generations various semi-lethal chlorophyll deficient types and completely lethal albinos though these were not present in the parents themselves.

In addition to the above, several cases of sterility where the spikelets remain chaffy without developing any grain are also met with. The chief manifestation of such spikelet sterility is the occurrence of non-viable pollen or male gametes. Cytological studies are able to connect the sterility with the peculiar behaviour of the chromosomes. Usually in interspecies crosses involving different numbers of chromosome the sterility is caused by the presence of these unpaired univalent chromosomes. This, however, does not apply to rice as all the species of Oryza so far examined have the same chromosome number. Sterility in this case must therefore be due to the different genic constitution of the chromosome sets. This is the characteristic of crosses between different geographical races.

Several cases of chromosome irregularities have been met with. There have been one or two instances where due to a stimulus, seed has formed without the fusion of the male gamete with the egg, the result being the plant arising from it contains only half the chromosome set, *haploid*. This plant is very much reduced in size, and completely sterile. Such a plant is found to set seed very occasionally due probably to the chance union of the haploid complement of chromosomes. The plants arising from such seeds should be absolutely homozygous.

Plants have also occurred with three sets of chromosomes instead of the usual two, *triploids*, due to the union of a male gamete with an unreduced egg. Such a plant is also sterile because of the uneven number of chromosomes but it occasionally sets seed giving rise to *polysomics*, where, in addition to the diploid chromosome sets, there are one or more extra chromosomes. Plants with $2n + 1$, $2n + 2$, and $2n + 3$ chromosomes have been obtained, the increase in the number of extra chromosomes being associated with corresponding decreases in stature, vigour, etc., of the plants containing them.

Recent researches in some plants have led to the production by artificial means of *tetraploids*, where, instead of the two sets of chromosomes, there are four. These that arise by the duplication of the chromosomes, are usually bigger in stature, more vigorous than the *diploids*, and form a new species altogether. These have been produced from hybrids of different species which though sterile become fertile by the doubling of the chromosome set brought about by suppression of the cytoplasmic division at meiosis. After repeated attempts a successful cross has been obtained between two species of Oryza, *O. sativa* and *O. latifolia*, and the production of tetraploids from this hybrid is being attempted. This attempt, if successful, should prove extremely interesting.

In addition to changes that occur in the whole chromosome sets as in the cases mentioned above, there can also be changes in the genic make-up of the chromosomes, such changes being termed point or gene mutations. Treatment of the plants with X-rays has been found to be a prolific source for producing such changes artificially. The work of subjecting rice to X-rays has already begun in Coimbatore. Some of the pure lines have, as a result of the X-ray treatments, thrown dwarfs, albinos, chlorophyll deficient types, etc., which usually occur in the progenies of definite crosses. The plants resulting from X-rayed seed are found to be sterile and their cytological studies are proving extremely interesting. Among other chromosomal disturbances chromosome rings are found to occur in the meiosis obviously due to reciprocal translocation of parts of non-homologous chromosomes.

Plant breeding as a branch of agricultural science stands for producing new crops or plants, the introduction of which should bring a greater return to the cultivator. It is well to recognise that the outlook of the breeder is thus conditioned by restrictions from which pure science, as a branch of scholarship, should be kept free. As the previous narrative has shown, rice breeding work in Madras has, by the evolution of a large number of superior strains and their cultivation by the ryots, materially increased the production and hence the return to the grower, but due, unfortunately, to the present slump in the rice market, the position of the Madras rice-grower is anything but bright. Prices have gone down terribly and in some cases even to the extent of 200% over the prevailing prices 3 or 4 years ago. Such a fall cannot easily be accounted for. At any rate over-production is certainly not yet a contributory cause. It is hoped that the enquiries of the special officer recently appointed for the purpose will throw light on the problem and result in finding ways and means of bringing some relief to the rice cultivator.

Optical Technology.*

By Dr. H. Parameswaran, M.A., Ph.D., D.Sc., F.Inst.P.

IN recent years the sciences have certainly reached a high state of development in India. The original contributions, reckoned either by their quality or quantity, constitute a record of which we could be proud. But when one considers the extent of knowledge of a practical character that prevails in the country which is necessary for the manufacture of apparatus with which these researches are carried out, one will make rather dismal discoveries. Not only is there a complete lack of instrumental skill but there is also a sort of contempt for the acquisition of that knowledge and skill. There is also a tendency to regard such knowledge and skill as purely mechanical and unscientific. I do consider this tendency highly detrimental to our material progress; the science of Physics comprises also applied and industrial aspects capable of extensive commercial application and it is high time that we concentrate and direct our scientific knowledge to this much-neglected direction and produce results

* Text of a paper read before the Bangalore Easter Science Congress, 1934.

of the greatest economic importance to the country.

I am particularly anxious that I should not be misunderstood. Theoretical researches will and should be going on under those specially inclined for it, but whatever we try to do by spending the country's feeble resources it should be useful and calculated to benefit the large suffering population.

