak; for example, in place of the old solignum the new preparation silvertown has been introduced.

New kinds of which we have tested the penetrating powers are: morbifugo, diphenso and pantox.

The results of our tests on the samples sent to us were as follows:

	Penetration after 10 days	
	Hard	Soft
Silvertown	1·1 mM	0·6 mM
Diphenso pure	1·0 ,,	0·7 ,,
Morbifugo pure	2·0 ,,	1·5 ,,
,, 2%	1·0 ,,	—

Morbifugo can therefore only be used in a concentration of, at the most, 10 per cent. Diphenso up to 20—50 per cent. with wax.

Pantox is a fraction of tar-oil dissolved in alcali soap, to which nitrobenzol is added. It is soluble in water and forms a yellowish fluid.

The penetrating powers of a sample, which was sent to us, were on Hevea bark as follows:

	Penetration.	
	Hard	Soft
Pure ...	1·5 mM	1·5 mM (dead)
Solution 2% ...	1·0 ,,	0·5 ,,

* Kinds of carbolineum are often brought forward which do not emulsify or at any rate quite insufficiently, in fact they have a more or less firm unguent constitution (Archief, 1918, p. 210).

† Meded. v.d. Phytopath. Dienst te Wageningen (information of the Phytopath. Service at Wageningen) No. 5, Nov., 1917, p. 22.

This penetration is too great for this preparation to be used undiluted, and furthermore, even undiluted, it is not a sufficient preventative of mould on Hevea bark, since after only a few days mould appeared on the wounds which had been treated with this preparation.

We can group the preparations thus:

1. Those that can be emulsified with water and
2. Those that cannot be emulsified with water except with the aid of further mixable preparations.

To the first group belong:

Name	Obtainable from	Usual concentrations	
		Preventative	Curative
Carbolineum plantarium	Lindeteves-Stokvis	5% *	20% *
,, excelsior	,, ,,	5 ,,	20%
,, heveaum	Harrisons & Crosfield	5 ,,	20%
Brunolinum plantanarium		5 ,, *	20 ,, *
Izal	Rowley Davies	3 ,, †	5 ,, ‡
Agrisol	,, ,,	5-10 ,, †	20-25 ,, †
Morbifugo		5 ,,	10 ,,

The objection has indeed been raised that those preparations mixable with water become quickly washed off by rain. This objection is however almost entirely imaginary, since the fluid soaks immediately upon application into the young green bark, which is not yet covered with a layer of cork, so that a later washing off by rain is really out of the question. On other portions of the tapping surface, where a cork layer is already formed, the disinfectant preparation only sinks in through the fissures and cracks and *these* are the very places where the infectious germs are able to develop.

The preparations which cannot be emulsified with water alone, must first be brought to a liquid state by the addition of soft soap.

This state of liquidity does not, as a rule, last long. They usually re-harden after a short time and must consequently always be re-prepared before use by being stirred up. It follows of course that when this work has to be left to coolies, the risk is run that it is not carried out efficiently. The danger exists then that using a partly solidified mixture, some portions of the tapping surface are treated with a disinfectant of either too strong or too weak concentration, whereby in the former case the bark is burnt and in the event of the latter the bark is insufficiently disinfected.

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* According to Petch

† The Agrisol-treatment of Rubber tree disease—Major & Co., Ltd., Hull, England

‡ Bulletin F. M. S. No. 31. Keuchenius in Archief v. d. Rubber cult Vol. VI. page 403, 1912, Maas, ibidem. p 513,

Hereunder is given a list of the most commonly used preparations.

Name	Obtainable from	Usual Concentration	
		Preventative	Curative
Solignum	Sime, Darby & Co., Sigapore Kock, Sparkes & Co., Bandoeng	5% *	20%
Silvertown †	Harrisons & Crosfield	5 ,,	10 ,,
Brunolinum ‡		5 ,, *	20 ,, *
Jodelite		5 ,, *	20 ,, *
Dougalite		5 ,,	20 ,,
Jeye's fluid	Harrisons & Crosfield	10 ,, *	20 ,, *
Diphenso	Rowley Davies	10 ,,	20-25 ,,

Less known preparations, such as harbas, arboretus, noxonia, etc., we do not make mention of here.

We had occasion to test on Hevea bark the penetrating powers of several of the above preparations and obtained the following figures:

	Penetration	
	Hard	Soft
Solignum A.	1·0	0·5 — 0·7
Solignum B.	1·4	0 7
Silvertown	1·1	0 6
Dougalite	1·7	0·9
Diphenso	1·0	0·7

We also tested the penetrating powers of the lowest fractions obtained by the distillation of solignum and brought to an emulsion with soft soap in different concentrations.

	Penetration	
	Hard	Soft
1% lowest fraction solignum	1 mM.	1 mM. and more
2 ,, ,, ,, ,,	1 ,,	1 ,, ,, ,,
5 ,, ,, ,, ,,	1 ,,	1 ,, ,, ,,

* According to Petch

† This tar preparation was lately introduced and brought on the market to replace the former Solignum.

