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#### CONTENTS

	PAC	PAGE		PAGE	
i.	Proceedings of a Joint Meeting of	iv.	Abstracts	466	
	the Indian Chemical Society, Mad-	v.	Reviews	470	
	ras Branch, the Society of Biologi-	vi.	College News & Notes	471	
	cal Chemists (India) and the Asso-	vii.	The late Rao Bahadur J. Che	1-	
	ciation of Economic Biologists,		varanga Raju	474	
	Coimbatore, held at the Agricul-	viii.	Weather Review	475	
	tural College, Coimbatore 43	3 ix.	Departmental Notifications	476	
ii.	Notes and Comments 46	60 x.	Additions to the Library	478	
iii.	Gleanings 46	54			

Proceedings of a joint meeting of the Indian Chemical Society, Madras Branch, the Society of Biological Chemists (India) and the Association of Economic Biologists, Coimbatore held at the Agricultural College, Coimbatore.

#### SESSION I.

1-30 to 4-30 P. M., Friday, 7th October, 1932.

#### SYMPOSIUM ON THE UTILISATION OF WASTE PRODUCTS

Chairman: Mr. S. V. Ramamurti.

Speakers: Dr. Gi bert J. Fowler.

Mr. K. S. Viswanatha Ayyar.

Dr. V. Subrahmanyan

Rao Bahadur B. Viswa Nath

Mr. T. Lakshman Row.

Mr. M. Sreenivasaya.

#### THE CHAIRMAN'S OPENING REMARKS.

Let me first extend a hearty welcome to those of you who have come to Coimbatore to attend this Conference. I am particularly pleased to preside over a discussion on Waste. I do not know who among you deserves the credit for suggesting such a simple-looking but crucially important subject. Waste in the physical world is the counterpart of evil in the moral world. I would define evil as unused good. Waste is also unused good. When religion was the dominant

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phase of human activity, the leaders of men were they who battled with evil. Now when science has replaced religion as the dominant activity of man, the battle is against waste. Therefore you who are scientists are in a goodly company—the company, namely, of Saints and Martyrs.

To be wicked is evil. To be merely good when you can be better is also evil. The throwing away of paddy husk, of cattle urine, of all manner of unused green stuff is a waste. But it is also a waste to grow only a thousand pounds of crop when you can grow double the amount. The work at Coimbatore has naturally lain against both these directions of waste. The utilisation of all organic stuff which can be used as manure, the method of treating soils so as to avoid waste of moisture, the way of avoiding losses by plant pests, as also the ways of improving upon existing strains of various crops have been receiving attention. I hope with the co-operation of the scientists at Coimbatore to orientate the research activities here definitely as a campaign against waste.

We who live in a tropical climate receive in the most bountiful measure the only income which the earth gets, namely, sunlight. Yet the heat of the sun is more often made a matter for complaint than for thanksgiving. We have not yet learnt how fully to use our wealth. In its unused form, it is a burden rather than an asset. And yet when sunlight is used to make trees, animals and all other organisms, they are, in the main, sources of wealth and comfort to us. Life bottles sunshine all round us and leaves them behind as it passes away. But we waste much of it. We waste paddy chaff while we eat the grain. We waste cattle urine while we use some of the dung and meat and milk. We use cashew nuts but waste the oily shells. We use sugarcane juice but mostly waste the molasses and the megass. We waste the nitrogen about us when more can be used to enrich the soil and yield heavy crops. We waste the bacteria which can be harnessed to do beneficent work for plants. We waste weeds and at the most destroy them when the best way would be for the soil to digest them. piece of organic matter which is not used is a case of waste of our wealth of bottled sunshine. To bottle sunshine and not to use it as well as the failure to bottle available sunshine is waste and therefore evil. The responsibilities of Indian scientists and generally of tropical scientists is correspondingly greater than that of scientists of temperate climates even as the opportunities for wealth and waste are greater in the former case. And yet we find that the efforts that have been put forth hitherto to attack waste with the help of science have been mainly outside the tropical climates.

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deals with the many manufacturers of such bottles have been considerably developed in Europe. But the conditions and problems of Europe and India are different. To the extent that they are common, the methods and results achieved in Europe have been communicated to us. The time has come when with the knowledge we have acquired, we have to develop an extension among different conditions. If sunshine in Europe is a river with its seasonal variations, it is in South India, an ocean. Our methods of navigating the ocean while based on what has been learnt of river navigation require large changes and fresh efforts. In spite of all that we have learnt of Science, there are large areas of waste which we do not know yet how to attack. Many of our agricultural products do not present problems to Europe. We grow paddy and export some of the rice but we keep all the husk. Europe has no need to study paddy husk. We grow the cashew tree and export some of the nut but we keep or throw away all the shells. Europe has no need to study cashew shells. We have no winter worth mentioning in Southern India. Our annual fallow time on paddy land is waste unless we grow green manure on it. It is not so in Europe because such fallow time is a time when nothing can grow on the land. We waste many varieties of bacteria by not knowing how to use them. They do not exist in such numbers in Europe and hence Europe has no problem of waste in that respect comparable with ours. We get an ocean of sunlight and we waste much of it. Europe gets less and its problem of waste is smaller. The time has come for us to recognise that our country is full of unused good and of unexplored possibilities and that it is we that should find methods of dealing with them.

There is one caution that I would like to give you in regard to the solutions which you may evolve. Our social and economic conditions make it imperative that the application of science should be spread over a large area rather than be concentrated in a few places. A few large industries requiring lakhs of rupees for a factory have much less chance of springing up than many small scale industries which can be run with moderate capital. Any methods which you evolve of attacking waste should satisfy this condition.

There is also one suggestion that I might make to you. If chemists and biologists wish to give practical shape to their ideas, they need also to be engineers. Some of you may find it useful to gain a knowledge It will be desirable for chemistry and biology to of engineering. attract more engineers to their ranks.

Above all, we need now men who not merely have learnt known solutions to known situations, but men who have acquired the ability to solve problems. India is now a vast wilderness of unsolved problems and unrealised possibilities and it is scientific research more than anything else that is needed to help India again to life and progress.

this work you are engaged and I offer you my heartiest good wishes for success in your fight against waste.

#### DOMESTIC WASTE

Dr. Gilbert J. Fowler. I have very great pleasure to listen to the speech of your President and to the very excellent introduction he has given to the subject we are going to discuss to-day. On a previous occasion four or five years ago, during the annual agricultural Conference held here, I had the privilege of addressing the gathering on a very similar subject; in fact, the title of my address was "Wealth from Waste". This fact and the points which the President has raised, about our solutions of scientific problems being capable of being tackled as small industries, make me find myself entirely in harmony with my surroundings today. I myself have been an advocate of small industries from the date of the Indian Science Congress in 1925.

I have been asked to talk to you about "Sewage and Domestic Waste". The importance of utilisation of this waste, you will realise from the example of Japan and China where for ages they have been able to manage with this waste alone for their crops, without the use of any minerals at all. The sewage problem in England and other countries is quite different from that here. There, they have a number of small rivers and the problem is to keep these rivers free from pollution. In India, however, we are concerned mainly with how best to utilise the nitrogen from sewage for the benefit of agriculture. We have vast tracts of land which are deficient in organic nitrogen. I may instance to you vast areas of nearly 125,000 acres under the Irwin Canal Scheme, which sadly stand in need of organic fertilizers.

One of the simplest ways of utilising sewage will be to pour it on the land, but sooner or later we tumble against a difficulty, viz., the formation of sewage sickness in the soil. This is because oxidation is incomplete and the collodial matter of the sewage also interferes with the healthy growth of crops. Therefore some form of preliminary treatment to the sewage is necessary before it can be applied to the soil to undergo further oxidation there. What I would call as the master-secret of Chinese agriculture is this treatment that they are giving. Investigations at Lyallpur and elsewhere have shown that raw sullage applied largely and continuously to soil is harmful and that therefore it must be copiously diluted with large quantities of fresh water. This however is not available everywhere, and where it is available, there is the danger that we will be giving very much more moisture to the soil than a healthy growth requires.

