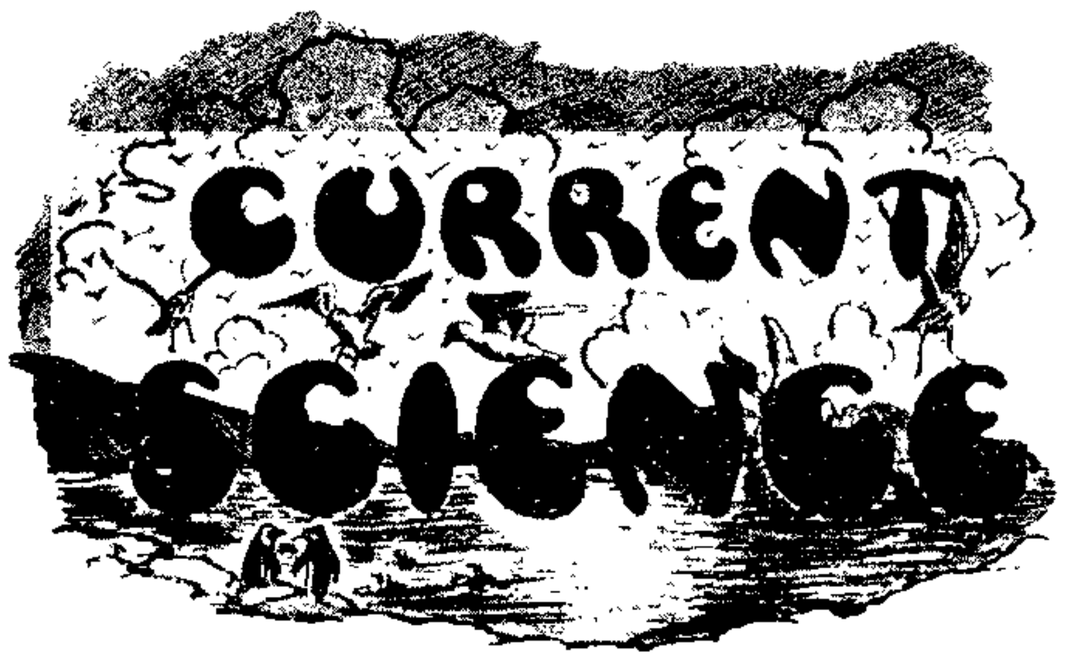

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Co-operation in Scientific Research.

ONE of the principal features of the recent development of higher education in India is the provision of facilities for scientific research in all the universities, and it is gratifying that the total annual output of work from their laboratories is increasing in volume and improving in quality. We have, at present, one university for every twenty millions of people and for every hundred thousand square miles. Judging merely from the geographical area of India and the density of her population, few will maintain that our eighteen or nineteen universities are excessive. We are rather disposed to think that in South India alone there is room for at least three more universities. It has now become part of the political doctrine of enlightened Indian public opinion that a wider diffusion of higher university education is indispensable to national progress.

Some well-meaning critics still hold that these centres of research and learning are directly responsible for the growth of unemployment in the cities, and propose that the funds now granted to universities should be diverted to the more useful and urgent purpose of spreading elementary and secondary education among the people. The disparagement of higher education by these popular representatives is probably due also to a vague apprehension that the money spent on the university benefits only a few, these few do not contribute directly to the earning power of the nation and the man who pays for them receives hardly any return for his money. We are afraid that this mode of reasoning can only be considered as a sample of the logic of democratic enthusiasm.

Furthermore, there is a class of reformers of Indian universities who advocate their conversion into technological and commercial institutions where young men undergoing practical training will be put in a position to earn their living and to contribute to the material prosperity of the society to which they belong. It is true that if universities are established in manufacturing centres, their technological sides will help to foster the local industries and may even help to maintain their supremacy; but it scarcely occurs to these zealous reformers that all universities are incapable of such transformation without prejudice to their more legitimate function. If a young man is destined for an industrial or business

career, it is in the workshop and the office of industrial institutions that he will learn his lessons more profitably than in the class rooms of the university. The village smithy, the local carpenter's table and the cottage handlooms provide really a more profitable training to the future rural industrialist than can be imparted in any secondary school. The fact is that all these adverse criticisms of the existing institutions are a product of an inverted snobbery.