We already see before us the sorry spectacle of a modern mechanical civilization coming into violent contact with a simple agricultural population. It has just educated them to increase their wants for manufactured articles before teaching them to manufacture them themselves. We find a similar deplorable state of affairs prevailing in the field of science as well. To take a simple example let us consider the familiar Raman effect. It is true it has given us international reputation. But it has not served to feed us. It has promoted the manufacture of a large number of costly spectrographs and their accessories in other countries. But in our own country it has only helped us to increase our imports of these very costly apparatus. Although I have the greatest admiration for the academic triumphs of our countrymen, I cannot but help feeling that some at least of these men would have done much better if they had directed their knowledge of physical science to the making of these costly spectrographs and their accessories. Work of this character does belong rightly to men of these academic attainments as well for in the design, construction, testing and adjustment of these instruments one finds ample scope for every variety of scientific knowledge. The very cost of these apparatus makes it worthwhile for an M.A. or M.Sc., getting in India barely Rs. 50 a month to engage himself in producing apparatus costing more than Rs. 2,000 a piece.

In work of this kind I find that the ratio of the cost of the finished product to the cost of the raw material range anywhere from ten to fifteen. The capital outlay required is comparatively small and hence particularly suited to small-scale production by individual efforts. Thus it is a line most directly suited to employ modern scientifically educated Indians. But as things are at present in India with our education in the universities running purely on academic lines divorced so much from practical realities with little insistence on knowledge of detail and practical skill, it is almost impossible to use the educated material available to-day for any such purpose. It affords in a way an explanation for there being so little of scientific instrument making in India to-day notwithstanding the enormous scope for it in this country.

Subjects like high class optical work on which is based the construction of spectrographs remain practically unknown even in the highest academic circles in India. To combat this deplorable position, we, at the Madras Presidency College Physics Department, have been devoting some attention to Optical as well as other aspects of Instrument Technology for the last ten years. We have been able to develop successful processes and methods for the production of high class optical surfaces—both large and small, plane and curved. There might be a feeling whether these products of ours finished by research students as by-products of their optical researches are exactly equal in quality to those imported from abroad. We are quite alive to our imperfections; at the same time the results achieved are very encouraging and our optical products employed under comparable conditions often give pretty much the same performance undistinguishable even by experienced workers.

There seems to be a universal belief even amongst scientists that work of this kind is based upon a large number of trade secrets. This appears to be largely untrue. At the same time it must be remembered that every successful work cannot but be having its own special processes developed by years of experience in the field. These cannot, by their nature, be public property. Beyond this I do not think there is anything of the nature of specially guarded secrets in the optical industry.

The raw material, optical glass, in any quality (dispersion) is easily purchaseable from well-known makers like Messrs. Chance of Birmingham. It is different from ordinary glass in that it is very homogeneous in composition and perfectly annealed to free it from double refraction arising from strains. It can be obtained from the makers in any size and shape. The next material is carborundum powder sold in a variety of grades of fineness. By working the glass against cast iron tools using a paste of carborundum powder and water as abrasive the glass surface can be made plane or curved as desired and given the requisite degree of fineness. This fine ground surface is then rubbed on a surface of pitch using a paste of rouge and water as the polishing medium, which results in the surface developing rapidly a good polish.

So far the work may be said to be mechanical and the piece of the article has barely doubled the price of the raw material used. Next comes the difficult and careful operation of figuring which alone gives the finished piece the optical perfection and is responsible for its proportionately high price. During this operation frequent optical tests, involving considerable scientific understanding of the factors involved, are required to control the work; and if one fails to make the correct interpretations of the appearances and adopt the proper remedial measures, articles of the required finish and accuracy are never attained. Foucault's tests for concaves, Newton's rings tests for planes and complimentary surfaces in contact are fields where our graduate physicists can find ample scope for the physics they have studied.

Very many optical pieces that are required in such large numbers in laboratories for conducting the routine teaching operations do not require any very high class finish and figuring and they can easily be made in India to-day. Work of a higher class, like Interferometers, have also been attempted at Madras by special processes with considerable success. We have now on hand a 24-inch diameter glass disc to be made into a paraboloidal mirror of focal length 12 feet for a reflecting telescope which, when finished, will be the largest telescope in India.

A point of doubt which it may be advisable to clear, is about the relative merits of hand-working and power-working. The amount of power required for optical work is in any case very very small and quite a considerable lot of work can be done by hand alone. But the preparation of such surfaces like the 24-inch disc is certainly hard work for the hand. In such cases, very simple inexpensive machines requiring not more than one horse power can easily be improvised.

The mechanical operations involved in the mounting of these finished optical parts into complete instruments, calls for no great equipment or outlay other than that of a modest workshop and good scientific guidance.

Thus, considered in every way optical or instrument technology seems to be a line in which the attention of the scientifically educated but unemployed in India should get interested, and it is hoped that in providing the necessary training the Indian Institute of Science will play its part.

Science Notes.