The Activated Sludge Process therefore is the best method of utilising this waste. The colloidal nitrogen is all collected and concentrated in one place and you can use it as and when you require it.

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The effluent contains reduced proportion of nitrogen and can be applied directly to the land without any further dilution. This will reduce the large waste of nitrogen, the value of which is being recognised only recently. For instance, at Poona they are selling the sullage on the basis of its nitrogen content. The value of nitrogen in the sewage can be gauged from the fact that according to Chinese figures it is valued at Rs. 2 per head of the population per annum. The great task therefore before the scientists of this country is the concentration of organic nitrogen along with solar energy, which I hold to be the two factors of crop production. In this connection I would remind you of the saying of Henry Ford, of having one foot on the land and the other in the factory, for if our wealth and well being are to increase, we cannot afford to ignore this efficient method of enriching our lands by a resort to simple machinery.

# UTILISATION OF FARM WASTES

Mr. K. S. Viswanatha Ayyar. In view of the fact that the organic matter of the soil gets rapidly depleted, and that the available supply of organic manures like farmyard manure, leaf compost, oilcakes etc. is far less than the demand, attempts have been made by various workers, to tap other sources of supplying organic matter to soil. The pioneers in this work, have been Richards and Hutchinson of Rothamsted who with the aid of suitable starters, evolved a method of converting waste organic matter of low manurial value, into a stuff of the standard and quality of farmyard manure, patenting a starter by name 'adco'. Hutchinson in India similarly obtained an odourless product of high manurial value by subjecting green sunnhemp to fermentation, using copper sulphate-potassium cyanide, as a deodoriser incidentally also demonstrating that the fermented stuff was far superior to the raw material.

Experiments in Madras in the direction of utilising organic farm waste, date from 1922, when paddy straw and calcium cyanamide were used as basic material and starter respectively. The resultant product which was ready in nine weeks, was very suitable as a manure, but there was a loss of 47 per cent. of organic matter, and 14 per cent. of nitrogen. This was proved to be due to the rise, during fermentation, of temperature which went up to 54 degrees. The next stage in the investigation was to introduce improvements, by providing aerobic and semi-aerobic conditions, by fermenting in heaps and in pits and by providing a shelter to minimise loss due to evaporation. These trials which were of a comparative nature showed that under semi-aerobic conditions there was less loss of nitrogen and organic matter than under aerobic, (2) that loss of nitrogen from experiments in pits was less in every case than that from heaps and (3) that sheltering minimised loss. But all the same, the experiments tended to show that the

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prime factor responsible for the loss of nitrogen and organic matter, was the too rapid decomposition at the initial stages of the fermentation. This was traced to the unsuitability to Indian conditions, of starters used elsewhere.

The next step was an analysis and a bacterial examination of the starter 'adco', and the use as starter of a synthetic mixture of calcium cyanamide, tricalcic phosphate, and potassium phosphate; this was compared with the 'adco' starter both on green and dry materials under laboratory conditions. The fermentation was found to be complete but loss of nitrogen occurred and the decomposition of the waste was accelerated, probably due to the stimulation of the organisms, by the phosphates present in the starters. An attempt was made therefore to use a slow acting starter like a mixture of bonemeal and cowdung. Experiments on cane trash with slow and quick acting starters, showed that with the former there was less loss of nitrogen. Based on numerous trials conducted all over the Presidency, the following technique of manufacture has been evolved.

The basic material is spread uniformly and loosely to a depth of 9 to 12 inches in a pit of convenient size (12' × 6' × 3') and water evenly sprinkled till the whole material gets moist. Then 1 to 2 lbs. of fine bonemeal are evenly broadcasted and over this an emulsion of 10 to 20 lbs. of fresh cattle dung in 5 to 10 gallons of water is applied. A second layer of basic material is placed over this and treated similarly. The whole material is thus disposed of until a heap about 2 feet high above the ground level is formed, and then the top and sides are mud plastered. After the fermentation has proceeded semi-aerobically for 4 to 6 weeks depending on the nature of the material, the plaster is removed to permit aerobic fermentation. If the heap has sunk unevenly, which is an indication of defective fermentation, the material is reheaped after forking and proper moistening. The raw material is ordinarily decomposed in 3 to 4 months and is fit for application as manure and can be made at a cost of Rs. 3 to 3-8 per ton.

Synthetic farm yard manure thus prepared compared very favourably in field trials with farm yard manure and the quality of the crop as evidenced by an analysis was also very good.

## UTILIZATION OF WASTE VEGETATION

Dr. V. Subrahmanyan. Millions of tons of plant materials are being annually disposed of either as pests or articles of no value. The object of this communication is to give an account of the nature and extent of occurrence of such vegetation and their possible utilization in arts and manufacture.

There would appear to be three main types of waste vegetation.—
(a) plants with gregarious habits like the water hyacinth of Bengal, the lantana of Deccan and the prickly pear of South India which are dreaded as enemies of agricultural crops and even forest plants,

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(b) various types of vegetation which grow spontaneously on uncultivated lands and in jungles which are considered harmless but which are not generally used except as fuel. This group would include the numerous species of trees which are now classified as junglewood, various shrubs which are considered to be poisonous and grasses which are ignored as being too coarse or otherwise unsuitable for cattle and (c) several plants or plant materials which are obtainable in plenty but the uses of which are either not fully known or cheap processes for converting them into useful products have not yet been discovered. This category would include hardy woods like the Mathi of Mysore, various starch-bearing tubers like the Kachara of the Konkan tracts, oil bearing seeds like the Dhupa of the West Coast, sugar-bearing fruits like those of coffee berry, cashew apples and mahua, tannin-bearing plants like the numerous cassias and acacias of Deccan the best known among which is Avaram or Thangdi, and essential-oil-bearing grasses or shrubs which abound in most of our jungles.

The plants classed as waste vegetation cover the major part of the uncultivated tracts of the country which may be reckoned to be over 500 million acres in India alone. They thrive under a variety of soil and climatic condition and are generally resistant to disease. They are all available in great abundance and the supply is well-nigh inexhaustible except when deliberately destroyed by man as in the case of the prickly pear.

The extent to which any plant material can be utilized is determined by (a) the abundance of the constituent for which the plant is valued (b) the ease of handling and (c) cost of collection and transport. The last is a fairly serious obstacle in certain cases but it can be overcome by choice of proper localities and intensifying the production.

There are several wild tubers from which strach or sugars can be manufactured. Thus the *Kachara* with which the author is acquainted contains about 60 per cent. starch and presents no difficulty in the working.

Sugars can be obtained either directly or indirectly from several plant materials. In the case of the mahua fruit or the cashew apples they can be extracted as such while those in water hyacinth or wood fibre will first have to be treated with acid. Most of the materials are suitable for the manufacture of glucose syrup which is so valuable in several industries. Thus, the author found that juice from the cashew fruit contains about 12 per cent. sugar which can be readily concentrated to a 60 per cent. syrup after treatment with lime or alkali.

Most of the sugar-yielding products are eminently suited for the manufacture of industrial alcohol. Thus Fowler and Dinanath Talwar found that the mahua husks which are now being wasted are eminently suited for that purpose. Sen and his co-workers noted that water

hyacinth and saw dust from certain woods (e.g. Excoecaria agallocha) yield large quantities of fermentable sugars on hydrolysis with acid.

The more refractory types of cellulosic wastes can be converted into fuel gases by digestion with sewage. Considerable amount of useful work has already been carried out by Banerjee in Bangalore and Sen in Calcutta, but further research is needed to standardise the process.

Several fruits are rich in pectins and the fibres in cellulose: except in a few solitary instances sufficient application has not yet been found for them.

