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Edited by

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SCIENCE AND CULTURE

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P E P*—Its Aims and Objects

"P E P is not just another Research body", says Mr Elmhirst, its chairman. "It combines the function of research with a definite social objective. It does not seek to implement its own findings, but it does believe that if it chooses its subjects in relation to their urgency, puts out its facts in the right way, gets them through in the right form to the right people, implementation will be the automatic result".

The social objective, which P E P has in view, is a gradual raising of the individual standard of living all along the line. It does not provide a more clear-cut definition of its aims. It realises that it would be far more fruitful to give a full picture of the society it envisages, with all the delicate adjustments in shades, than to attempt to devise some omnibus label for its views or to compress them, by some intellectual Procrusteanism, into one particular "ism". The widespread habit of thinking in terms of anti-thetical ideologies and the threadbare use of certain stock phrases carrying complex associations have created an atmosphere in which a closer definition of aims and objects would be more likely to mystify than to enlighten, the more so when an institution feels that it has common points with all the current ideologies though it can identify itself with none. P E P therefore deals with concrete realities and expresses its views one by one on the complex problems which beset us leaving it to interested parties to string together these conclusions and construe the type of social order it envisages.

Thus P E P prefers to work from the specific to the general, from the concrete to the abstract rather than the other way round. It does not enter into abstract and abstruse discussions of ends, but tries to reveal all the major contours of the society it stands for and works for. It often cuts right across all contemporary "isms", while its conclusions are like a series of bridges over the gulf which now divides one camp from the other. Act like men of thought and think like men of action, once urged a French philosopher. The wisdom of this epigram was instinctively grasped by P E P right from its start. As a result, it has avoided that divorce between thought and realities, which is increasingly proving a formidable obstacle to social progress in our generation.

P E P, like any objective student of social science, is struck by the large-scale persistence of poverty and destitution in the twentieth century. These may have been unavoidable in certain phases in the evolution of the human society. But there can be no justification for them when modern science and technique have opened up vistas of unlimited possi-

* P E P or Political and Economic Planning was founded in London in 1931.

bilities in the production of wealth. If want still persists in the midst of plenty, it must be attributed to the shortcomings of existing institutions which have failed to secure an equitable distribution of the wealth produced and have also prevented a full harnessing of scientific knowledge to the production of more wealth. Accordingly, P E P sets out to discover how a society could best utilise the available material resources with the help of present-day science and technique so as to ensure to every individual a minimum standard of living in food, clothing, housing as well as in education and other amenities and enjoyments of life.

P E P is further impressed by the fact that at present many vital problems of public affairs do not receive anything like the attention they deserve. Civilisation has become more technical than ever before, investigation of most of the social and economic problems call for specialised knowledge, yet, in a country like England, no suitable apparatus has been developed to tackle these problems and people have continued to rely on the out-moded technique of a by-gone age. Government departments would not take up a problem until there is a public demand backed by sufficiently powerful agitation. Parliament and Press have too many things to attend to and can at best deal superficially with such problems. The major political parties lack the personnel or equipment to formulate a sound policy on more than a fraction of the numerous problems which Government has to tackle. Nor would it be a blessing if political parties were to take up such problems on a large scale and adopt a partisan view on them. Besides, even when Government deals with an issue, a thorough and impartial scrutiny of the results by independent critics would still remain necessary. P E P rightly thinks that "neither Party nor Government bodies and publications can always think and say all the things which somebody must think and say if the material for a true judgement is to be available."

Thus in a country like England there tends to persist a large number of socio-economic problems on which public attention is imperfectly focussed and which, if at all taken up by the existing political institutions, are tackled with a superficiality which affects the welfare of the community. As technical civilisation advances, the number of such neglected or inadequately treated problems increases. Here, then, is a serious gap in democratic countries, which calls for a research organisation like P E P.

As its title indicates, P E P stands for planning as against *laissez-faire*. It does not subscribe to the nineteenth century thesis that "all would be well in social and economic affairs through blind automatic adjustments". The evils of *laissez-faire* are well illustrated by the results of ribbon building. Undiluted individualism claims that a man should have the right to erect a house when he likes, where he likes and how he likes as long as he can pay for it. Ribbon building has been applied along the London-Brighton route for a long time. As a result, half of the fifty miles route has become a built-up area, duplication of transport facilities has heavily affected railway finances, necessiting drastic State intervention ; congestion has increased and very much more time is required to cover the distance ; accidents went up to a figure which shocked the public ; property values have depreciated as a result of haphazard building while the face of the countryside has been disfigured. All this could have been foreseen and avoided with timely planning. Nor would any dictatorial powers have been required for the purpose. In fact, more moderate measures would have sufficed to prevent these evils than those became ultimately necessary to redeem the situation.

Very often a *laissez-faire* policy is allowed to proceed for a long time and, when an intolerable situation arises, the need for planning is grudgingly conceded. But by then the mischief is done and it becomes a question of making the best of a bad job. "Salvage planning" can never be as effective as "development planning". Here as elsewhere prevention remains better than cure. Planning is not a post-mortem operation. Its real function is to forestall evils.

Nor is P E P daunted by the arguments of anti-planners who are mostly academicians erecting a theoretical structure on assumptions which, whatever their validity in the nineteenth century, no longer conform to the present-day realities. For example, it is frequently urged by the *laissez-faire* school that planning will take away the consumer's freedom of choice. P E P points out that at present the number of varieties of many articles available in the market is much too high, that hardly any consumer cares to examine them all, that varieties of many commodities could be reduced without restricting consumer's choice while the latter would benefit from the consequent price reductions.

While deprecating unbridled individualism, P E P equally rejects whole-hog planning. It does not believe that planning will have to, or, in fact, will be carried to the extreme. If *laissez-faire* in its heyday could not prevent a steady growth in State and municipal activity, there is no reason why planning should mean an end of individual liberty. P E P regards planning as a means to an end and not an end in itself. Nor is there, in its view, any real anti-thesis between a planned and a free economy. It considers that, as in the past, there will always be an element of both in every economy, though the porportion in which the two are mixed up will depend on circumstances. In a technical age the need for planning is greater. The *laissez-faire* procedure was to start from a point at which the full liberty of the individual was assumed and the burden of proof for every deviation was thrown on the State. P E P would be inclined to start more from the planning end and leave the residual rights to the individual, though the extent of these rights would, it believes, be still ample for him. "Planning is not incompatible with the essence of liberty", said Sir Arthur Salter in 'Recovery'. P E P would perhaps go a step further and insist that planning, if rationally carried out, would reinforce the real content of individual liberty which is often rendered illusory by the unfair incidence of the conditions now prevailing in democratic countries.

Thus P E P is essentially a body of moderate planners. It steers clear of the Scylla of extreme individualism which leads to social chaos and the Charybdis of State interventionism on a totalitarian scale which leads to social tyranny. No wonder that P E P should have little difficulty in functioning within the frame-work of British democracy. "We can safely take for granted the desirability of a Parliamentary democracy, of personal liberty, of a growing mesure of community control and of economic order, of progress by evolution, and so forth, because these principles are in fact accepted by the majority of responsible leaders in all political parties, and may be said to have passed into our national political inheritance."

Within the existing social and political system P E P works "in terms of immediate needs and immediate possibilities." But it recognises "the strong trends towards the assertion of the public interest as against private interest, towards the application of scientific technique in fields of industry, politics and social development in which such a technique remained to be fully adopted, towards the reconciliation of individual firm interests with industry interests and of local with regional and national or international interests, towards a state in which production exists for the sake of consumption and not consumption for the sake of production, and so forth."

It should be clear from the above that in the main it is the socialistic trends within the British democracy which P E P recognises and tries to reinforce. But instead of pleading for socialism it allows facts to lead us to that goal. This procedure has a double advantage. Firstly, the case, because broad-based on facts, becomes unanswerable and can more easily overcome opposition and ideological cleavages. Secondly, it shows in concrete terms how socialism can be realised in actual practice.

Incidentally, like the Fabian Society, P E P would rely on evolution for the realisation of its social objective. But "Fabian gradualism", if anything, is too gradual for P E P. In the eyes of P E P gradualism as such is no virtue. Besides, the urgency to plead for the acceptance of the socialistic goal has diminished, as that goal is now accepted by large sections of the community. This generation faces the more practical problem of how to realise that goal in reality. The great utility of an organisation like P E P lies in the fact that it is formulating a body of reforms which constitute the essence of socialism.