‡ 1 lb. black soap in 4·5 litres (1 gal.) brunolinum-(See Fungoid and other Diseases of Rubber Trees and their Prevention and Cure. The Standard Disinfectant Co., London)

Here also the powers of penetration, which even in the case of a weak 1 per cent. emulsion amounted to 1 mM. and more, were far too great.

As with tar, the burning of the bark can most probably be put down to the matters present in the lowest fractions.

An old recipe, which can always be recommended for emulsifying these disinfectants, is the following: (H. J. Quanjer. De Ind. Cultuur-almanak, 1912, p. 233).

One makes a concentrated " standard " solution, from which one can obtain the quantities of disinfectant, as required, by dilution: Mix 1 KG of soft soap with 6 litres boiling water, while continually stirring add to this 1, 2 litres of the disinfectant material. From this standard emulsion, which remains in a good emulsive state for a long time, one can make emulsions of any required concentration by adding the necessary proportion of water.

Another recipe which is used in the Straits and from which one obtains an approximate 5 per cent. solution, is as follows:

Disinfectant	1 litre	(2 pints)
Soft soap	113 grams	(4 ounces)
Water	18 litres	(4 gallons)

In order to bring solignum to an emulsion the following can be recommended:

1 part soft soap, 10 parts solignum and 40 parts water *

In order to be able to control whether the coolies give regular treatment, some lime should be added to the disinfectant preparation. According to Keuchenius the following proportions are the best: 1 part izal, 1 part unslaked lime and 30 parts water. It is, as a matter of fact, better to mix a small quantity of Fuchsine-colouring-matter with the preparation; this leaves a good red colour on the tapping surface, which disappears after a short time.

For an izal solution fuchsine should be used in a 1 per cent. concentration and for carbolineum in a 3 per cent. concentration. The necessary amount of colouring material should first be dissolved separately in a small quantity of methylated spirits, in doing which one should be careful that no grains of the colouring matter remain undissolved. This fuchsine solution is then poured into the already diluted disinfectant preparation. These solutions keep in a good state for about 2 months. Fuchsine is obtainable from the Besoekisch Proefstation, Djember, at f 14.50 per tin of 1 KG.†

Using a 1 per cent. concentration of the colouring matter, when about 2½ cM^3 of the disinfectant preparation is used per tree, the cost-price for the treatment of 800 trees works out at from 3-5 cents.

The firm Behn Meyer & Co. have at present for sale a grade of fuchsine, the price of which is higher (1 KG f 19.—), but which in practice is more economical than the other fuchsine, on account of its colouring power being so intensive.

Besides these preparations there are other mixtures with wax and fats, which in addition to the disinfectant qualities of the mixture provide a covering and screening influence.

A mixture, that has for a number of years been employed with success on several estates in West Java for combating stripe-canker and which has

* Ultee, A. J. Rubberarchief, 1917. p, 411.

† Circular No. 4 Besoekisch Proefstation, 1922.

up till now always been recommended, is the following:

1 part solignum and 3 parts melted battik-wax (malam) are heated over charcoal in a tin, that has a handle of iron wire, and thus liquified: The tapping surface is then smeared with this mixture by coolies using a small brush of sepet. Provided that the mixture is sufficiently warm it can be applied thinly and is therefore economical in use.

Tests which we made on the same tree with mixtures of wax and different disinfectant preparations, which naturally require heating before use, gave the following results.

	Penetration in mM.	
	Soft	Hard
Solignum + 20% battik-wax	0·5	0 5
Solignum, pure	1·0	1·0-0·2
Silvertown + 20% battik-wax	1·0	1·0
Carbolineum heveanum + 20% wax		1·5
,, ,, pure	1·5	2·0-3·0
Diphenso + 20% battik-wax	0·75	0 75

From these figures it is apparent that solignum is the least harmful of the tested preparations and that mixed with 20 per cent. wax it does not burn the bark.

The greatest objection with such preparations, the application of which must be left in the hands of the coolies, lies in the fact that they need heating before use to make them liquid.

For that reason we would in every respect prefer a preparation with the same good qualities that does not require heating prior to use.

In Ceylon mixtures of tar and fat are used, for example 90 parts fat and 5 parts tar; sometimes indeed 60 parts fat and 40 parts tar. Mixtures of resin, benzine with solignum or carbolineum are sometimes recommended; these preparations form a transparent layer of varnish on the tapping surface, but they do not seem to have given satisfaction.

Of other mixtures which are used in West Java for combating mouldy-rot, we mention the following: 9 katti resin, 1½ katti wax, 750 grams creoline, 200 grams tar and 12 litres spirits: further mixtures of tar and animal (cow) fat: solignum and asphalt residue; brunolinum or solignum with paraffin; carbol, tar and fat, etc.

Resin and benzine in the proportions of 1: 5 have for some time been used with success in several countries for giving a covering layer to the tapping surface. The layer of varnish which is formed prevents any kind of mouldy growth and furthermore the mixture does not require heating.

As a matter of a fact we prefer a mixture of *resin and spirits*, to which can be added one or another of the tar preparations, for instance carbolineum or as Gandrup * has suggested 10—15 per cent. solignum.