Considerable amount of work has been carried out by Sudborough, Simonsen, Sanjiva Rao and their co-workers on the essential oils from various types of grasses, shrubs and trees. Some of them are highly valuable in perfume industry; others, as shown by the author and De, possess far greater deodourising and germinial properties than phenol and being also proportionately much cheaper can easily take the place of coal-tar disinfectants now so commonly used.

There are several jungle plants which contain highly potent insecticides and fungicides. The work of Tattersfield and his associates in England, the late Dr. Kunhi Kannan, B. T. Narayanan and their co-workers in Bangalore have gone a long way to establish that extracts from several tubers (e.g. Derris elliptica), flowers and leaves (e.g. Pongamia glabra) destroy some of the most pernicious agricultural pests without in any way poisoning the plants themselves as the mineral insecticides are often known to do.

We are today importing enormous quantities of wattle bark and bark extract though we have almost inexhaustible stock of tannin-bearing plants in the country. The main difficulty in the way of tanners using Avaram bark is the prohibitive cost of collection and transport but it should be possible to improve the condition by (a) intensifying the culture of the plant and (b) preparing concentrates. In both the above some useful beginnings have already been made at Bangalore.

Many of the wild plants are rich in various enzymes which now find extensive application in medicine and industry. Particular mention may be made of the lantana leaves which contain active forms of all the more important enzymes and the hongay seed which contains the most active urease among the plants so far examined.

It may not be generally known that most of the powerful herbs and drugs used in Ayurvedic, Unani, or allopathic medicine are derived from the so-called waste vegetation. Very little systematic attempt has however so far been made to cultivate the plants intensively so that the cost of collection is now almost prohibitive. It is known that many of the plants respond readily to artificial culture so that it

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should soon be possible to develop a flourishing business in medicinal plants.

Chiefly on account of their perishing qualities, junglewoods have so far been outcasts from structural materials but thanks to the modern developments it has now become possible to preserve them even better than metal or concrete. In this communication particular mention should be made of the recent Fahl-Kamesam process which it is hoped will open out a bright future for junglewoods.

Almost every form of waste vegetation when not otherwise used is eminently suited for use as manure either in the green state or after composting with chemical and biological starters. As instances of these may be cited the observations of Fowler and Gopalakrishnamurti who noted that in addition to enriching the organic and mineral matter of the soil prickly pear also helped to fix the nitrogen of the atmosphere. Jagannatha Rao and the author observed that lantana leaves make excellent synthetic manures when composted with sewage or nightsoil. The preparations thus obtained are characterised by fairly high nitrogen content (1.2 per cent.) and a very large percentage (2.5) of phosphoric acid which our tropical soils so badly require.

Very little systematic work would appear to have been so far done on the distillation of waste vegetation. This would appear to be a highly promising line of enquiry for the future since in addition to the charcoal some valuable chemicals may thus be obtained.

The waste vegetation of today constitutes some of the sturdiest offsprings of nature which eke out their livelihood from the poor offerings of uncultivated soil unassisted by men. It is true that they have not so far found much application, but in the light of increasing knowledge with regard to their possibilities every effort should be made to preserve them. They should no doubt be prevented from invading agricultural lands or overpowering the more valuable saplings of timber trees; but they have their own uses in the service of mankind and our ignorance of their utility should not be a plea for destroying them.

WASTE PRODUCTS OF PADDY AND SUGAR CANE CROPS.

B. Viswa Nath, Coimbatore. The possibilities of utilising paddy husk, broken rice, sugar cane megass and molasses without machinery and elaborate equipment are discussed.

Paddy husk: Paddy husk can be made into activated carbon for use as a decolourising agent in jaggery and sugar manufacture. Activated carbon can be prepared by beating paddy husk out of contact with air and treating with activating agents, either mineral or gaseous. The usual methods of activation adopted on the industrial scale are however not suitable under village conditions. A fairly simple process has been devised, in which paddy husk charcoal is activated by treating with soda or lime polysulphides and igniting a mixture of 4 of sodium

holders, electrical fittings, umbrella and stick handles, buttons etc. The articles thus made are uninflammable unlike celluloid.

Lactose. The whey drained off the curd in the manufacture of cheese contains most of the lactose present in the original milk. This could be recovered by first removing the milk albumin by precipitation with acetic acid and then concentrating the clear filtrate in vaccuo until a syrup was obtained from which the sugar crystalises out on cooling.

## SOME INDUSTRIAL WASTES.

Mr. M. Sreenivasaya:—The Indian lac industry, which is now passing through a crisis, has many by-products which could be exploited with advantage to the industry. The dye liquors which result in the washing of stick lac are rich sources of fat, and nitrogenous bodies, some of which yield valuable amino acids. A process of recovering these products has been developed in the biochemical laboratories of the Indian Institute of Science, Bangalore. The brewery waste offers us a source of vitamins while the slaughterhouse refuse constitutes a source of digestive ferments, harmones, and other valuable pharmaceutical products. The utilisation of these wastes constitutes towards the economic stabilisation of the industry against possible competition and should therefore be adopted as a matter of prime necessity.

## DISCUSSION.

Dr. V. Subrahmanyan. There is a prevalent impression that sewage applied to sugarcane brings on disease and the quality of the cane suffers. I would like to know from Dr. Fowler whether this is so and also how best excess water from the sludge plant can be utilised. With regard to Mr. K. S. Viswanatha Ayyar's paper I would like to know what exactly he means by aerobic and semi-aerobic conditions. I disagree with him that the utilisation of night soil will be prohibitively costly. Night soil has any way to be collected and is collected. The cost will only be for dumping. With regard to Rao Bahadur B. Viswanath's paper and his reference to molasses I cannot see why it cannot be purified and used as an article of diet. Regarding Mr. T. Lakshman Rao's scheme for the manufacture of casein products I can only say that we have not enough milk for our food requirements and under such conditions I wonder what waste products we can have therefrom. As regards his reference to the preparation of photographic films from casein I want to know if they are superior to those on the market already, otherwise there is no point, just for the sake of utilising a possible waste product, in bothering about it.

Rao Bahadur M. R. Ramaswami Sivan: I want to mainly draw your attention to three things in this discussion, viz. waste, molasses and casein. What is after all waste and what exactly does utilisation mean? Everything is after all returned in the natural course of things to mother earth and there utilised. In its narrowed sense therefore utilisation of waste is probably the removal of undesirable things from one place to another where it can be made use of. This is very well illustrated by the Chinese method of preparing composts which they have developed into a perfect system; As regards molasses we must think of molasses for food, if possible avoiding the preparation of

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Everything is earth and there is probably the it can be made d of preparing regards molasses preparation of

alcohol therefrom. Molasses are prepared from badly collected palmyra jaggery. All that is wanted is to prepare it in pure and good condition. In fact we can all go in for jaggery alone. Apart from its containing more vitamins possibly than white sugar it will obviate the objections of orthodox people whose sentiments stand in the way of their using refined sugar for which bone charcoal has been used. As regards casein I do not at all agree with Mr. Lakshman Rao's views on the subject. It is too valuable a food to be utilised in the directions he has outlined. In Calcutta not a bit of it is lost, but is absolutely used for the preparation of a nutritive and valuable delicacy known as 'sandesh'. If only proprietors of South Indian restaurants will learn the recipe for this sweet North Indian dish, we will get a demand even here.