In this country conflict of ideologies has already assumed an acute form. We have yet to realise that slogans are not an aid to clear thinking, that they can not take us nearer the goal. P E P literature can serve as a healthy antidote in such an atmosphere. From our point of view the most significant fact about this organisation is that it has severely stood aloof from the clash of "isms". While its aims and objects are inspired by high idealism, its approach to social and economic problems has none the less been strictly realistic. It has taken up one subject after another, examined each of them from all conceivable angles, tried to harmonise conflicting interests, and drawn, as it were, a social balance-sheet for each issue, on the basis of which it has made its comprehensive recommendations. It has, however, refused to embark upon doctrinaire discussions of the utility of the nationalisation of all the means of production. The objective towards which it has been working has an unmistakably socialistic ring. But it has not set out on the endless theoretical journey to establish in advance the claim that the State has a

right to intervene everywhere and a duty to regulate economic life on the basis of a comprehensive paper plan drawn up in advance. Instead of enunciating theoretical principles as to the scope of public and private enterprise, it has shown enough practical sense to judge each issue separately and give its verdict after carefully weighing pros and cons every time. In the spirit of a truly British institution it has displayed enough realism to insist that we cannot decide on abstract grounds, but must tackle on its merits in detail, what Burke called "one of the finest problems in legislation, namely, to determine what the State ought to take itself to direct by the public wisdom, and what it ought to leave, with as little interference as possible, to individual exertion".

As regards the *modus operandi* of P E P, the first point to be noted is that research is not done by individuals working in isolation, but by groups, each of which consists of eight to twelve members. The reasons for the emphasis on group procedure are not far to seek. As already mentioned, the object of P E P is to deal with subjects which are vital for national well-being, but which are too complex or too technical to receive any or adequate attention from political parties or official quarters. For the same reason individuals, working in isolation, are at a great disadvantage in tackling them successfully. A subject has usually many facets and an individual expert, while competent to deal with some of them, is usually unable to do justice to the rest. The formation of a sound social policy on a specific issue, on the other hand, frequently requires a thorough investigation of all its varied aspects. Besides, in all social questions it is of great importance to strike a balance among multifarious, sometimes conflicting, considerations—a task which can be best undertaken by a group of persons pooling their views and attitudes. There is also the more practical consideration that to share a work among several persons is to lighten the burden of each. Moreover, as will be presently seen, P E P reports mainly grow out of discussions among members and involve a minimum of academic research in the sense in which the term is understood in university circles. The discussion method imposes the least possible strain on the experts, who have other calls to attend to and have therefore only a limited time at their disposal. Lastly, it is a cardinal principle of P E P to draw upon the experience piled up by practical men in various spheres of life in the course of their day-to-day work. Group method is eminently suitable for tapping this source.

Subjects for investigation are chosen with an eye to their immediate urgency as well as their ultimate social significance. Each subject is entrusted to a group specially formed for the purpose. As it must be dealt with from a comprehensive social angle, a typical group, say, in the Economic Division, would include one or two picked civil servants, one competent economist, one competent sociologist, one competent scientist, one outstanding industrialist of all-round view, one outstanding retailer and one or two socially minded professors.

Group research being the corner-stone of P E P, much naturally depends on the composition of these groups. Experiments in the early stages were not successful and sometimes groups had to be dissolved before any tangible results were achieved. "Our experience is rich in examples of how not to do things, as well as in more fortunate experiments." Practical experience, however, gradually revealed the conditions which must be fulfilled, if this type of research enterprise were to yield the best results. Personal harmony among the members of a group is essential. Members must be animated by a spirit of give-and-take. They may not see eye to eye on all points at the outset, but they must have faith in the fact-finding approach and must be ready to surrender all preconceived notions before the weight of factual evidence. Nothing is more detrimental to such an enterprise than an ism-ridden outlook which strikes at its very root. Only when these conditions are fulfilled, would it be possible to arrive, by an interplay of minds, at the greatest and not the lowest, common factor among the members. Expert knowledge, it should be noted, is not enough. A spark of idealism is equally necessary. Unless there is a spur of social service behind a group, the social objective for which P E P works, may easily be lost sight of. Experience, too, has shown that to arrive at a balanced view on a subject, it is always wise to go in for a mixture of experts and laymen on that subject. Apart from the ability and adaptability of the group members, there are, of course, other more or less obvious factors on which the quality of the final contribution of a group would depend, *e.g.*, the amount of personnel available, the financial resources, access to the range of information available as also a sound working programme, effective leadership, the quality of material supplied, of drafting, of organisation, and of presentation. Best results can be achieved when a group is strong on all these points.

There is no hard and fast rule as regards the frequency of group meetings. Some meet once a week or oftener, others fortnightly or even with longer intervals, some prefer to work in a somewhat irregular fashion. Meetings are held at the office of P E P club (16 Queen Anne's Gate, London). The usual practice is to hold a meeting at lunch or dinner time, which has several practical advantages. It gives an informal touch to the meeting, indeed a P E P group meeting is very much like a friendly gathering; it is easier for all members of a group to meet at a meal time; while the time taken of the members is in this way kept at a minimum.

Usually a paid P E P secretary is attached to each group. It is his task to prepare and circulate the agenda of each meeting in advance, to take down notes in shorthand as the discussion proceeds, to prepare a summary embodying the main results and to circulate a cyclostyled copy so as to give each member enough time to go through it before the next meeting takes place. The summary may again be discussed and modifications suggested. This procedure simplifies the task of final drafting, sometimes these running summaries with minor alterations become parts of the final report. It also ensures that no relevant points raised in the course of discussion should be overlooked when the report stage comes.

Sometimes knotty points arise which cannot be tackled without having recourse to more extensive facts. Field research may be instituted for the purpose. But the usual P E P practice is to keep first-hand field enquiry and research, strictly so called, at an absolute minimum.

As the work proceeds a group very often comes across technical points on which none of the members is perhaps competent enough to throw sufficient light. It then seeks outside reinforcement. Persons who are known to be experts on those points are called in as consultants. In many places P E P has expressed its gratitude for the ready response and willing co-operation it has received from specialists who are not directly connected with the organisation. Their readiness to take a hand in this way has added "enormously to the value of the work we have been able to do, and as so many of the points at issue are not touched upon by any published work, at any rate of an up-to-date nature, we have been heavily indebted to those who deal with these problems in the course of their daily work and who have taken trouble to make their experience available to us."

After the work has made sufficient progress and some solid results have been achieved, these are placed before the public in an issue of 'Planning', a broadsheet issued by P E P usually every fortnight. This gives an opportunity to watch public reaction. In the light of the criticism offered by journals, public men, specialists and others, adjustments may be made on particular points.

When the whole ground is covered by a group, the stage of final drafting comes. This task is entrusted to a competent secretary. The draft is then discussed in every detail in a series of meetings till it is finally approved. Experts are again consulted at this stage, who go through the drafts or proofs and in the light of their criticisms further revision may be undertaken. No voting takes place in P E P meetings. Conclusions are always reached by agreement and never by a vote.

The report now goes to the press. As soon as it is published, it is extensively reviewed all over the country. P E P maintains direct contacts with press people so that the conclusions arrived at in a report may receive the widest publicity throughout the country and also abroad.

The main work of the group is finished with the publication of its report. But a social subject rapidly becomes out of date. New developments take place and after a relatively short period the question of supplementing the original report has to be faced. The public too sends in all kinds of enquiries to the P E P about the later developments not dealt with in the main report. Obviously the group which brought out the first report is the most competent body also to deal with these enquiries. Accordingly, it has become a standing practice for P E P to ask a group to revert to its subject after some time and submit a supplementary report. These findings are then published in a special issue of the broadsheet. Groups have sometimes met after years and have enthusiastically undertaken this task. Indeed long collaboration leads to the growth of a strong *esprit-de corps* among group members who, on their own initiative, arrange to meet at suitable intervals to keep up the discussion on their respective subjects even after the publication of their report. P E P groups are thus gradually becoming standing bodies, each with an established reputation for specialised knowledge to deal with some urgent problem of public affairs.

Groups function more or less as autonomous units. The supervision by the central Executive, which consists of four members, is almost negligible. Even the terms of reference suggested by the Executive are elastic. A group may adopt them with or without amendments. As the work develops there may be further deviation from the original terms of reference. A co-ordination committee deals with the progress of work in each group, investigates the causes when it falls behind its time-table, tries to meet difficulties, such as shortage of personnel, examines if new groups have to be formed to deal with special issues arising out of the work of existing groups, brings about closer contact among groups whenever necessary, considers any general criticisms of the work and reports to the Executive with recommendations on important points. The Executive which deals with all such points, is the ultimate judge of "the pace, balance and standard of the work done". The larger Council, and the working members, to whom the Executive is responsible, are only summoned "when important divergences of opinion arise or critical steps have to be taken."

It may be mentioned that in the first few years of P E P, when it had little experience of its own or of others to guide its activities, sharp differences of opinion were not uncommon, while the need for drastic readjustments in personnel and organisation was more frequently felt. By trials and errors it has evolved a machinery which now functions without undue friction.