Till recently the history of our universities has been one of routine and examinations and the colleges coming under their influence were naturally pre-occupied with fostering a kind of education devised to satisfy the rather arbitrary demands of public examinations, almost to the neglect of the equally important part of their function of promoting independent enquiry and freedom of thought. Where a system of external examinations is permitted to dominate the education of an affiliated institution, the latter tends to become mechanised and the products of such education will also tend to conform to an inelastic type, scarcely possessing a well-differentiated individual intellectual trait. In the universities in which there is abundance of good education and less examination, the result has always been a beneficial stimulation of post-graduate work in the laboratories and diminished numbers of bookworms, intellectual idlers and irresponsible critics in the country.

None of the numerous witnesses who deposed their evidence before the Sadler Committee has praised the system of university education, or upheld the unscientific method of examination then in existence; and almost every one attributes to these two causes the lack of an adequate output of work from research laboratories. It seems to us that a radical reform of the syllabuses of study for the various degree courses and a more humane scheme of examinations are urgently called for and that this desirable end can be secured only through the increasing exertions of the Inter-University Board. The general experience of the professors is that the intellectual curiosity of some of the brilliant young men, if it escapes the freezing influence of examinations, is in danger of being stifled by their poverty and naturally they proceed to seek employment under government rather than stay in the university to take up a piece of original work. For the purpose of increasing the output of original investigation from Indian universities, we would repeat and emphasize the well-known suggestions about a generous and stable financial scheme of research fellowships and post-graduate studentships which not merely attract and retain some of the ablest research workers in the universities but also provide for periodical encouragement by way of increments to their emoluments, the establishment of a number of endowed research chairs, financial provision for scientific expeditions other than official and the release of professors from routine which in the existing conditions gives them little time and less inclination for laboratory work. The public mind of India is steadily recognizing the value of scientific work and it is hoped that before long the wealthy section of the community will come forward with munificent donations for the creation of a network of research centres all over the country.

In the meantime the scientific investigations now being conducted in the different universities, in aided research centres, official scientific departments and laboratories maintained by private industrial organizations, can be strengthened and the rate of their progress accelerated through a definite scheme of co-operation and an agreed plan of work. At present the Indian Science Congress follows rather too closely the practice of the British Association for the Advancement of Science, in providing a forum for the reading of papers at the sectional meetings, in organizing public lectures on scientific subjects and joint meetings of sections for discussion of topics of common interest. There is, however, no provision in the Congress organization for directly promoting the advancement of science in India and its relation with the universities is not even formal. Its influence, therefore, on the general progress of scientific investigations is indirect and in the nature of things, quite remote. Separated by great distances, the workers in different centres of research might select and investigate almost identical problems and discover after the completion of their research that they have been anticipated, one by the other.

This avoidable and unnecessary duplication of work can be prevented if the delegates attending the Congress would meet and discuss the facilities afforded by their research laboratories for special work in the different branches of pure or applied science and the problems in which their colleagues,

their research scholars and themselves are most interested. The paths of allied sciences cross each other in many ways and the joint meetings of the sections might be devoted to a careful consideration and selection of the problems and their assignment to different research centres by common understanding. At the annual session of the Congress there would be, under such a scheme, presentation of completed papers or preliminary communications of results on known subjects. Besides preventing duplication, men of science will be aware of the nature of work progressing in different research centres and will be able to obtain such information or assistance as they may require from those departments likely to provide them. Without unduly curtailing the freedom of the researcher, a definite policy such as this will ensure for every paper, that is read before the sectional meeting, a most complete and illuminating discussion. It is absolutely impossible to read and discuss fully all the hundred and fifty pieces of research now submitted to sectional meetings within the twelve hours at their disposal and consequently the scientific message of a large number of papers is practically forced to remain subconscious.

Perhaps one effect of the plan of carrying on work on a co-operative basis may be diminution in the number of papers. Though this is to be regretted it is hoped that the lack of quantity will be more than compensated for by the quality and the fruitful results of a complete discussion and free exchange of thoughts.

One other advantage that will result from a programme of the type outlined above will be the recognition of different centres as being associated with definite lines of research. Such places will also be recognized as centres for disseminating reliable and accurate information in those and related branches of science. Thus will spring up a series of *information bureaux* which will assist not only fellow-scientists with relevant literature and other technical information but also other members of the public interested in the utilization of such knowledge. In view of the bewildering increase in scientific literature during recent years and the inadequate library facilities at many of the research centres in the country, the importance of such an organization can hardly be over-estimated.