* Gandrup, J. N. I. Rubber en The—tijdschrift No. 11, 1924, p. 349.

It appears, according to Hartley, * that success has been obtained in Java by using this mixture (resin and spirits, 1 : 1) for the treatment of cacao pruning and canker wounds.

In West Java a similar preparation is used, which is composed of: 12 litres spirits, 1 litre creoline and 6 KG resin (since altered to: 18 litres spirits, 2½ litres creoline and 6 KG resin, which brings the proportion of creoline to about 10 per cent.).

The penetration powers of the first mixture on Hevea bark proved after 10 days to be: in hard bark 0·75 mM. and in soft bark 0·5 mM

It is thus absolutely harmless and at the same time the bark surface is excellently shut off by it.

With the altered mixture the following figures were obtained:

	Soft Bark.	Hard Bark.
Mixture containing 10% creoline ...	0·7—1·0 mM.	0·8—1·0 mM.
Watery emulsion of 10% creoline ...	0·7—1·0 ,,	1·0—1·2 ,,

The objection, which is occasionally raised, to the effect that such resin mixtures are too expensive is mere imagination.

According to our calculations this mixture costs at present about 37 cents per litre. Assuming that about 3 c cm. are used per tree, then 1 litre is sufficient for treating about 300 trees which works out at about a cost of only ⅛ cent per tree.

A preparation introduced to this market a short time ago under the name of " wondlijm " probably serves the same objects equally well.

The penetrating power is small, namely:

Hard Bark.	Soft Bark.
0·5 mM.	0·5 mM.

Further tests in this direction would be welcome, also in connection with good fractional distillations, with which soaps can be mixed to obtain good emulsions.

The contents of the foregoing paper can be summarized as follows:

1. By biological tests it can be shown that the quality of tars and tar preparations varies considerably and that a preparation should still be analysed before use.

2. We have attempted to lay down fixed conditions with which these preparations should comply in order to be of utility for combating diseases and we have given a method for analysing these preparations.

Wood tar is entirely unsuitable for treatment of the tapping surface.

Coal-tar, if of a good quality, can be used for that purpose, but there are so many disadvantages that it is not advisable to use it either for this purpose or for the covering over of tapping wounds. On the other hand a good tar can be used for the treatment of branch-stumps, large wounds, djamoer œpas and root-diseases.

The signs of burning, which are frequently apparent, when using coal-tar, are in all probability due to the elements present in the low boiling fraction (up to 200—210°) of the tar.

3. We further attempted to find a preparation which has strong disinfectant properties and at the same time small powers of penetration and we dwelt on the possibility of mixtures of resin, spirits and creoline or solignum, or " wondlijm " meeting this requirement.

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* Hartley C. Wondbeschcrming ("De Ind. Culturen 24 Dec. 1925, p. 745)

APPENDIX.

Methods of differentiating for tar, creosote and distillations thereof.

Water.—Take 100 gr. crude oil and add to this xylol, which has been shaken with water—until thoroughly mixed. Distil the mixture (after adding some pieces of pummice-stone) until 80—90 c.c. have been transferred to a measuring glass, following the Hofmann-Macusson method. Wash the cooler with xylol and collect together by means of a stirring-rod all the drops of water. The quantity of water transferred can then be directly read.

Creosote should be distilled in the usual manner with care.

Specific gravity.—The Twaddell areometer can be used at 15·5°C. Or take 500 c.c. oil in a large beaker and warm the whole in a water-bath to 5°C. The ammoniac-water rises to the top and is removed with a filter paper. The remainder is placed in a Renault-bottle for determining the specific gravity at 15·5°C.

Naphthaline is determined by letting it freeze, filtering and placing under pressure, after which the crystals are weighed.

With creosote, first wash the bottles out with caustic-soda lye and allow the oil to cool to 4—5°C. The naphthaline then crystallizes of itself and is treated in the above manner.

Ash is determined by reducing it to ashes in the ordinary way and with the necessary care in a porcelain or platinum crucible.

Free carbon.—Heat in a small evaporating dish 1 gram tar with 5 grams aniline and pour the thin liquid mass into an unglazed porcelain plate, the soluble ingredients of the tar and the analine are absorbed and the free carbon left behind. Wash the basin out with 2 grams pyridine and place the carbon-crust on a tared watch glass. When dry, weigh (vide Kraemer and Spelker, Umspratt's Chemie). The free carbon shows the quantity of pitch.

Distillation. From this one obtains:—

light oil	to 170°	or according to English classification		crude naphthaline
medium oil	,, 230°	,,	,,	high oil
heavy oil	,, 270°	,,	,,	medium oil
	350°	,,	,,	heavy oil
anthracene oil to end and above				pitch

Proportions of phenols and pyridines. The different fractions are shaken in a graduated measuring-glass with 100 cM3 natronlye (spec. gr. 1·1) and the volume of the lye is noted. For every cM3 gain 1 % phenol is registered.

In order to find the pyridine bases, the oil, which is extracted by the lye, is treated with 30 cM3 sulphuric acid and the volume gain of sulphuric acid is measured:—Archief Voor De Rubbercultuur, 10 e Jaargang, No. 5.