At the fifteenth annual conference of the Association of Special Libraries and Information Bureau (A S L I B), held in London in 1938, Mr Max Nicholson, secretary of P E P, explained the way in which the British Press was investigated by a special P E P group and how the material for the P E P Press Report was compiled. The paper which he read on the subject is highly interesting as an illustration of the actual functioning of a P E P group which, to judge from authoritative opinion expressed in various quarters, was eminently successful in its investigation. A few points may be mentioned here. The press group originally consisted of twelve members, ten of whom served up to the last, the other two having been prevented for unavoidable reasons from continuing the work. Practically all the members belonged or had belonged to the press so that for P E P standard the group was a little too expert.

The members themselves undertook to collect the necessary material. Some of them, owing to the nature of their jobs, had access to very useful information, which no academic research worker could have enjoyed. Available publications were used for what they were worth. At the first meeting it was decided that the group should meet every fortnight. As the work proceeded, the direct experience of the members had to be increasingly supplemented by collecting evidence from others who had better opportunities to deal with particular points. Altogether eightyone full meetings were held, those in the final stage having been weekly ones. The total number of meetings in this case was appreciably more than the average number required for a P E P report. This was partly due to the fact that the members being hard pressed for time, meetings were usually shorter, and partly to the fact that a very large number of aspects had to be considered.

"One of the striking things emerging in group work of this kind", said Mr. Nicholson, "is the amount of essential information which individual specialists carry in their heads without being in the least conscious of its wider significance, until well-directed discussion brings this out." The main function of P E P reports, he said, "is to assemble and make available large masses of unpublished information and unwritten or even previously unconscious experience on problems of public affairs, and in the course of eliciting and sifting this material we seek to create an outlook favourable to constructive and continuous examination of the subject in future."

As already emphasised, P E P reports not only use blue-books, ordinary books, and professional trade organisations and papers but also tap many other sources, by group or personal interview, by questionnaire or otherwise. It would therefore be "absurd to attach a personal name or names to a P E P report, which is the work of a multitude of different hands." Anonymity also serves as a valuable safeguard. To depart from this principle "would raise all sorts of rival claims to credit and all sorts of bargaining attitudes about the frank statement of facts". In many cases outside experts may be willing to submit their evidence on specific issues only if anonymity is assured. It is one of the most encouraging things in the world, said Mr Nicholson in conclusion, "to find how many busy and intelligent people both inside and outside the P E P groups are not only willing but eager to give an immense amount of time and trouble to seeing

that the facts are fully and accurately stated, well knowing that they will not get the slightest personal credit for their contribution in the Report as it appears."

So far over twenty groups have been organised by P E P. These fall into two main divisions: Economic and Civil, while there are "intermediate groups" (such as Town and Country Planning Group, Distribution Group), which have close links with the two broad divisions, but do not belong to either. Started in 1931 when England, like the rest of the world, was in the throes of the great depression, it had by 1938 published comprehensive reports on the British Iron and Steel Industry, the British Cotton Textile Industry. Housing in England, the Entrance to Industry, the Exit from Industry, the Coal Industry, the Supply of Electricity in Great Britain, International Trade, the British Social Services, the British Health Services, the British Press, in addition to a large number of broadsheets dealing with these and a host of other subjects of national importance. Since the outbreak of war it turned increasing attention to an examination of vital problems which war was bringing in its wake and published its recommendations in the broadsheets. Soon after the outbreak of hostilities P E P organised post-war reconstruction groups which dealt with the subject on a comprehensive scale providing a full picture of the future political organisation in the international sphere, of economic and social life, as envisaged by P E P. The first drafts of the final reports on these subjects were circulated in manuscript form to invite criticism from people entitled to have a say in the matter. War conditions have naturally hampered the normal functioning of P E P, but the publication of the fortnightly broadsheet has continued.

Thus not only in the equality, but also in the volume, of its output P E P can stand comparison with any other research organisation. It can tackle a problem much more effectively and expeditiously than the cumbersome machinery of official committees and commissions. Lastly, P E P manages all its business with a budget of £10,000 in a normal year. When one recalls the amount spent on an official committee or commission for the investigation of one single problem of public life, P E P must be regarded as a highly efficient organisation also from the angle of economy.

Besides as we have seen, it is gradually building up a body of enthusiastic research workers with a commonness of outlook. This in itself would be no mean achievement. As many P E P members play an active part in various professions and in public life generally, they carry the ideas for which P E P stands, to larger sections of the community, while politicians and other public men are having increasing recourse to its publications for information on problems of contemporary life. P E P, as has been aptly said, is "a leaven in the nation".

In the early days of P E P, many people looked askance at it because of its professed aim to plan the economic and social life. Others considered its sponsors to be either visionaries or cranks. In the course of a decade public opinion has completely veered round. The value of its approach and the high standard of its impartial and painstaking studies on numerous socio-economic problems now find increasing recognition in England and abroad. The visionaries of yesterday are now admitted to be men of vision.

What are the possibilities of developing a research organisation in this country along the lines of P E P? The National Planning Committee, whose activities had to be prematurely suspended, so far remains the only example in India of co-operative research on a large scale. The immediate objective before this Committee was to formulate a plan for the economic development of the country, which might serve as a guide to the Congress ministries then in power. Subsequently its scope was widened so as to include all the varied aspects of the nation's social and economic life with a view to preparing a comprehensive plan, even though it was fully realised that its execution would not be possible until Indians had acquired the necessary powers to mould their destiny and to set their own house in order. The work undertaken by this Committee was without doubt of great national importance. Its organisation, aims and objects as well as its *modus operandi* were, however, not the same as those of P E P.

Anyhow, to our mind there persists in India a real need for a research institution of the P E P type, where specific issues of national import could be tackled, as they arise, by a group of like-minded enthusiasts with imagination and ability, laboriously collecting facts, interpreting them to serve a definite social objective and presenting them in a challenging form to the public and the authorities. It was this conviction which led Mr Leonard K. Elmhirst while in India some three years back, to take the initiative

and float an organisation called Social and Economic Planning Association which was to be an Indian counterpart of London P E P.

A little reflection will show that the success of P E P has been due to a combination of factors which is not easy to find in Indian conditions. Firstly, there is the all-important question of finances. The annual P E P budget consists of a sum of well over a lakh and a quarter, the bulk of which is supplied by a few patrons, a part raised from smaller public donations while the rest is now realised from the sale of reports. It may not be an easy matter to find the support of such generous and farsighted patrons in this country while to depend on Government for funds would defeat the main object of such an organisation as it would invariably tell on its independence of thought and outlook. Secondly, there is a palpable paucity of primary data in this country. The data provided in official publications are fragmentary in character, they relate to a few sectors of our economic and social life while their reliability is not above question. As a result, the planning organisation will have to undertake primary research on a large scale which would be all the more difficult in a vast country like India and would in any case impose on it a heavy financial burden. Thirdly, P E P is also fortunate in the sense that there is no dearth of experts in England while with its seat in London which is the nerve-centre of the public life of the country, it can practically draw upon any number of experts in any field. A planning organisation, say, in a place like Calcutta would be severely handicapped in all these respects. It should also be remembered that in this country the habit of give-and-take in intellectual matters has yet to be cultivated on a larger scale and, even if it were possible to bring together a group of people able and willing to join hands in discussing questions and formulating policies, the principle of anonymity may not appeal to all the members.

These are great disadvantages which S E P A had to face from the very start. In spite of these, some progress might have been made during the last three years. But the outbreak of war soon after it was launched gave it the final *coup de grâce*. More vital and more immediate issues were pressed to the forefront and public mind became engrossed in other directions. This was not the atmosphere in which research work could flourish.

Normal times will, however, return some day and conditions will settle down once again. A host of social and economic questions would then be pressing for solution more inexorably than ever before. There can be little doubt that a research organisation of the P E P type could then render an invaluable service to the country. It is well to remember that good intentions do not always ensure good legislation on social and economic questions. This has been proved to the hilt by the plethora of legislations passed in recent years in various provinces of India. Most of these measures bear the impress of haste, betray an imperfect appraisal of the situation and rest on a slender basis of facts. Yet if social legislation is to yield the desired fruit, the necessary spade-work will have to be done in advance by some competent body. Considerations of economy and utility point to an organisation like that of P E P. Difficulties there are and these difficulties explain why the first S E P A was a still-born organisation. Nevertheless, if a start is made by the right people in the right direction with the necessary finances it is not much to be hoped that, in normal conditions, these difficulties could be overcome with a little push and drive. The growing complexities of a technical age are a challenge to our generation. The needs of the hour are unmistakable. A P E P or a S E P A can go very far in meeting those needs, and, if it does so, it will sooner or later triumph over the forces of inertia and indifference which now cumber the path of progress in this country.