It seems to us that a federation of research centres under the moral countenance of the Indian Science Congress, directed on the principle of effective and cheerful co-operation, will produce results in the future in an increased measure and quite as brilliant as those that already stand to the credit of most Indian universities. The main idea is that a professor working on a problem should have the means of assuring himself that it is not also simultaneously engaging the attention of another professor in some other Indian university and that the schools of research into which the universities have already become differentiated should be more widely and practically recognized. Moreover, every research worker should have the fullest possibility of receiving information and assistance whenever he requires them. Under existing conditions, in which investigation is conducted in almost water-tight compartments, progress must necessarily be slow though a few have succeeded in accomplishing international distinction. But this is not enough to build up an Indian scientific reputation and tradition quite as honourable and enduring as those of any of the European countries. The intent of co-operative research must be to mobilize the intellectual resources of the country for the achievement of common ends. Apart from the Asiatic Society of Bengal and the Bombay Natural History Society, there are no institutes of science and learned societies such as occur in European countries, on an all-India basis and there are no all-India scientific journals for the publication of original papers in different branches of science. The existence of such national institutions is calculated to provide additional stimulus to greater endeavour than now and the possibilities of founding them would be a fit subject of examination by the Indian Science Congress.

The ideal of co-operative research is selflessness and self-sacrifice, without limiting opportunities of adding to one's individual reputation. If we assume that the tradition of a country is the history of its achievements made possible by common endeavour, then we are still a long way from establishing one for India. Suppose that it becomes feasible to establish a federation of research centres in India, the scientists concurring in a coordinate effort to lay the foundation of a new tradition, the furtherance of this object can only be secured by the institution of more than one all-India scientific journal for recording the total output of work produced in different branches of science

within her boundaries and by preservation of them in her archives. The question of international publicity and priority of announcement of discoveries, so essential for Indian science, need not necessarily present insuperable difficulties. The former is secured by the determination on the part of all the scientists working in the country to publish all their best results in India and the latter is most effectively secured through the facilities already available for them through *Current Science*. We have not the slightest hesitation in thinking that the greatest ideal of all the leading men of science in India is not so much to achieve personal triumphs as to dedicate their services for common interests, ideals and traditions. Given the right spirit and incentive to high endeavour, it would not be fantastic to suppose that before the next quarter of a century elapses the new generation of scientists in India will move for the grant of charter for the establishment of a Royal Society and in this task the present generation will have to pull together as pioneers. To the Indian Science Congress one must naturally look for the birth of great ideas and we are of opinion that the time has arrived for this representative unofficial body to conceive a nation-wide scheme of constructive programme of scientific work.

The growth of industries and commerce and urban life has already established an intimate liaison between their problems and those of science; and the next generation will emphasize this relationship even more strongly. The official research departments can no longer function independently of the universities which in their ultimate scope will be found to possess a common purpose. The problems of agriculture and forestry really belong to more than one branch of science and it is here that co-operative research may prove of great importance. The Indian Institute of Science should be more widely utilized by the universities and official departments than now for the advancement of the material prosperity of the country. The Imperial Council of Agricultural Research through a scheme of grants for research in applied and pure science, has already taken steps to enlist the co-operation of the universities with the laboratories of the official departments, and similarly the Indian Medical Research Fund Association is functioning in close co-operation with the Department of Public Health and other research institutions of medical science.

Unless the efforts of all these research centres converge towards a common ideal, the mass advancement of science itself must for some time remain a dream in India. It must be pointed out that the co-operative research that we suggest will neither hinder nor eliminate the opportunities for individuals engaging in special fields of enquiry. We are aware that an investigator starting to solve a problem in accordance with the principles of our scheme, may discover in the course of his work other ideas which will take him away from the original problem. This is decidedly an advantage to the scheme itself. There is no intention to put obstacles on the freedom of the research departments or to apply rigid rules to their methods of work by the advocacy of co-operative research.