Rao Bahadur T. S. Venkatraman. The first occasion when I was confronted with the molasses question was when a member of the Sugar Committee suggested that the Sugarcane Station might be closed because molasses were not disposed of. You can have an idea of the large quantities of molasses that Java produces from the fact that it is directly pumped on from the tanks to the steamers for transport to Calcutta and other markets. The problem is becoming very serious here, because sooner or later, India will become a self-contained sugar country. In Northern India mollases are used for curing tobacco; this will not however go far and many will not consider it the right kind of use, for tobacco after all is not a very desirable commodity. Messrs. Parry & Co. Nellikuppam, have been putting in the market a syrup called the 'golden syrup' prepared from molasses. This also is not a very satisfactory and permanent, solution and we have got to find ways and means of utilising it. Java's solution is to use molasses as manure added judiciously to the soil. As regards megasse the problem is not so serious, for we are now able to utilise all megasse as fuel, and in fact the demand now is for cane with more fibre. In Louisiana megasse is even used for the preparation of cardboards etc. Most Indian factories are able to utilise all the megasse. Dr. V. Subrahmanyan referred to the preparation of syrup from other kinds of vegetation than sugarcane. Scientifically it may be very interesting but practically it will be adding to our difficulties, for until chemists and bio-chemists are able to tell us how exactly to dispose of our sugarcane molasses profitably I would ask him not to continue with his researches into the preparation of other kinds of syrups. Sugarcane trash is best utilised by collecting it in drains near the field, in layers like the loose-box system for collecting manure. In about a year it forms very good manure, which on analysis compares very favourably with cattle manure. In Nellikuppam trash is being utilized by being buried in alternate trenches in alternate years thus adding to the richness of the soil. I also echo a previous speaker's remarks about the application of sewage to sugarcane. Sugarcane is a crop that does not require much food in its later stages; especially nitrogenous fertilisers applied late to the crop results in rank vegetative growth vitiating the quality of the juice. My opinion is that sewage is best not applied to sugarcane, but directed on to other crops.

Rao Sahib T. V. Rajagopalachariar. I was very much interested to listen to Dr. V. Subramaniam's reference to the prickly pear plant fixing nitrogen. A prevalent practice among the Coimbatore ryots who use the earth under prickly-pear bushes as a valuable manure for their soil is probably based on this phenomenon. I can also cite the instance of gingelly, a non-leguminous plant which is supposed to enrich the soil on which it is cultivated. K. S. Viswanathier's formula for preparing the composts is very interesting, but the cost of composting is actually more than the value of the composts themselves. With regard to Rao Bahadur B. Viswanath's paper, his work on preparing an activated form of charcoal from paddy husk is all right, but I can mention that I have seen places on

east coast where paddy husk has been ploughed into the soil for improving its physical texture.

Dr. G. J. Fowler. I listened with great interest to Mr. M. Sreenivasaya's paper; the figures given by him are very significant and his paper is not merely of scientific value, but shows a good knowledge of market conditions as well. Lac dye is one of those substances which coalesce into their component parts; its value lies in the fact that it has got very great resistance to light and it has still possibilities therefore for the future. With regard to Dr. Subramaniam's question, what to do when a crop has more water than it can do with and how to dispose of the large quantities of water from the sewage plant, I can suggest to him a practice that obtains in China, viz., leading this effluent to fish ponds and rearing fish therein; fish thrive well on this water and grow to quite a good size and so there is a possibility of pisci-culture becoming a useful side industry to a sewage plant.

Mr. C. Tadulinga Mudaliar. Dr. Subramaniam's reference to different kinds of vegetation running wild in several parts of the country induces me to bring to his notice, if he does not know about it already, the existence of a plant, Croton sparsiflorus, which is found growing as a weed all over the country. This is a euphorbaceous plant foreign to this country and is becoming fast established as a nuisance to our crops. It would be worth while to find out if this could be utlised in any way. With regard to the activated sludge plant at the Agricultural College, we experience a difficulty in that the only water available for us is very alkaline. I would therefore like to know if the effluent could be used for irrigation and if there is any practical way of correcting the alkalinity.

Mr. K. Krishnamurthi Rao read an extract from the International Sugar Journal which in humourous and in succint language visualized a day when mankind would be able to get on with sugar and sugar products only in the way of furniture, and home and office accessories. In the face of such an extract he was of opinion that a day would come then molasses from cane sugar refineries would be utilised to the fullest extent.

#### THE PRESIDENT'S CONCLUDING REMARKS

We have digested, I believe, enough of a very important subject and the discussion has tended to show that there are martyrs and saints to the cause of science as I outlined in my preliminary remarks. Mr. Sreenivasaya's hitherto unsuccessful attempts at getting a suitable dye from the red liquid of lac industry waste will dub him a martyr while Dr. Fowler's successful solution of sewage disposal will put him amongst saints.

In the evolution of a scientific solution of any problem for advancing human interest, I believe, that the solution is complete only when a scientist is no longer required and the non-scientific lay public are able to adopt the method by themselves. The direction of success should also be towards developing the method on the scale of a cottage industry. Judged by this standard Dr. Fowler's solution of the problem is complete, but not simple. Mr. Viswanatha Iyer's is simple, but not immediately useful. Dr. Subramaniam's solution is not yet complete, but his work is in the right direction. His work also shows that scientists have to run a race with time. His reference to prickly-pear being a very valuable plant comes a little too late when all the

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m for advancete only when ay public are ion of success le of a cottage of the problem s simple, but on is not yet ork also shows ace to pricklye when all the prickly-pear in the land has been destroyed through the agency of the cochineal. Even now his work on the utilisation of the lantana plant must proceed rapidly for we are now looking on the plant as a nuisance and are out to destroy it by all means. Rao Bahadur B. Viswanath's paper is still in the formative stage like Dr. Subramaniam's; but here also the direction is all right and the Singanallur experiment may very soon give us a new kind of sugar manufactured in our own country which contains more vitamins than the one we are using. As regards Mr. Lakshman Rao's paper the concensus of opinion has been against it and I also agree that milk is too valuable a nutrient to be utilised through its waste products. Mr. Sreenivasaya's solution is complete and simple, but his paper must open our eyes to the competition we are having from synthetic products. It is a wonder to me that most of our synthetic products are manufactured from coal which is after all a dead vegetable. If science has helped us to utilise this dead vegetable in so many different ways, why not we make live vegetables yield more, for after all a day must come when even coal must be exhausted. Scientists and educationists must therefore bestir themselves and universities must change their scope of education to impart training to their alumni in such a way as to induce in them a spirit for research and for the practical application of science.

Vote of thanks. Rao Bahadur M. R. Ramaswami Sivan on behalf of the Indian Chemical Society, Madras Branch, Dr. V. Subramaniam on behalf of the Society of Biological Chemists (India) and Mr. S. Sundararaman on behalf of the Association of Economic Biologists proposed votes of thanks to the President after which the session terminated.

# SECOND SESSION OF STREET STREET

head per day are required the total amount of nitrogen

Public lecture at 6. 30. P. M.

A CASE FOR THE ELECTRO-CHEMICAL FIXATION OF ATMOSPHERIC NITROGEN IN INDIA.

Speaker:— Rao Bahadur B. Viswanath.

President: - Major Howard.

President's preliminary remarks. The subject is of great national importance and at the present time one which should receive the very earnest attention of not only scientists but the public men and legislators in this country. It is an economic problem to increase the yields per acre of our crops and every possible attempt must be made to harness available resources to this end.

Rao Bahadur B. Viswanath's Speech. Realising that the electro chemical fixation of atmospheric nitrogen is a factor directly and intimately connected with food production, several countries in the world have paid enormous attention to this problem and are producing nitrogen in quantities suitable for areas of production; India alone is producing nothing although it is not wanting in natural resources. Authorities have estimated the probable water power of India for maximum development as 12,680,000 kilo watts. The problem has been under discussion for the past ten years having been studied by the Sugar Committee, the Board of Agriculture, the Indian Science Congress and the Royal Commission on Agriculture. The last body relegated the possibilities to a distant date. But we are not to rest content with their findings for as long as there is not over production there is no justification for India not to produce more. We are handicapped by being late in the field. The use of commercial fertilisers to the detriment of the conservation of other forms of nitrogen available for the ryots, is a disservice to the country. But if for feeding the population the available natural supplies are inadequate the artificial utilisation of atmospheric nitrogen becomes a paramount necessity.