Sudhir Sen

Zoogeography of India*

B. PRASHAD

Director, Zoological Survey of India, Indian Museum, Calcutta

ZOOGEOGRAPHICAL REGIONS

ZOOGEOGRAPHIC studies can be carried out along different lines in accordance with the ideals in view, but the *raison d'etre* of all such studies is the elucidation of the constitution of the fauna of any particular area, its distribution, origin and relationships..

Older authorities on Zoogeography like Wallace, Huxley, Sclater, Sharpe, Heilprin and others mainly considered the present-day distribution of the various groups of animals, with casual references to their geological history, and from the data thus obtained attempted to divide the surface of the earth into zoogeographical regions or realms. In fact, as Ortmann [1] remarked, 'any research in this direction is deemed incomplete that is not finished by the creation or discussion of "regions"'. This method resulted in the division of the earth's surface into a varying number of realms or regions, 21 according to Schmarda [2], 6 according to Sclater [3] and Wallace [4], 2 according to Huxley [5], 7 according to Blyth [6], 9 according to Gill [7], 3 according to Blanford [8], 4 according to Dahl [9], and various others. The regions were further subdivided into subregions or provinces, but the divisions were based mainly on the distribution of mammals or birds. In spite of Wallace's assertion [10] that his slightly modified scheme of Sclater is applicable to all groups of the Animal Kingdom, there is little doubt that no one scheme can serve equally for all the groups.

INDIAN AREA

As Blanford [11], one of our most distinguished geologists and zoogeographers, remarked, 'For the study of zoological distribution there are few, if any, regions on the earth's surface that exceed British India and its dependencies in interest. The area is large, nearly 1,800,000 square miles, and although the vertebrate fauna is by no means thoroughly explored, it is well known throughout the greater part of the area..... The variety in elevation and of climate is remarkable; the country is bounded on the north by the highest of known mountain ranges, and by the loftiest plateau on the earth's surface, and it includes within its limits both the almost rainless area of the Sind Desert, and the locality in the Khasi Hills distinguished by the heaviest rainfall known. Another element of interest is the fact that the Peninsula of India is a land of great geological antiquity, there being no evidence to show that it has ever been submerged, although the greater part of the Himalayas and Burma have at times been beneath the sea'. Blanford [12] admirably defined the limits of the area as consisting 'of the dependencies of India with the addition of Ceylon, which, although British, is not under the Indian Government. Within the limit thus defined are comprised the whole of India proper and the Himalayas, the Punjab, Sind, Baluchistan, all the Kashmir territories with Gilgit, Ladak, etc., Nepal, Sikkim, Bhutan and other Cis-Himalayan States, Assam, the countries between

* Being the second part of the author's presidential address (dealing with his own subject) at the annual meeting of the National Institute of Sciences of India at Baroda, on January 1, 1942.

[1] *Proc. Amer. Phil. Soc.*, XLI, p. 271, 1902.
[2] Schmarda, K., *Die Geographische Verbreitung der Tiere*, Wien, 1853.
[3] *Journ. Proc. Linn. Soc. London* (Zool.), II, 130, 1858.
[4] Wallace, A. R., *The Geographical Distribution of Animals*, Vols. I, II, (London, 1876).
[5] *Proc. Zool. Soc. London*, 294, 1868.
[6] *Nature*, III, 427, 1871.
[7] *Proc. Biol. Soc. Washington*, II, 1, 1884.
[8] *Proc. Geol. Soc. London*, 76, 1890.
[9] Dahl, F., *Oekologische Tiergeographie*, I, 102, 1921.
[10] *Nature*, XLIX, 610, 1894.
[11] *Phil. Trans. Roy. Soc. London*, CXCIV, 336, 1901.
[12] Blanford, W. T., *Faun. Brit. Ind., Mammalia*, p. iv, 1889.

Assam and Burma, such as the Garo, Khasi and the Naga Hills and Manipur, the whole of Burma with Karenni, and of course Tenasserim and the Mergui Archipelago, and last the Andaman and Nicobar Islands'. With this we have also to include the Laccadive and Maldive Islands, which not only are under the Indian Government, but the fauna of which shows very distinct affinities with that of the Indian area. On the other hand Burma, which administratively is now a separate entity, must still in view of the faunistic relationships be included within the Indian area.

ZOOGEOGRAPHICAL POSITION

It will be presumptuous to claim that we are, by any means, fully acquainted with the forms of animal life which inhabit this vast subcontinent, but one would not be far wrong in saying that we are today fairly well informed about the main features, and in many cases, even the details of its fauna. The limits of India, as defined above, fall mainly within the Oriental Region of Wallace or the Eastern Palaeotropical Region of some authors. Probably, however, as Blanford suggested, the best name for the region, owing to the earlier use of the name Oriental by the botanists for South-western Asia and Persia, is Indo-Malay, as explored by Elwes for Birds. This name also is not very suitable, as practically the whole of the Western Frontier Province, the greater part of the Punjab, and the Western Himalayan area to the western limit of Nepal with Gilgit and Ladak should undoubtedly be included in the Holarctic or the Palaearctic Region rather than the Indo-Malay. Further, parts of the Indo-Gangetic Plain show closer affinities to the Western Frontier Territory than to the rest of the Indo-Malayan area.

SUBREGIONS OF INDIA

Owing to the heterogeneous nature of the faunas of the different parts, the division of this vast area into subregions is not an easy task. The affinities of the faunas of the different areas are very complicated, and probably the best course under the circumstances is to take physiographical rather than zoogeographical tracts as the basis for the consideration of the faunas of different parts. In this connection it will be useful to consider here briefly the history of the various attempts that have been made by earlier workers for subdividing the Indian area into subregions. Jerdon [13] taking the Birds and Günther [14] the Reptiles, as the bases for their conclusions, divided India into several subregions, but their subdivisions were based mainly on geographical units rather than on the available zoological data. Blanford [15] basing his scheme on the distribution of the Land Mollusca divided India into four Provinces which he designated: (1) the Punjab Province; (2) the Indian Province proper; (3) the Eastern Bengal Province; and (4) the Malabar Province with Southern Ceylon. The Indian Province proper was subdivided into four sub-provinces. Elwes [16] who considered India with Malay Peninsula as a single unit (Indo-Malay Region) for Birds, divided it into three subregions: (1) Himalayan or Himalo-Chinese; (2) Indian; and (3) Malay. Wallace [17] from a general consideration of the distribution of all the groups of animals divided the Oriental region into: (1) Hindustan or the Indian subregion consisting of the whole of the Peninsula from the foot of the Himalayas on the north to somewhere near Seringapatam on the south-east and Goa on the south-west; (2) Ceylon and South India; (3) Himalayan or Indo-Chinese subregion comprising the Himalayas as far west as Kashmir from the base to an elevation of 9,000—10,000 feet, and the countries to the east of the Bay of Bengal, Assam, Burma, Southern China, Siam and Cochin China; and (4) Indo-Malaya or the Malayan subregion consisting of the Malaya Peninsula and the Archipelago. Kobelt [18] basing his conclusions mainly on the distribution of the Mollusca divided it into: (1) the north-western area of the Indus Plateau limited in the south-east by a boundary running almost in line with the Aravalli mountain range; (2) the greater part of the Peninsula in the south bounded by a line from Goa on the west to Madras on the east, on the north-west by the Aravalli range and including almost the greater part of the Gangetic shed—the latter bordered on the north by the Himalayan chain and on the east by a line running from the eastern border of Nepal to a little to the west of Calcutta; and (3) the Basin of the Brahmaputra including a part of Bengal, the whole of Assam and the hill areas of

[13] Jerdon, T. C., *Birds of India*, p. xxxix, 1862.
[14] Günther, A. C. L. G., *Reptiles of British India*, p. vii, 1864.
[15] *Jour. As. Soc. Bengal*, XXXIX, pt. ii, p. 336, 1870.
[16] Elwes, H. J., *Proc. Zool. Soc. London*, pp. 652-682, 1873.
[17] Wallace, A. R., *op. cit.*, I, pp. 81, 82, 321, 1876.
[18] Kobelt, W., *Ber. Senckenberg. naturf. Gesel. Frankfurt a. M.*, p. 89, 1899.