Lady Tata Memorial Trust.—The Trustees have announced the award of the following scholarships for the year 1934-35, on the occasion of the third anniversary of the death of Lady Tata:—*International Scholarships* (£ 400 per mensem) for research in diseases of the blood with special reference to leucæmias—Dr. Walter Bungeler (Free Town of Danzig); Dr. Leonid Doljanski (Copenhagen); Dr. Martin Gril Gordon Israels (Manchester); Dr. Charles Oberling (Paris); Dr. Julius Enzelbreth Holm (Copenhagen); Dr. Max Otto Kaalund-Jorgensen (Denmark); Dr. Rolf-Meier (Leipzig); Dr. Lucy Wills (London). *Indian Scholarships.*—(Rs. 150 per mensem). H. D. Srivastava (Allahabad); S. K. Ganguli (Calcutta); N. C. Datta (Bangalore); M. V. Radhakrishna Rao (Waltair); M. C. Nath (Dacca), A. R. Rajavanshi (Allahabad); B. D. Kochhar (Lahore); S. K. Mahabaleshwar (Manchester); K. N. Gaind (Bangalore); and Y. V. Sreenivasa Rau (Bangalore).

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India Institute of the Deutsche Akademie has announced 21 new scholarships for the acadamic year 1934-35, for carrying on higher studies in various German Universities. The successful candidates are:—(1) A. K. Ghose, M.Sc. (Chemistry); (2) B. C. Roy, B.Sc. (Applied Geology); (3) C. D. Dwarakanath, L.I.M. (Medicine); (4) S. G. Joshi, M.B.B.S. (Medicine); (5) S. K. Sharma, M.A. (Sanskrit); (6) K. P. Mukhopadhyay, M.A., B.L. (Political Science and Economy); (7) B. K. Kar, M.Sc. (Botany); (8) T. V. G. Menon, B.A., B.Sc. (Agriculture); (9) Y. V. Sreenivasa Rau, M.Sc., A.I.I.Sc. (Plant Physiology); (10) Miss P. B. Devi, B.Sc. (Physical Chemistry); (11) D. C. Lahiri, B.A. (Medicine); (12) T. L. Kannappan Naicker, M.A., L.T. (Physics); (13) S. Vahiduddin, B.A. (Philosophy); (14) I. R. Barua, M.B.B.S. (Medicine); (15) Miss A. M. Jansz, B.A. (Economics and Political Science); (16) G. Kadambi, M.Sc. (Mathematics and Statistics); (17) A. K. Mitra (Anthropology); (18) D. R. Mehta, B.Sc. (Pharmaceutical Chemistry); (19) R. Ramamohan Rao, B.E. (Civil Engineering); (20) A. S. Gupta, M.B.B.S. (Medicine); and (21) Satyaketu Vidyalankar (History).

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The Sir Pratap Singh Memorial Scholarships (£ 100 each) tenable at the Indian Military Academy, Dehra Dun, have been awarded to Messrs. Muzaffar Khan (Campbellpore); Rawind Singh (Multan); Mahomed Sidiq Khan (Rawalpindi); and Wales (Rawalpindi).

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Imperial Institute Awards.—The Imperial Council of Agricultural Research awards each year one Gold and two or three Silver Medals for improvements of distinct merit, in the science and art of Agriculture and Animal Husbandry of an All-India importance.

Applications are invited for the award of Medals during 1935 for Improvements in Dairying and Care of Animals. All entries should reach the Secretary, Imperial Council of Agricultural Research, through the proper channel by the 1st December 1934. Scheduled forms and other particulars can be obtained from the Secretary, Imperial Council of Agricultural Research, Simla.

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Colonel Sewell, Leader of the Sir John Murray Expedition, and his colleagues who have been carrying on the Oceanographic Survey of the Arabian Sea since September last, have, according to a press report, made a spectacular discovery of the existence of a submarine mountain range running from Thagos Archipelago to Socotora in a line with Cape Guarda Firi on the East African Coast. Another submarine range was located in the Gulf of Oman running from North-East to South-East across the Gulf of Aden.

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A Provincial Research Committee with Lt.-Col. N. W. C. Noel, Director of Agriculture and Allied Departments, as President, has been appointed by the N.W.F. Province Government with the object of preparing Research Schemes for consideration by the Council of Agricultural Research. The Committee will work in close co-operation with the Imperial Council of Agricultural Research.

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A condolence meeting of the Staff and Students of the Royal Institute of Science, Bombay, was held on the 16th June to express deep regret and sorrow at the sad demise of Dr. A. N. Meldrum, the ex-Principal of this Institute. Dr. Meldrum was connected with the Institute for over 7 years, and it was under his able guidance that the germs of scientific research was first laid in the Institute in fact in Bombay Presidency. The Meeting passed a vote of condolence to the bereaved family of Dr. Meldrum and the Institute was closed on the 18th June as a mark of respect to his memory.

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Dr. Mata Prasad, Professor of Physical Chemistry, Royal Institute of Science, Bombay, has proceeded to England on a six months' leave to study the latest technique in X-ray Photography and Crystallography, which is his special subject of research. Mr. C. L. Mankodi is now working in place of Dr. Mata Prasad.

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Dr. W. McRae, D.Sc., F.L.S., Director, Imperial Institute of Agricultural Research, Pusa, has been granted long leave preparatory to retirement. He came to Pusa in 1908 but his services as Government Mycologist were lent to the Madras Government. He returned to Pusa again in 1919 and was appointed Director in 1931.