The nitrogen position in relation to food shows on examination, that the present requirements of the world's population in terms of food nitrogen is six million tons per annum. The world's capacity for nitrogen fixation is two million tons per annum. The production of Chilean saltpetre supplies an equivalent of one-third million tons of nitrogen per year. Assuming that the food eater is vegetarian and a nitrogen efficiency of 20 % in the grain, it would require thirty million tons of nitrogen to be added as manure to make up the deficit. Assuming in India that the food requirements are lower than in America or in England, and that 75 grams of protein or 12 grams of nitrogen per head per day are required the total amount of nitrogen necessary for feeding a population of 333 millions is found to be 1,522,312 tons per year. As against this only 1,071,138 tons of nitrogen are produced as calculated by analysis of plants. Thus so far as food is concerned we are short by roughly five lakhs of tons of nitrogen. In other words we are at present producing food sufficient for the proper feeding of only two-thirds of the population.

The total amount of nitrogen likely to be supplied by our livestock is 3,319,629 tons of nitrogen not taking into account other sources like human excreta etc. We may make up food shortage by proper conservation and utilisation of indigenous sources of nitrogen but it will be at the expense of industrial crops. This can be done (1) by increasing acreage under food crops and (2) by increasing production per acre. The former has practically reached the limit and the latter is our only way out of the difficulty. A case is therefore made out for the use of nitrogen fixation product and for their manufacture in India. As re Habe is a c in w colla

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by our liveother sources age by proper trogen but it done (1) by ag production and the latter made out for cture in India. As regards the particular process—"the arc", the cyanamide "or" the Haber-Bosch "—which would be most suitable for our conditions that is a case for the immediate institution of nitrogen research laboratories in which chemists and electrical engineers should work in close collaboration.

Chairman's Concluding Speech. Rao Bahadur B. Viswanath's enthusiastic advocacy has made me wonder whether there is any one else present in South India who would be able to present it so well as he. He has brought out very clearly the deficiency of nitrogen and how it is imminent on us to produce nitrogen. But to me the problem is how much to produce, how to go about it and how to make the people use the product that is manufactured. In my opinion the best process to be adopted here is the Arc process. The problem is also economic and must be interpreted in a much wider sense than the merely scientific. We have, at the start, to decide on giving a national orientation to this enterprise if it should be any economic success later on. What exactly I mean by nationalizing such industries can be illustrated by referring to Japan, and Italy, where great strides have been made in scientific progress on account of the Government taking a chief hand in such enterprises. I can also quote to you the instance of Egypt where two million pounds have been sanctioned for the erection of hydro-electric works on the Nile and another two millions for the manufacture of fertilizers. I am perfectly sure because they are state-undertaken that even this vast expenditure will be justified in bringing useful returns.

I am not very sure of Pykara being a suitable site. It is not merely from economic considerations but because also that it is not particularly suitable. Nearer to us we have Mettur, an ideal site in my opinion. It is not very safe to take our figures from Norway. Norway was the first to start nitrogen fixation electro-chemically and the figures are of pre-war days. Power in Norway is produced at £ 2 a kilo-watt a year. The Nitrogen Fixation Committee's finding is that this would be equivalent to £ 4 at present. We can produce at Mettur easily at £ 4 and that with profit.

One thing however we must bear in mind and that is the competition from foreign markets. The Agricultural Commission went into this and it was this that made them argue against electro-chemical projects in this country. In the early stages at least, therefore, we must start with protection from the Government and in my opinion that is the only economic solution. I am in sympathy with the lecturer not merely sentimentally but also practically.

# THIRD SESSION.

Saturday 8th October, 1932. 1-30 p.m. CHAIRMAN. Dr. Gilbert J. Fowler D.Sc., F. I. C.

- 1. THE INFLUENCE OF ATTACHED RINGS ON THE FORMATION AND STABILITY OF HETEROCYCLIC COMPOUNDS.
- T. N. Ghosh, Bang slore. Some aryl-carbamidopropionic acids have been prepared which, on treatment with acetic anhydride, yield oxazine derivatives. The evidence obtained from the action of hydrolysing agents on the above oxazine derivatives and B-lactylurea on the one hand, and benzoxazine derivatives and o-benzoylenurea on the other, points to the well-marked influence of the benzene ring in increasing the stability of the heterocyclic systems. The remarkable stability of an eight-membered lactone ring obtained from salicylideneanthranilic acid is attributed to the presence of two benzene rings.
- 2. DILATOMETRY OF HOMOGENEOUS CHEMICAL REACTIONS. PART I. Complexes of Mannitol with Arsenic, Boric and Molybdic Salts.
- The formation of the complexes M. Srinivasan and M. Sreenivasaya Bangalore. of mannitol, which is accompanied by an enhancement of the optical rotation, has been found to give an elevation in the dilatometric column. A 5% solution of the sugar alcohol, with arsenite, yields an elevation of 3.5 c. c. per litre.

# 3. THE NATURE OF INULASE.

N. Keshava Iyengar and M. Sreenivasaya, Bangalore. The original enzyme extract derived by the cytolytic maceration of the dessicated fungus powder has been analysed for total solids, total and amino nitrogens, total ash and inulase and invertase activities. These data have been determined for different extracts subjected to dialysis for different periods of time. The dialysis has been carried out at room temperature (23°-24°C) against a stream of distilled water in parchment and collodion thimbles. It has been found that while parchment allows the passage of both the enzymes at slightly different rates, the collodion thimble, during the first 5 days' dialysis, does not allow the passage of any enzyme as evidenced by the rentention of the original activity, the dialysis effecting the enrichment of the enzyme 40 times when the total solid content is considered. The total nitrogen content also decreases to more than fortieth of its original value without loss of activity.

## 4. CALORIMETRY IN ENZYME ACTION PART I. THE CALORIMETER.

H. B. Sreerangachar and M. Sreenivasaya, Bangalore. A modified form of Bunsen's ice calorimeter has been constructed and calibrated employing diphenylmethane. The precautions to be taken for its working are described. The apparatus has been employed for a preliminary study of invertase-sucrose and ureaseurea systems.

## 5. THE ORIGIN OF COHESIVE FORCES IN PLANTS.

M. Sreenivasaya, Bangalore. A bio-chemical explanation of the origin of cohesive forces in the capillary conduits of the plant is given. Results of recent dilatometric studies in enzyme action lend experimental support to the theory.

## 6. TRANSPORT OF THE INFECTIVE PRINCIPLE OF SPIKE DISEASE.

M. Sreenivasaya, Bangalore. Several experiments on the transmission of spikedisease to healthy sandals by patch grafting under controlled conditions have shown that the region between the bark and the wood is the most susceptible, infection not taking place when the diseased tissue is inserted in any other vertical section of the stem. This has been confirmed by ringing experiments. Further corroboration has been obtained from experiments on sandal plants

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which have been split vertically up to the root; infection introduced into one of the fork, manifests itself at the other. From this it appears that the infective principle is transported by the downward current of sap.

> 7. THE USE OF ARSENICALS AND OTHER CHEMICALS IN THE ERADICATION OF SPIKE-DISEASE OF SANDAL.

> > A. V. Varadaraja Iyengar, Bangalore.

8. STUDIES ON THE SPIKE-DISEASE OF VINCA RASEA.

A. V. Varadaraja Iyengar, Bangalore.

9. THE MECHANISM OF SYNTHESIS OF PROTEINS IN PLANTS.

K. S. Varadachar, Bangalore.

10. EFFECT OF INJECTION OF AQUEOUS EXTRACTS OF ORGANIC SUBSTANCES ON THE GROWTH OF HELIANUHUS ANNUS

G. S. Siddappa, Bangalore. Sun flower plants of Sutton's Giant Yellow variety were raised on washed sand supplied with complete minerals and when they had grown sufficiently they were injected first with distilled water and then with aqueous extracts of dried yeast, farmyard manure, dried blood, soil and sewage effluent. It was observed in almost all the cases that the injected plants responded to the treatment as indicated by their all-round development such as height, stem-thickness, foliage, dry weight and root formation. The effect on flowering was striking as previously observed, yeast coming at the top with a flower per plant of an average dry weight of 9.64 gms. While the control plant gave a flower of only 3.29 gms. Farmyard manure and soil extract were equally good in their influence on flowering.