the Garos, Nagas, etc., and bounded on the east by a line running from Cape Negrais along the Arrakan Yomas and then running further east along the Irawadi river to Tibet. He did not include Burma and Tenasserim in this account. Sharpe [19] from the distribution of the Birds divided the Indian region into: (1) Indian Peninsular subregion; (2) Indo-Malayan subregion (3) Indo-Chinese subregion; (4) Himalo-Malayan subregion; and (5) Himalo-Chinese subregion. Blanford [20] in the Introduction to the Mammalia in the *Fauna of British India* divided the region into six subregions: (1) Tibetan; (2) Himalayan; (3) Indian; (4) Malabar or Ceylonese; (5) Burmese; and (6) South Tenasserim. Newton [21] and Gadow [22] in discussing the distribution of Birds and W. L. Sclater [23] of the Mammals, followed Wallace, but united his Indian and Ceylonese regions into a single unit. Blanford [24] in his classical work on the Distribution of the Vertebrates of India, divided the whole area into 5 subdivisions: (1) The Indo-Gangetic Plain; (2) the Indian Peninsula; (3) Ceylon; (4) the Hamalayas; and (5) Assam and Burma, and further sub-divided these into 19 tracts. Alcock [25] taking the freshwater Crabs as the basis for his work divided India into 6 territories: (1) The Western Frontier territory; (2) Western Himalayan territory; (3) North-Eastern Frontier or Eastern Himalayan or Eastern sub-Himalayan territory; (4) Burma-Malay territory; (5) Peninsular territory; and (6) Indo-Gangetic Plain. Annandale [26] found that the distribution of the freshwater Sponges and Polyzoa confirmed Alcock's conclusions, but it was necessary to divide the Peninsular territory into (*a*) the main area consisting of the Peninsula east of Western Ghats, and (*b*) Malabar zone including the Western Ghats from the Taptee River to Cape Comorin and eastwards to the sea. He also considered Ceylon as a separate territory. Stephenson [27] in discussing the Geographical Distribution of the Oligochaeta opined that in addition to the territories recognised by Annandale it was necessary to separate the norrow southern end of the Peninsula below the level of Goa and south of the fifteenth parallel from the eastern to the western shore as a distinct region. Christophers [28] for the Anopheline mosquitoes divided India into 6 areas: (1) Trans-Indus area; (2) Indo-Gangetic area; (3) Peninsular area; (4) Malabar and Ceylon; (5) Assam and Burma; and (6) Himalayan area. Taking into consideration the results of systematic work on various groups of animals I [29] suggested the following scheme: (1) Western Frontier Territory including Baluchistan, the North-Western Frontier Province and the greater part of the Punjab; (2) the Himalayas consisting of the Upper Indus Valley with Ladak, Gilgit, etc., the Western Himalayas from Hazara to the western limit of Nepal, and the Eastern Himalayas from the limit of the Western Himalayas to the Mishmi Hills above the Assam Valley; (3) Assam and Burma comprising the greater part of the Lower Brahmaputra Drainage System and the Burmese territory including Tenasserim; (4) the Gangetic Plain to the east of Delhi, and including the whole of the United Provinces, Bengal, and parts of Assam up to the base of the Assam Hills, together with the plain of the Brahmaputra as far as Goalpara and Cachar, Sylhet and the plains of Tipperah; and (5) Peninsular India, with the Malabar zone as a very distinct subdivision, and Ceylon. Malcolm Smith [30] suggested the division of the Indian subregion into: (1) the Desert Area or North-West India including Baluchistan, the North-West Frontier Province, the Punjab, western Rajputana as far as the Aravalli range, and Sind; (2) Kashmir and the Western Himalayas as far east as, but not including, Nepal; (3) the Gangetic Plain, extending from the valley of the Indus in Sind to the right bank of the Brahmaputra in Bengal; (4) Central India—the tract of country lying between the Gangetic Plain and the Deccan and bounded on the west by the Aravalli range and on the east by the Chota Nagpur area; (5) the Deccan, consisting of the greater part of the Peninsula of India between 12° and 21° north latitude; (6) the Mountains of the Malabar Tract and Ceylon; and (7) the Chota Nagpur Area, consisting of Bihar south of the Gangetic Plain, the northern part of Orissa and the

[19] *Nat. Sci.*, III, 108, 1893.
[20] Blandford, W. T., *Faun. Brit. Ind., Mammalia*, p. iv, 1888.
[21] Newton, A., *Dictionary of Birds*, p. 356, 1893.
[22] Gadow, H., Bronn's *Klass. Ord. Thier., Vogel*, p. 296, 1893.
[23] Sclater, W. L., *Geogr. Journ.*, VII, 380, 1896; also see Sclater, W. L. and Sclater, P. L. *The Geography of Mammals*, 1899.
[24] *Phil. Trans. Roy. Soc. London*, CXCIV, 343, 1901.
[25] Alcock, A. W., *Cat. Ind. Dec. Crust. Coll. Ind. Mus.*, pt. i, fasc. ii, pp. 9-14, 1910.
[26] Annandale, N., *Faun. Brit. Ind., Freshw. Sponges, Hydroids and Polyzoa*, pp. 7-10, 1911.
[27] Stephenson, J., *Faun. Brit. Ind., Oligochaeta*, p. 12, 1923.
[28] Christophers, S. R., *Proc. Fourth Entomol. Meeting*, p. 206, 1921.
[29] Prashad, B., *The Indian Empire*, pp. 190, 191, (Calcutta, 1927).
[30] Smith, Malcolm, A., *Faun. Brit. Ind., Reptilia and Amphibia*, I, 18, 1931.

eastern part of the Central Provinces. Recently Mahendra[31] from a study of the distribution of the amphibian and reptilian species divided India into ten provinces: (1) the arid or semi-arid Province of North India; (2) the Western Himalayas; (3) the Trans-Gangetic Province; (4) Southern Burmese Province; (5) the Gangetic Plain and the adjacent country as far south as 20° latitude; (6) South India below 20° latitude excluding the Travancore Province; (7) the Travancore Province; (8) Ceylon; (9) the Andaman Islands; and (10) the Nicobar Islands.

These attempts to divide the vast area of continental India, useful as they are, have unfortunately not helped materially in unravelling completely the very complicated questions of the origin, distribution and relationships of its fauna. In what follows I propose to give a brief outline of the faunal constitution and their relationships for the different parts in accordance with my scheme referred to above.

WESTERN FRONTIER TERRITORY

The fauna of the Western Frontier Territory is markedly different from that of the rest of the area. Practically all the genera of the Vertebrates are either Palaearctic (Holarctic), or are peculiar to this subregion; the relationships of the latter are also with the Palaearctic rather than with the Indo-Malayan forms. Blanford basing his views on the distribution of the Vertebrates suggested that this subregion should be classified with the Eremian or Mediterranean subregion of the Palaearctic, and this view has been fully confirmed by the distribution of the various groups of the Invertebrates that have been studied since 1901. Some forms of the Gangetic Plain have also migrated into this subregion, but they are of no importance from the zoogeographic point of view. The Western Frontier Territory consists of desert or semi-desert tracts, except near the rivers or the artificially irrigated and cultivated parts. The annual rainfall is not heavy, and the fauna on the whole is poor.

HIMALAYAS

In the Himalayan subregion the ranges above the forest limits, a part of the Tibetan plateau and the Upper Indus Valley including Ladak, Gilgit, etc., constitute a distinct division. This area is very bare, the mountains are perpetually covered with snow, and there is a very great difference in the altitudes of the mountainous ranges on the one hand, and of the intervening valleys on the other; the annual rainfall is generally low. Our information about the fauna of this part is not sufficiently detailed, but in the main it is almost entirely Palaearctic. In view of these faunistic affinities this division may later have to be included with the Western Frontier Territory. The second division consists of the forest zone of the Himalayas from near the base to an altitude between 10,000 and 14,000 feet, the uppermost limit of the forest zone. It forms a belt of varying breadth between the higher mountain ranges and the Indo-Gangetic Plain. The rainfall in this division is heavier, more so in the eastern than in the western parts, and the forests of the eastern ranges are also more extensive, richer and truly tropical. A fair number of Palaearctic animals from the higher mountain ranges wander down into the forests, while a few species penetrate northwards into the rather warmer valleys from the plains in the south. The western forest region has a predominantly Palaearctic fauna, while the eastern, which has a very marked Malayan element, was on this account separated with Assam, Burma, etc., into what Blanford designated as the Trans-Gangetic subregion.