The doctrine that, "neither science nor the people would lose much if no attempt ever was made to bring them together", should not commend itself to the local self-governing institutions whose problems need the aid of science in every detail and particular. Science indeed loses its entire significance if it does not establish an intimate contact with the vital forces of civic administration. In modern life it is becoming increasingly clear that science and society must collaborate for the fullness and enrichment of both, and science is deprived of none of its dignity by being associated with the problems of every-day life. The introduction of fast moving vehicles in India without a previous preparation of the road conditions in the cities has been the cause of certain wide-spread diseases of the throat and the eye from which, as the Reports of the Medical Inspection of schools and colleges have abundantly shown, a large majority of the school-going population is suffering. Traffic in the cities has become positively dangerous. The disposal of town refuse or its utilization is essentially a scientific problem. Town-planning, the distribution of wholesome water, the drainage system, the supply and control of unadulterated food-stuffs, the protection of people against outbreak of epidemics, the preparation and interpretation of vital statistics and a number of other municipal problems require the effective assistance of scientific research for their solution. The municipalities ought to take the fullest advantage of the universities and the Indian

Science Congress to which they should present their own local problems for investigation. In order to widen the scope of the usefulness of the Science Congress it may be deemed desirable to admit within its province the problems of municipal administration which directly concern the health and efficiency of the people.

Under the reformed constitution Indian scientists will be confronted with tremendous problems, and their preparedness to grapple with them on the basis of a common purpose and common understanding, must in a measure constitute the vindication of the general demand for the freedom of the country to progress.

Announcement.

WE have pleasure in informing our numerous readers that Sir Richard Gregory, Editor of *Nature*, will arrive in Bombay on or about January 19th. 1933, by the P. & O. SS. *Mongolia* and will be in India for about a month. He will be accompanied by Lady Gregory and hopes to visit Allahabad, Calcutta, Madras and Bangalore during his short stay in the country. Any communications intended to reach him on arrival should be addressed to Messrs. Macmillan & Co., Ltd., 276, Hornby Road, Bombay, and afterwards to their branches at Calcutta and Madras. We welcome Sir Richard A. Gregory and Lady Gregory to our country.

Effects of Temperature on the Determination of Size of Species.

By Dr. C. C. John, M.A., D.SC., D.I.C.

GRAY (1931) by his experiments on the eggs of *Salmo fario* has shown that the size of the embryo at the end of larval life is smaller at a higher temperature than at a lower. For the eggs of any given species of animals there exists a range of temperature within which the embryo is capable of developing into a normal healthy individual. If the temperature of incubation is raised, the rate of development of a cold-blooded embryo is increased and if the temperature is lowered the rate of development is retarded. Though the rate of growth at a higher temperature is more rapid, the final size at the end of larval life is smaller at a *higher temperature than at a lower.* This is because a larger proportion of yolk is required for the maintenance of the embryonic tissue at a higher temperature and only a smaller proportion is available for the formation of new tissue. Each of the many processes accompanying development is altered and a "new state of dynamic equilibrium is established" with the increase in temperature. These facts can be extended to a consideration of the development under natural conditions. The temperature of the seas increases as we proceed from the polar to the equatorial regions, so that the larvæ which develop under these different conditions are bound to show differences in size and the same conclusions may be applied to the adults also which develop from these larvæ. If this could be proved it means that individuals of any given species of aquatic animals (invertebrates and cold-blooded vertebrates) living under colder conditions will be larger than individuals of the same species in warmer seas.

The genus Sagitta is well suited for the verification of this fact, because of its occurrence in all the seas of the world under all conditions of temperature and depth, from the Arctic and Antarctic to the Equatorial seas. In a general consideration of the distribution of Sagitta the most disturbing factor is the difference in length of the specimens of any particular species obtained from different localities. For instance *S. enflata** obtained from San Diego region (Michel, 1911) are about 15–21 mm., whereas the specimens collected at Madras are only about 11·5–13 mm. The same kind of difference is also noticed in *S. neglecta*. In fact all the species found to occur both in tropical and temperate seas show differences in length, the tropical form being always smaller in length, compared to those obtained from temperate seas.

There are some species such as *S. lyra*, *S. hæmata*, *S. macrocephala*, *S. elegans* and

* The Sagitta of the Madras coast have been wrongly identified as *S. bipunctata* (Shankara Menon, 1931). I was kindly permitted to re-identify the material and have been able to describe five species *S. enflata*, *S. gardineri*, *S. tenuis*, *S. neglecta* and *S. robusta*. Probably a few more species may be discovered by more systematic method of collection.