#### 11. RESPIRATION OF MANGOES

G. R. Rao, Bangalore. The amount of CO2 given out by a fruit during normal ripening indicates the progress of ripening. The respiration of mature greenish yellow Neelam mangoes was studied at various temperatures, 22°C. (room temperature), 10° C. and 5°C. On an average the amount of CO2 given out per Kilo of fruit in 24 hrs. at 22°, 10° and 5°C. was 1.642 gm., 0.748 gm., and 0.596 gm. respectively.

At 22° the amount of CO2 given out increased till about the 4th day (when the fruit ripened) and then fell till about the 10th day when rotting started. At 10°C. the amount of CO2 given out increased gradually. The fruit ripened on the 12th day. At 5°C. the amount of CO2 given out appeared to be fairly constant but the fruits did not ripen even after about 25 days. The fruits were all kept at about 70% humidity and these were healthier looking and better coloured than those kept without humidity control. Although they had lost considerably in weight they did not appear to have shrivelled up.

From these respiration studies it appears that the best temperature for preservation of mangoes is between 5°C. and 10°C. Mr. B. N. Banerjee finds through actual storage experiments that 5-10°C. is the best temperature for storage of Neelam mangoes and Dr. Cheema (Horticulturist to the Govt. of Bombay) finds that 40-45°F. is the best temperature for preservation of Alphonso fruits.

12. A BIOCHEMICAL STUDY OF THE RAGI PLANT AS AFFECTED BY MINERAL TREATMENTS AND SEASONAL FACTORS

S. Rajagopal & A. V. Varadaraja Iyengar, Bangalore.

13. THE RELATIVE VITAMIN-A VALUE OF 5 DIFFERENT FRESH WATER FISH OILS

N. C. Datta, Bangalore.

14. TANNINS IN CASSIA AURICULATA 1. ESTIMATION

N. Srinivasan, Bangalore

15. DETERMINATION OF NITROGEN IN SOILS

A. Srinivasan, Bangalore.

16. THE NATURE OF FENUGREEK MUCILAGE

B. N. Sastri & C. R. Harihara Iyer, Bangalore.

The mucilage obtained from the bran has been purified. Saturation of the aqueous solution of the mucilage with magnesium or ammonium sulphate removes the associated nitrogen and phosphorus containing impurity. Similar results are obtained by treatment with trichloracetic acid, suggesting that the nitrogenous impurity is of the nature of a protein. The purified mucilage is free from silica and phosphorus and is a mannogalactan or a galactomannan, containing the two sugars in equal quantities.

17. RHAPONTICIN FROM REEUM EMODI—WALL.

M. Ghouse Mohiyuddin, Bangalore

18. THE PLATE METHOD OF COUNTING SOIL POPULATION.

M. Ghouse Mohiyuddin, Bangalore.

19. ON THE ESTIMATION OF TOTAL ALKALOIDS OF PLANT MATERIALS

B. H. Krishna, Bangalore. Two new methods are described;—(1) of extraction of the material with trichlorethylene and (2) using methyl alcohol. Colouring matters which are observed to affect the results in a number of cases along with extractable carbohydrates, are removed by preliminary treatment of material with copper sulphate and freshly prepared milk of lime. Comparative figures are given of the results obtained with a number of cinchona barks and also by methods suggested for the new B. P. by self et. al. employing ammoniacal alcohol.

20. PROTEINS OF FENUGREEK.

R. Rajagopalan, Bangalore

21. CONTRIBUTIONS TO THE STUDY OF SPIKE DISEASE OF SANDAL Part III. Nitrogenous constituents.

Y. V. Sreeniyasa Rao and M. Sreeniyasaya Bangalore.

22. DECOMPOSITION OF ORGANIC MATTER IN PRESENCE OF CERTAIN INORGANIC CATALYSTS.

J. Jagannatha Rao, Mysore.

23. PHYSIOLOGICAL PRODUCTS OF THE LAC INSECT PART I.
NITROGENOUS CONSTITUENTS.

N. K. Ranga Rao, Bangalore.

24. DEVELOPMENTAL STUDIES ON RICE PLANT IN RELATION TO APPLICATION OF FERTILISERS

K. Ramiah, Coimbatore. To get the maximum outturns from a crop, adoption of improved and judicious agronomic practices have to go hand in hand with the growing of improved strains. Application of fertilisers is an important practice that may have to be increasingly resorted to in future, to augment yields. Yield is an end result of the vital activities of the plant in relation to its surroundings throughout life, and to understand the response of the plant to its environment and the effect of such response upon the final result, the important phases of plant development must first be determined. The paper discusses the relationship between the developmental phases of the rice plant and the application of fertilisers.

The two important phases of development in rice plant, as in most cereals, which bear a direct relation to final yield are (1), tillering, which is an index of

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vegetative development and (2), the ear formation, which is the reproductive phase. The interrelationship between these two phases is traced.

The object of the application of fertilisers should be (1), to increase active early tillering and thus increase the number of ears and (2), to increase the size of the individual ear; both these are known to contribute to bigger yields. It is found that the significant increase in yield brought about by the application of a quick-acting manure like ammonium sulphate in an experiment conducted at Coimbatore, was mainly due to the increase in the size of the ears. These results are confirmed by similar studies conducted at Aduturai, Pattambi, and Maruteru, where the maximum yields were obtained by the application of ammonium sulphate, one or two months after the transplanting of the crop when the active tillering phase was over.

#### 25. STUDIES OF COTTON OVULES WITH REFERENCE TO THEIR POSITION ON THE PLACENTA

V. Ramanathan, Coimbatore. The history of development of cotton ovules located in a lock, is traced through different stages of growth, with a view to determine the period and the manner of production of differences in the lint weights. Variation is first observed among the ovules a few days after the formation of ovular primordia. But on the day of flowering, the ovules at the middle region show highest weight, while the mode of distribution of the number of hairs is similar to that noticed on the matured seeds. Fresh crops of hairs continue to be produced in the same ratio, without being affected by the fertilisation of the embryos. During the thickening stage of the fibres, the mode for seed coat and lint weights gradually shifts from the centre to very near the base of the lock, while the mode for embryo weights continues to be at the middle zone. This observation indicates that factors for the embryo and the lint development are different.

A study of the several chemical analyses made on lint reveals that there is a distinct fall in the nitrogen content, as bolls mature.

It is suggested that the appearance of a type of colloidal particles in the lint cells, may be responsible for the transformation of the nuclear contents and for the surface expansion of the lint cells and that the differences in the amount of colloidal particles may be a cause of the variation observed in the number of lint cells produced.

#### 26. POD FORMATION IN GROUNDNUT, (Archais hypogea).

Dr. J. S. Patel. The stalk of the ovary or the gynaphore is visible in about five days after fertilisation. The gynaphore grows downward and pierces the ground to a depth of 2 to 5 cms. in about two to three weeks depending upon the position of the flower. It takes nearly sixty days from the time of fertilisation to the complete development of the pod

The gynaphores formed pods in sand, vegetable charcoal and clay irrespective of the medium being wet or dry. It would appear that a certain amount of resistance is required in the mediums, as pods failed to develop in cotton, sawdust, water and darkened atmosphere. Though the gynaphores are capable of taking in water, its presence in the media was not found necessary.

The shelling percentage, moisture content of shell and kernels, percentage of oil in fresh and dried kernels and the acid value of the oils were determined at intervals of a week from 25 to 60 days after fertilisation. The transference of organic materials from the shells (pericarp) to kernels begins about the thirtieth day and continues up to the sixtieth day, and the development of the kernel is very rapid in the last two weeks. The rate of oil formation is rather slow in the earlier stages. The curve of the oil formation does not follow a parallel course with that of the transference of the materials from the shells to the kernels. The

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# 27. STUDIES ON THE MOVEMENTS OF COTTON POLLEN TUBES.