ASSAM AND BURMA

In Assam and Burma the northern region, comprising the northern part of the drainage area of the Brahmaputra and Assam, consists of hilly tracts with dense forests except in the plains of Assam; the annual rainfall in this tract is fairly heavy. Physiographically, parts of this area belong to the Indo-Gangetic Plain, but its fauna is distinctly Burmese. In Upper Burma, which is roughly the drainage area of the Irawadi, there is a large number of hills thickly covered by forests, while the undulating ground between the mountains is densely overgrown by brushwood and high grass; the annual rainfall in this region is pretty heavy. The Tenasserim area consists of two distinct tracts, (i) the northern, covered by thick forests on a hilly ground and with a fauna of the Burmese type; and (ii) the southern area which in its physiography is similar to the northern; the annual rainfall in this tract is not so heavy as in the northern area, and its fauna is distinctly Malayan. The Andaman and Nicobar Islands, which are also included in this subregion, are

[31] SCIENCE AND CULTURE, IV, 374, 1938-39.

covered by dense forests and have a heavy rainfall. The fauna of these islands is by no means identical; the Andamans having an impoverished Burmese fauna, while that of the Nicobars is undoubtedly Malayan.

GANGETIC PLAIN

Since the main part of the Indus Plain has been separately considered above in the Western Frontier Territory, I use the name Gangetic Plain for the rest of the Indo-Gangetic watershed. Its extent has been noted already, and its physical features only need be considered. Most of the western area is cleared and used for cultivation, and only some of the uncleared areas are covered by tall grasses. The annual rainfall generally is not very heavy. In the eastern part of the area, except for the Sunderban forests in the deltaic region of the Ganges, the country is similar to that in the north-western part, but the rainfall is heavier, and there are more extensive tracts of uncleared land. The fauna of the area is generally of the same type as that of Peninsular India, but in the north-eastern parts there is a large admixture of the eastern or Blanford's Trans-Gangetic types. The freshwater fauna shows a very marked similarity and in many cases actual identity with the forms occurring in the Indus System.

PENINSULAR INDIA

The greater part of Peninsular India, with the exception of the Malabar Tract, consists of either cultivated land or low hilly country covered with brushwood or thin forests; the average rainfall is from 35 to 50 inches. In the Malabar Tract, on the other hand, we have the high mountain ranges of the Western Ghats and the west coastal area of the Peninsula. Most of this part is covered with thick tropical forests, though there are many places near the coast which are cleared and cultivated. The island of Ceylon, like Peninsular India, consists of two types of country. About three-fourths of the island along the north and the east resembles the main area of Peninsular India, and is almost plain or only slightly undulating country of no great elevation, with an average annual rainfall of about 50 inches. The rest or the south-western part of Ceylon, like the Malabar Tract, is hilly, with rich tropical forests and an average rainfall of over 100 inches.

In this area a peculiar admixture of the different faunas seems to have taken place. In main characteristics the fauna of this area differs from that of Blandford's Trans-Gangetic partly in the absence of numerous Eastern types, and partly by the presence of two other distinct constituents, which form, especially in the forests, the majority of the animal population of the area. One of these constituents to which Blandford gave the appropriate name—the Aryan faunal element—consists of certain genera of mammals, birds and reptiles. The typical genera of this Aryan element are, for the most part, represented in the tropics of Africa at the present day, but do not occur in Western Asia or Northern Africa. Other genera of the Aryan element found in Peninsular India occur in Western Asia and are represented at the present day by allied species. Both these groups of genera are well represented in the Pliocene Siwalik Fauna of the Himalayan foothills, and it appears probable that most of them are descended from animals which appeared in India, so far as we know at present, in the Pliocene period; a few, however, may be later migrants. On the whole, this Aryan element is subtropical rather than tropical, and is best developed in parts where the rainfall is moderate. Several of its most conspicuous and characteristic members, such as the antelope and nilgai, are not found in the extreme south of India or in Ceylon, and they are inhabitants of the grassy and bush-covered plains with scattered trees, not of dense forests and bamboo-jungle in which the gaur and the elephant flourish. The second constituent of this fauna is the Indo-Malayan or the Oriental element. It is more diffuse and much more richly represented in the damp tropical forests of Malabar and Ceylon than in the drier parts of the Penninsula. The diffusion of the Indo-Malayan element seems to indicate that it is older than the Aryan element mentioned already, but there can be little doubt that it is an immigrant and not an indigenous element, for it is only an impoverished representative of the typical Oriental life found in the countries to the east of the Bay of Bengal. Its main representatives are amongst birds and mammals, and like the Aryan element it appears to have migrated into Peninsular India about the Miocene times driving the earlier Dravidian element into high ranges of hills, etc. Some authors have opined that the Oriental or the Indo-Malayan fauna, owing to the presence in it of representatives of the Lower Miocene and Oligocene faunas of Europe, is of Palaearctic

origin and that it was driven down into the tropics by the diminishing temperature of the Holarctic region in the Miocene times. The third element in this fauna that can be recognised distinctly from the other two is what Blanford termed Dravidian. It is thoroughly tropical and damp-loving, and is only represented by lower groups of the Animal Kingdom, *viz.*, reptiles and batrachians. It is probable that this is the oldest element and may have inhabited the country since India was connected in Mesozoic and early Cenozoic times with Madagascar and South Africa, across what is now the Indian Ocean.

In the fauna of the Peninsula in Malabar and Ceylon there is a much greater concentration of the Oriental element. There are, for example, various mammals, reptiles, batrachians, fishes, and invertebrates, which are represented in Burma and the Malay countries but not in northern India. There is also the occurrence of certain Himalayan species on the mountains of Southern India and in Burma and even further south but not in the intervening areas. These faunal anomalies have been explained as a result of the Glacial Epoch, but the explanation is not quite satisfactory, though it is hard to understand how otherwise the animals of temperate Himalayan types could have migrated to the hills of Southern India and Ceylon on the one hand, and those of Burma and the Malay Peninsula on the other. After the Glacial Epoch when the country became warmer, the Oriental fauna must have migrated rapidly from the south-east into Eastern Himalayas. At the present day the comparatively narrow plain of the Brahmaputra in Assam is far more extensively covered with forests than the much broader Gangetic Plain, and if, as is probable, the same differences existed at the close of the Glacial Epoch, it is easy to understand why the Trans-Gangetic fauna of Burma and the south-east had greater chances of occupying the vacant region of the Himalayas than the Cis-Gangetic fauna which had been driven much further south by the cold. A reference may here be made to the Aethiopian element in the fauna of Peninsular India. As was pointed out by Annandale[32], several groups of Invertebrates, Sponges, Polyzoa, Hydroids, Oligochaetes, Crustacea and Mollusca, found in the Malabar tract, show a very great affinity, if not distinct identity, with the forms found in Africa.

[32] Annandale, N., *Proc. Ninth Congr. Internal. Zool. Monaco*, pp. 579-588, 1914.

PALAEOGEOGRAPHICAL CONSIDERATIONS

Finally, reference may be made to some palaeogeographic facts in regard to the origin of the Indian fauna. The early Tertiary or placental mammals of Europe, and presumably also those of Asia north of the Circum-continental sea, the Tethys, drifted either as such or as their descendants by certain routes—of which we have only indications—into the fragments of Gondwanaland represented by Aethiopian Africa on the one hand and Peninsular India on the other. Meantime, evolution went on rapidly to the north of the Tethys giving rise to the more modern and highly evolved types of mammals. About the end of Tertiary times, as a result of the receding of the Tethys, communication between the northern with the southern lands seems to have become easier, and this, combined with the climatic changes, led to a great rush southwards of the more modern types. These overwhelmed the earlier fauna in the southern lands, driving its few representatives into the more outlying or upland areas, or wiping them out altogether off the face of the earth. In case of the Oriental region the Central Himalayas which had meanwhile risen as the mighty mountain chain of Asia and the Tibetan plateaux to their north formed a real barrier. In the north-west, where this mountain chain is comparatively less higher and less continuous, this barrier was not so effective, but the Afro-Asian arid belt which is continued into India as the Sind desert, formed a very efficient barrier. Through the passes in the north-west of the Himalayas the recently evolved mammals found their way into India, but naturally only forms which could withstand arid conditions or were adapted to mountain life, were able to use this route. The areas further to the east, which have been clothed for a long time with forests and are without high mountain barriers, offered greater facilities for the spread of animals adapted to wooded regions. India proper may thus be conceived as having had two converging streams of immigrants, one coming from the north-west and the other from the north-east. In view of the fact that the Indian Peninsula narrows southwards, it is clear that very few representatives of the Tertiary fauna in this area could successfully withstand the inroads of the more highly evolved immigrants from the north. The area to the east of the Assam neck, or the region where the Bay of Bengal pushes upwards towards the Himalayas narrowing the country into a bottle-neck shape, was, however, more favourably placed in this respect, as only a few

immigrants were able to traverse the Assam neck. Further, as the members of the earlier fauna were pushed southwards by the incomers into an area of almost equatorial climate, it is not difficult to surmise that survival was possible only for such forms as could adapt themselves to the highly specialised climate and surroundings. As a result this earlier element of the fauna was mainly wiped out, and at the present day is only poorly represented in the area.