V. Ramanath Ayyar & G. Seshadri Ayyangar, Coimbatore. The results obtained on the order of fertilisation of cotton ovules within a lock, definitly show that the ovule nearest to the stigmatic end is not the first to get fertilised, and that the maximum frequency of fertilised ovules is at the ovule of third position. It was also seen that the frequencies were less in all the even position ovules than in ovules of odd positions.

As all the even ovules belonged to one placentum and the odd ovules to another, the observations led to the study of the course of pollen tubes in the

placenta themselves.

Three interesting facts were noted: - (1) A large number of pollen tubes on entering the ovarian cavity, were deflected towards the side bearing the first ovule. (2) There was a crowding of the tubes near the third ovule. (3) The pollen tubes were often found to cross from one placentum to the other.

This behaviour of the tubes in relation to the placenta and the ovules was examined and three possible causes were made out. (1) The variation in the perceptive capacity of the pollen tubes. (2) The presence of an exciting influence in the ovules. (3) A variation in the intensity of the orienting stimulus.

Attempts were also made to study the developmental variation in the pla-

centa themselves. But no definite conclusions were arrived at.

The growth of the pollen tubes in culture media, with reference to ovules of different positions was studied. (1) Positive, negative and indifferent reactions. were noted with regard to the direction of their growth in relation to the ovules (2) There was a greater positive reaction with reference to odd ovules and greater negative reaction with reference to even ovules. These facts emphasise the possibility of the presence of a chemotropic stimulus which directs the course of the pollen tubes.

## 28. THE OCCURRENCE AND INHERITANCE OF A TYPE OF LAX EAR-HEAD IN THE ITALIAN MILLET

A type of lax panicle, G N. Rangaswmi Aiyangar and P. Seshadri Sarma, Coimbatore. characterized by fewer spikes, and fewer spikelets than the compact normal earhead appeared and behaved as a simple monohybrid recessive to the normal condition. There was chronic sterility and the duration was a little longer. Evidences of primitive affinities in the bristles were noticeable. This appears to be a negative single gene mutant.

# 29. PERIOD OF RECEPTIVITY OF STIGMA IN RICE

K. Ramaswamy, Coimbatore. A knowledge of the period of receptivity of the stigma is necessary for any hybridisation work towards crop improvement. The paper deals with investigations carried out at the Paddy Breeding Station, Coimbatore, to determine this period for rice.

The rice flowers were emasculated in the usual way and the stigmas were pollinated at definite intervals commencing from two hours after the normal flower opening, up to 8 days, and the percentage of setting determind by growing the set grains. It was found that the stigmas were most receptive for the first three days after emasculation, and the receptivity gradually declined and was lost entirely after the sixth day.

# 30. THE PROBLEM OF LODGING OF RICE CROP IN GODAVARI DELTA

C. R. Sreenivasa Ayyangar, & K. Ramiah, Coimbatore. The lodging of straw is a serious problem of the tract mentioned, particularly, in the western delta.

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The paper discusses the observations recorded about the morphological differences of plants in lodged and non-lodged areas at the Agricultural Research Station, Maruteru. Detailed measurements of internodes, heights etc., of the two sets of plants show, that lodinging is brought about by too rapid a growth in the initial stages resulting in comparatively longer bottom internodes.

The conditions which bring about lodging and the cultural practices adopted by the rice growers of the tract to overcome the defect are described. Improvements in such practices, such as judicious pruning of the vegetative growth at the right time, planting seedlings which have been kept for some time after pulling out, application of fertilisers in partial doses after planting etc. are suggested.

# 31. THE ECONOMIC DANGER IN THE INTRODUCTION OF SOME FOREIGN ANIMALS AND PLANTS

Dr. T. V. Ramakrishna Ayyar, Coimbatore. It is well known that, due to the action and reaction of various factors in nature, there is maintained what is called 'a balance of life' in this world. Human agency sometimes upsets this balance by indiscriminate transport of plants and animals from one country to another. The introduction of the mungoose into the West Indies, the rabbit into Australia, and the Prickly pear and Lantana into the old world are examples of how man, without any evil intentions, was responsible in bringing about an undesirable state of affairs.

Though the geographical position of India is more or less isolated, in these days of quick and easy transport facilities for all sorts of agricultural products there is every likelihood of undesirable exotic forms of insect pests and weeds gaining admission into the country without our knowledge. An attempt is made in this paper to survey the present position with regard to some of the important introduced exotic plants and insect pests, studied by the writer and suggestions are offered for preventing such introductions in future.

### 32. BETELVINE WILT (CAUSED BY PHYTOPHTHORA SP)

C. S. Krishnaswamy, Coimbatore. A serious disease causing enormous amount of damage to the Betelvine crop has been prevalent in some villages of Chingelpet District since 1927. The disease is caused by a species of Phytophthora, and control measures are difficult owing to the peculiar cultivation practices, obtaining in the locality. Absence of rotation, lack of adequate drainage facilities and excessive use of nitrogenous manure are the chief predisposing causes of the disease.

The disease is most virulent immediately after the North East rains. Experiments have been laid out in the locality to test the effect of lime, iron sulphate, and Bordeaux mixture on the incidence of the disease

Systematic spraying of the vines and the soil tends to keep the disease incheck.

#### 33. ERI SILKWORM REARING AS A COTTAGE INDUSTRY IN S. INDIA

Dr. T. V. Ramakrish a Ayyar, Coimbatore. In these days of in creasing unemployment, the rearing of silkworms as a cottage industry may be found to be a suitable and practical proposition.

Among the different varieties of silkworms found in India, there are only two kinds which can be utlised for domestic breeding. One is the well known mulberry silkworm (Bombyx mori), which produces the great bulk of world's commercial silk. The other is the one known as 'eri' or castor silkworm (Attacus ricini Boisd), a native of the submontant tracts along the south eastern Himalayas, the rearing of which was till lately confined to parts of Assam and known as Assam silk on that account.

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Methods for the determination of exchangeable hydrogen and the degree of saturation of soils are discussed, and the method of Crowther and Basu is shown to be inapplicable to humic soils. The need for accurate and reliable methods is emphasised.

## 38. THE CHEMISTRY OF BORDEAUX MIXTURE.

R. Satyanarayana, Coimbatore. In spite of a large amount of work done on the subject, the Chemistry of Bordeaux mixture still continues to be a disputed problem. Millardet thought that the interaction of calcium hydroxide with copper sulphate resulted in the formation of copper hydroxide and calcium sulphate. Pickering, Wober and others objected to this and suggested the existence of basic sulphates of copper. The products of the reaction under different conditions, such as variations in the equivalents of interacting substances and the reaction period, were examined. The basic sulphate theory of Pickering and others is not substantiated. Copper hydroxide is formed at 1.0 equivalent and the presence of calcium sulphate checks the decomposition of the hydroxide.

## 39. A NEW METHOD FOR DETERMINING NITRITES IN WATERS INCLUDING SEWAGE.

P. D. Karunakar and T. Rajagopala Ayyangar, Coimbatore. Dimethyl-alpha-napthylamine was tried in place of alpha-napthylamine with success. The colour produced is identical in both cases. In the case of the former the colour developed keeps longer within a limited concentration of nitrite. The addition of sodium chloride up to 100 parts per million accelerates the development of colour and at the same time prevents it from fading over a long period. The hydrogen ion concentration of the solution has a very great effect on the colour production.

## 40. A NOTE ON THE DETERMINATION OF NITRATES IN SEWAGE.

P. D Karunakar and T. Rajagopala Ayyangar, Coimbatore. Oxidation of the colourless and soluble organic matter as well as nitrites by hydrogen peroxide rather than by potassium permanganate was more effective. A modified procedure has been worked out in detail.

## FOURTH SESSION

Saturday, 8th October 1932. 8-30 to 11-30 a.m.

#### THE PRESENT STATUS OF THE SANDALWOOD SPIKE DISEASE IN SOUTHERN INDIA

Mr. M. Sreenivasaya. Speaker:

Chairman: Rao Bahadur K. R. Venkataramaier.

#### CHAIRMAN'S INTRODUCTORY SPEECH

I greatly appreciate the honour done to me in being asked to preside over the Session when scientists of repute are met to discuss a very important disease of sandalwood. And I particularly appreciate the spirit of goodwill and brotherhood with which scientists and laymen are brought together to tackle a scientific problem. The sandalwood spike has recently been very much in the public eye and I am sure Mr, Sreenivasaya and others will help us to a correct understanding of the present status of the disease.

Mr. M. Sreenivasaya: The sandalwood spike disease has been noticed as early as 1899 by McCarthy and others. Right from the beginning, there have been at least two schools of scientists and others, who have advanced reasons for the incidence of this disease. One, the physiological school, quotes that it is due entirely to physiological factors affecting the plant, while the other school contends that the disease is due to an infection which is capable of being communicated. A large amount of experimental work has been done to elucidate information about what you may call the infectious theory. In 1917 Dr. Coleman of Mysore gave experimental support to the infectious theory by his grafting experiments wherein diseased scions were grafted to healthy stocks and communicated the disease. There were of course certain defects in Dr. Coleman's experiments; they do not take into account the percentage of success attained or the nature of controls run. The possibility of transmission from the soil was also not eliminated.

The lecturer then explained clearly with a number of slides how experiments were devised to test the physiological and infectious theory. As regards the first, the disease could not be produced although the symptoms were created and the most significant factor was that the symptoms could not be communicated whenever they had been produced by alterations of physiological conditions. On the other hand, experiments designed to test the infectious theory by means of the leaf insertion method tended to show that the disease was communicable. This proved definitely that the sandalwood spike disease was due to some infectious principle. During the study of the disease every host plant of sandal was examined to find, if possible, any resistance could be attained to the disease by host association and in fact, hosts like accacia, cajanus, pongimia were found to render the sandal plant susceptible to disease while plants like melia, and cassia, impart relative resistance to the infection. The future of the work will depend for its success on selecting such resistanceimparting plants as hosts and by pollarding suspected trees in order to reveal the masked disease and then eradicating all deceased trees to eliminate the sources of infection.

**Discussion.** Mr. C. Tadulinga Mudaliar referring to a botanical survey in 1903 of the Mysore zone by Dr. Barber and others, wished to suggest to Mr. Sreenivasaya to infest if possible the *alocacia* family with spike disease as a preliminary to get some information on the incidence of disease and varietal differences.

Mr. C. Dover gave a short account of the entomological work done in connection with this disease to accumulate information about possible insect vectors for the spread of the sandal spike disease. A survey of the insect fauna of sandal wood forests is being systematically made and it is hoped that very soon the particular insects responsible for carrying the disease might be located.

Mr. G. N. Rangaswami Ayyangar speaking with the experience of one privileged to deal with annuals and the difficulties a crop specialist has to surmount, gave a note of warning about dealing with a costly parasitic tree like the sandal. He suggested a broad genetic attack of the problem with a view to get more knowledge about the sandal tree.

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Dr. T. V. Ramakrishna Iyer wished to have more information about the bodies which had been isolated from diseased specimens. Apart from sandal wood he wanted to know if any one example of transmissibility of disease could be cited as having been passed by physiological conditions.

Rao Bahadur T. S. Venkataraman remarking humourously that a systematic botanist works in straight lines while life gets on in a circle, said that while on the authority of a systematist we might be working on different varieties it might happen that they were all the same and vice-versa. Genetic composition is sometimes different from systematic label and he would therefore suggest more study of the varietal differences as regards the incidence of disease.

Mr. C. S. Krishnaswami observed that transmissibility of the disease was the crux of the whole matter and if physiologically well nursed plants do take the infection it cuts at the root the physiological theory. With reference to Mr. Dover's observations that only insects found on the sandal might be possible vectors of the disease he quoted the instance of Aphis maidis which thrives on cholam but has been known to be the carrier of the sugarcane mostic.

Rao Sahib T. V. Rajagopalachariar speaking as a layman referred to his observations of a sandal thriving on pomegranate as a host and wanted to know if sandal hosted on itself was more inclined to spike.

#### PRESIDENT'S CONCLUDING REMARKS.

I must thank Mr. M. Sreenivasaya for the very clear exposition he has given of the subject. We forest department people have been trying to find ways and means of stamping out the disease but it has been sylviculturally impossible. It is a matter of regret to me that Mr. Jivanna Rao is not here today to give us the benefit of his arguments in support of the physiological theory. I myself for a long time was a disbeliever in the infection theory. As a forester I have had occasions to come in close contact with the sandal tree. I observed one tree spiked, and another not, and others escaping for years together. My inference naturally was that it could not be infectious. Only when I had positive proof of communicability by artificial inoculation in experiments done by myself at the Institute, as a result of my own handling, did I get occular satisfaction and became a convert to the infection theory.

Sandal is a deciduous associate formation and is naturally limited through reserves. The species is transitory reaching a climax type in virgin forests and vanishing near the fringes of reserves. It therefore grows under a covered condition hugging shelter of lantana and other bushes and is denied sun light till a particular stage of growth. Unbalanced circulation of sap sets in and this was for a very long time supposed to be the predominant cause for the disease. The peculiar conditions of light and shade in which it grows and the fact that it is a root parasite and therefore does not get normal food supplies, are reasons which make one believe in this unbalanced circulation of sap. This in fact is the basic argument for the physiological school.

I will now enumerate to you the several points against this physiological theory. If food is cut off or rapidly used up the

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irresponsiveness of the root to continue to supply to the leaves results in difference of osmotic pressure. This is the argument of the physiologist. Treating host plants therefore not to do their function must therefore result in this physiological condition. If you cut the roots the sandal must produce the spike. Such things have been done but never was spike produced. In fact single trees were isolated, dug up all round, roots cut off and even a polished platform provided to cut off moisture. The tree of course did not show normal growth but never produced spike symptoms. Even stronger measures were adopted. Strong sulphuric acid was poured into the roots. The lantana bushes were destroyed ruthlessly. Even fire as a killing agency was tried. The trees after sometime put on new flesh but no spike was produced.

All these conclusively dealt the death blow to the physiological theory. I however still believe, convert as I am to the infactious theory, that physiological and ecological factors have something to do with the disease. If they do not cause the disease they are at least responsible as predisposing causes for the trees to take on infection. I am not also yet convinced of the efficacy of destroying wholesale valuable plantations to stop the spread of the disease. Because even after destroying the trees one is not quite sure that the infection may not yet spread. There is no point therefore in eradicating these trees. Until therefore more efficient methods of combating the disease are found my opinion is that it is unwise to cut off plantations. My own experience is that there is an equilibrium set up by nature itself and sooner or later the infected trees get naturally immunised. Statistics as far as I know do not warrant our destroying so much wood of commercial value.

Motes and Comments.

Universities and Applied Sciences. Though no one can deny the need for research in the fundamental and general problems of the sciences it must be accepted that the time has come for those responsible in carrying on scientific investigations such as Universities and Research Institutes to divert the lines of research as far as possible, from the time-honored beaten tracks of mere academic lines towards So far most of the Unithe utilitarian aspects of scientific research. versities, at any rate in India, have been arranging their research courses in such sciences as Botany, Zoology, Chemistry, etc., more along the aspects of pure science than along fields of the applied It is needless to add that these are times aspects of such sciences. when the mere academic pursuit of any pure science will not be of any great help to the immediate needs of the country; workers in different branches put their hands together, co-operate, and make the very best use of their scientific knowledge towards the urgent needs and the calls of the country. Specialisation in different branches is certainly essential and commendable but as the writer in 'Nature' put it 'Science is