FAUNAL ANOMALIES

In this account I have not considered the very interesting cases of the occurrence of identical aquatic species in the Indus and the Ganges river systems, which at the present day constitute quite distinct and unconnected systems. This has been explained on the hypothesis of a continuous river in place of the two river systems during the Tertiary times. The mighty river, which has been designated the Indo-brahm by Pascoe or the Siwalik River by Pilgrim, is supposed to have run from the east to the west and broken up into three river systems with the elevation of the Himalayas, resulting in similar forms being left in the different river systems.[33] Similarly closely allied, if not identical, aquatic species which occur in Bengal-Assam region on one hand and Peninsular India on the other, are to be explained on the basis of very different river systems during the Tertiary times in these areas, and the changes that occurred during recent geological times due to river captures, beheading of rivers, etc. In this connection the continuity of the mountain ranges of the Chota Nagpur Plateau westwards to the Satpura range and eastwards to the Himalayas has also been suggested, and it is surmised that along this continuous chain of mountain ranges the migration of the Himalayan aquatic fauna to Peninsular India took place. Further work in connection with these problems is, however, necessary before they can be satisfactorily dealt with. Similarly the occurrence of *Typhloperipatus* in the Abor Hills of Assam, *Herpele* in Assam, *Pseudomulleria* in the Kadir Hills of Mysore and other archaic types needs a great deal more of intensive zoological work before their relationships and distribution can be properly understood.

[33] For a detailed discussion of the present position in reference to this Tertiary river, see Prashad, B., *Rec. Geol. Surv. Ind.*, LXXIV, pp. 555-561, 1939.

Hilsa Investigations in Bengal Waters

HILSA, the so-called Indian Shad, needs no introduction to the general public of Bengal. This remarkable freshwater, estuarine and foreshore fish is known from the Persian Gulf right up to the coasts of Burma, ascending far up into all the big rivers and thus being available in a fresh condition very far inland. A closely allied species forms a very valuable fishery in China. The *Hilsa*-fishery season proper is confined in Bengal to the monsoon months when the fish occurs in immense quantities and is a popular article of diet among the rich and the poor alike. It grows to over a foot and a half in length and may weigh as much as five pounds. Its flesh is delicious, especially when mature and full of fat, and contains practically all the essential nutritive ingredients. The fat and the roe are well known for their high vitamin contents. The family Clupeidae, to which *Hilsa* belongs, earns the greatest amount of the revenue for the fisheries of the world. Complete statistics of *Hilsa* catches in Bengal are not yet available, but the value of the fishery can be judged from the fact that from Chandpur alone 26,152 maunds of fish were exported, mainly to Calcutta, between April and October 1939. The economic importance of the species has long been realised, and, in view of the weighty recommendations of the late Sir K. G. Gupta, a special officer was sent by the Government of Bengal to America as early as 1908 for studying Shad-culture.

As a rule, fisheries form a primary exploitative industry of the State, next only to agriculture, and a thorough grasp of the sources of supply and their conservation and increase by protective measures or artificial replenishment are essential for their continuous prosperity. It has often been said that unlike

the cultivator of land, where one has to invest for the sowing and tending of his crop, the fisherman has only to go and reap a golden harvest from the bountiful aquatic field. However, it is worthwhile to remember that fisheries, if not exploited on a sound scientific basis with a thorough knowledge of the bionomics of the species concerned, will in the long run become depleted to such an extent that later it may become difficult to revive them. The statement made some time back by Dr S. W. Kemp before the British Association for the Advancement of Science that "throughout almost the whole of the vast stretch of the Indo-Pacific region there is scarcely a fish whose life history is fully known and whose various stages from egg to adult can be recognised", clearly appraises the pitiable situation of our fisheries. This unfortunate state of affairs has, however, been rectified to a great extent in the case of *Hilsa* through the recent investigations carried out by the Zoological Survey of India.

From an analogy of the breeding habits of the American Shad, the spawning grounds of *Hilsa* were for a long time supposed to be higher up in the Ganges system, somewhere in the vicinity of Monghyr, whence the eggs, larvae and early stages of the fish were believed to be carried down to the sea or to the estuaries for further development. Since the *Hilsa* investigations stopped with the closing down of the Fisheries Department of Bengal in 1923, no work was being done in that line till 1936, when Hora was able to locate the spawning grounds of the species in the river Hooghly in the neighbourhood of the Pulta Waterworks. Since then *Hilsa* has been found to spawn in all the big rivers of Bengal, and the researches of the Zoological Survey of India have gone a long way in unravelling the mystery of the life-history and wanderings of this fish of such economic importance. The new findings about the breeding, development, rate of growth and feeding habits of *Hilsa* are not only of scientific interest but are of great value in their application for the proper conservation and exploitation of the fishery. It has been found that *Hilsa* breeds extensively in all large rivers, with a peak period during the rainy season. Its delicate larva feeds on microplankton and grows quickly reaching the fingerling stage in a couple of months' time. *Hilsa* feeds on planktonic organisms throughout its life and grows approximately at the rate of an inch per month, and though the growth is somewhat retarded during the winter months, a marketable size of about 10-12 inches is attained by the end of the first year. The investigations extended to the various rivers of Bengal have revealed that the Jatka fish to which Finlow and Jenkins had referred and which yields extensive fisheries in the rivers of East Bengal during February-March, is the young of *Hilsa*, two to five months old. It is surmised that Jatka migrates upriver from the estuaries for feeding purposes. Another tentative finding is that while the mature *Hilsa* swarm into the rivers during the flood seasons for spawning purposes, a number of young individuals also ascend, and these travel far inland before they become sexually mature. Studies on the movements of *Hilsa* in the sea have shown that all growth stages of the fish move about in shoals within ten fathom depth along the foreshore and estuaries of the Bay of Bengal till the sexual urge and other factors goad them to enter fresh water mainly for spawning purposes.

Some of the above findings have corroborated the observations already made by the Department of Fisheries, Madras.

Now that considerable advance has been made in the knowledge of the life history and bionomics of this important food fish, the next question is how to exploit the fishery to the maximum advantage without depleting the stock. Since the greatest output of a battery of hatcheries would be but a trivial fraction of the output from a relatively small number of natural spawners, it has been recommended that proper protection should be afforded to the *Hilsa* fry, a small fraction of the teeming millions of which, if enabled to mature year by year, would yield a continuous supply of nourishing food. Owing to the pressure of the increasing population of the country on its food resources, the ignorant and shortsighted fishermen lose sight of the future well-being of the fisheries and recklessly capture the young of *Hilsa* in tons during November-December, when the waters fall low and make it possible for them to use small-meshed nets both in the rivers and in the estuaries. Occasional stormy weather affords a certain amount of protection to the young, but as is well known, Nature often succumbs to a ruthlessly scheming intellect. It will thus be only a matter of time for the waters to be depleted unless they are protected by effective legislation. However, it must be remembered that the poor fisherman, who is not to be blamed for his ignorance of fish bionomics, should be alternately engaged in some other occupation during the off season. A close season for *Hilsa*, as enjoined by the *Shastras*, would do great benefit to the fisheries and indirectly

to us all. It is worthy of remark that the need for a close season for fishes was recognised as early as the 3rd century B.C. when Asoka made it known to his subjects through his 5th pillar edict.

As *Hilsa* is present almost throughout India and thrives under diverse ecological conditions, there is a possibility, as suggested by Jenkins, that it comprises several races or varieties capable of living and breeding under different environmental conditions; these may require slightly different regulations for the protection of their respective fisheries, for without definite knowledge of their bionomics the methods of protection or propagation will not be successful on an all-India basis.

Another significant suggestion that has been made is that there is a five year cycle in the fishery of *Hilsa*, that is to say, every fifth year there will be a bumper crop of *Hilsa* for no apparent reason. Many of the readers may be aware of the last two bumper crops, one in 1939 and the other in 1934. During 1939, in the absence of suitable transport and marketing facilities, tons of this valuable fish were allowed to go waste. If the tentative suggestion of the five year cycle is borne out by systematic research in future, there will be great industrial possibilities—cottage as well as factory—whereby the waste can be checked and the surplus utilised as preserved fish during the lean years. The *Hilsa* fishery by itself is of such economic value to the province of Bengal that a band of well trained and competent scientists is needed to investigate it from all aspects and to suggest ways and means to exploit and conserve it on sound lines for the betterment of the present generation and the well-being of posterity.

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T. J. Job.

Work of Indian Central Jute Committee

THE Indian Central Jute Committee held its first meeting in February 1937 and during the short period of its existence has made visible progress all round. The Technological Laboratory established at Tollygunge and the Jute Research Laboratory at Dacca (the older name Agricultural Research Laboratory was perhaps more appropriate, for both deal with jute research) are now in full working order. It has been possible in the annual report for the year 1940-41 to give a good account of the progress that has been made and to enumerate the different technical problems which the research personnel appointed under the Committee have taken up for solution. The report is divided into seven chapters and nine appendices.

After a statement of the aims, objects and the constitution of the Committee and matters related to the administrative machinery, the Report reviews the jute position in 1940-41. The various factors on which the price of raw jute and jute manufactures depend have been discussed as also the attempts made by the Government of Bengal to regulate the price of raw jute. It is stated that "the problem of surplus in regard to manufactured goods has been

well nigh solved, albeit at some cost to the industry and the consumers." From the figures given on p. 16 it appears that whereas from June 1940 to March 1941 the price of jute manufactures rose gradually from 94 to 131, taking the prices obtaining in 1914 at 100, the price of raw jute fell from 80 in June 1940 to 51 in February 1941 and rose thereafter to 56 in March 1941. These figures show that the measures taken to secure a good return to the cultivator have not yet borne fruit. The rise in the price of jute manufactures has been almost continuous excepting a fluctuation in August, but the price of raw jute has shown wider fluctuations and remained at about 55% of the 1914 level towards the end of the last financial year. The Committee seems to be aware of the situation and it is pointed out on page 20 that "the liquidation of the issues raised by the policy of control of production of manufactured goods on the one hand, and the rigid restriction of the area under jute on the other, must still remain the immediate problems of the coming year".

The Report claims that the Indian Central Jute Committee which is "an advisory body" has been "responsible for setting up an entirely new stage in scientific research of jute". It were better if it had more freedom in its sphere of activities and were not merely "advisory". Summaries of the work done at the two laboratories prepared by the two directors of the research laboratories are included in the Report.

The director and the librarian of the Technological Laboratory deserve congratulation for having accumulated in their card index 1800 references to articles in journals and other sources of information bearing on the work being done in the laboratories. It is perhaps not often realised how essential is a systematic collection of available information, spread as they are in a variety of publications not always easily accessible, for the solution of problems of industrial research.

The main lines of agricultural research that have been undertaken are (i) cultural experiments, (ii) investigation on retting, (iii) causes of defects in fibre, (iv) colouration of fibre ; and (v) diseases and pests of jute. The conclusion has been drawn from experiments with different varieties that the "quality of fibre is principally determined by conditions under which jute is grown and retted and not so much by the variety". It is stated on p. 66 that these experiments have so far been limited to only three varieties and to bring out the varietal differences a wider examination is necessary. On the agricultural side soil aspects admit of a more systematic approach. It is hoped that these and physiological experiments on the jute plant will receive fuller attention in the future. The experiments on retting and the water analysis may have a definite purpose but, if so, this is not clear from the report.

The main lines of research undertaken at the Technological Research Laboratory were spinning technique tests, fibre character in regard to spinning quality, tests on commercial fibre samples, testing of commercial yarn samples, moisture relationships of jute, utilisation of jute waste and improvements in the quality of cuttings, chemical retting, and reduction of the hygroscopicity of jute.

On the basis of tests on samples sent from the Agricultural Research Laboratory, it is mentioned that the superiority of the Fanduk variety has been confirmed although the "yield per acre of the variety is not greater than that of improved departmental strain but it should be remembered that the yield and quality may be negatively correlated". The work so far done shows that not much of a correlation exists between the chemical character of the fibre as determined by routine estimations of their organic constituents and spinning quality, but a fairly close relation between quality and loss in weight in a 'standard alkaline boil' is indicated.

The economic investigation dealt with under the auspices of the Committee, which has been maintaining a separate staff for this purpose, comprise marketing of jute ; such developmental work as the dissemination of jute prices ; co-operative marketing of jute in Orissa villages, and the grading of jute. The final figures for the infiltration of jute from Assam to Bengal were compiled during the year under review. They showed that approximately 10,13,000 maunds of jute in loose and *kutcha* baled condition, were sent from Assam Valley to the baling stations in Bengal in 1939-40, 2,48,000 maunds by country boat, 2,90,000 maunds by railway and 4,75,000 maunds by steamer. The work on the census sample of the area under jute was continued during the year 1940. A thorough random survey in principal jute area in Bengal was undertaken during the year. "This, it was thought, would provide all the information needed in planning a Provincial Survey in 1941". The total cost of field and statistical branches on 1940 survey was Rs. 91,036.

Reverting to the problem of stability in the price of raw jute, a matter which so closely concerns the main objective for which the Committee has been established, it seems to the reviewer that so long as new and profitable methods of utilisation of jute are not found, it will be difficult to secure a stabilised price for jute. The research programme should aim at a satisfactory answer to the question, "what can we make out of our jute with benefit to all?" The decision of the Committee to extend its activities towards finding new uses of jute is therefore welcome. "A scheme for the extension of the activities of the technological laboratory of the Committee to which a brief reference was made in the last year's Report (p. 21) has been accepted by the Government of India in principle." (?) It involves an expenditure of Rs. 3,65,000 to Rs. 3,85,000 non-recurring and from Rs. 30,000 to Rs. 43,000 recurring. The Government of India have made a provision of Rs. 1,95,255 for this scheme during the year 1941-42 and the detailed estimates await their sanction. A word of caution in this connection will perhaps be not misunderstood. A thorough search of the available information which is likely to be helpful in defining the lines along which new uses are likely to be found should be the first step in drawing a programme of research for the purpose. One basic scientific study which is expected on theoretical grounds to be found useful for a variety of technical purposes appears to be the rate of chemical action of usual cellulose solvents on jute fibres and the viscous and other properties of the resulting mass at different stages of attack by these chemicals. The information will perhaps be more helpful in the work of correlation of physical and chemical properties of jute fibres with its spinning qualities than a routine estimation of its organic constituents. While X-ray methods will give useful information about the structure of jute fibre, additional knowledge which has a more direct bearing on many technical problems is likely to be afforded by the investigations mentioned above.

The Report is well presented. It will however be helpful if experiments in their initial formative stages are omitted. Is it so necessary to publish the personnel of all committees? Some committees do not seem to have been mentioned at all. Another question may be asked why do such distinguished men as Professors M. N. Saha and S. N. Bose and their colleagues happen to be co-opted members of admittedly scientific committees?

J. N. Mukherjee

Sons of the Soil*

IT is indeed strange that we know so little about the people of different portions of our own land. Very few of us can tell what food the Malabar peasant eats every day, or the kind of shoes that a farmer in Bundelkhund wears, how a Kanarese on the leeward side of the Western Ghats builds his house, what kind of dances or music the farmer in Chotanagpur loves and so forth. About the products and manufactures of different portions of India, we know perhaps just a little more ; but even that does not seem to be enough. But this is a state of affairs which we can mend very easily with a little amount of love and sympathy, if we add to that also some amount of intelligent travel in the unfrequented places of rural India.

There was a time when British officers were deputed to gather an account of the arts and crafts of each province in British occupied territory ; and this was often entrusted to men who were of outstanding ability. Men like Buchanan-Hamilton or Baden-Powell spent years of their life studying the conditions of rural industries ; while others undertook to acquaint themselves with the tastes of the people of different provinces in the matter of dress and ornaments and even in respect of humbler things which they use in their daily life. All this knowledge, laboriously gathered and carefully marshalled, was made to serve special ends—the ends of British trade and manufactures in the newly acquired subcontinent of India.

But even that interested survey of the rural arts and crafts of India and of her economic products was a great and a good thing. What was lacking was a similar investigation undertaken for the benefit of the

* *Sons of the Soil* edited by W. Burns, D.Sc., I.A.S., Manager of Publications, Civil Lines, Delhi, 1941. Price Rs. 2/6/- or 4s. Pp. ix+128+43 plates.

masses of India's toiling humanity, who had come, by force of various circumstances, under the rule of the British Government in India.

During the last twenty years, there has been a new awakening in the political life of our country, and educated persons have of late begun to take an interest in the life and labours of their humbler brethren who live far from the comforts and enlightenment of towns. The start was given by Mahatma Gandhi in the year 1920; but it has mainly been after the sovietization of Russia that we have awakened, in a new sense, to an interest in the life of the toiling millions. Surveys of various kinds have been undertaken here and there—survey of living conditions, of the diet of the people, of the ultimate causes of famines and floods,—and much knowledge has slowly been accumulating from day to day, and this has been bringing the sons of the soil into a more intimate relation with the various agencies which profess to work for the welfare of our land.

The picture which has slowly emerged from the interest and activities displayed during the last decade and more is of anything but an encouraging kind. Where the truth has been told, we always hear of the growing divorce between the educated and uneducated people of the land, we hear of the gradual decay of arts and crafts of many kinds, the increasing pressure upon agriculture, the decay of old irrigation systems and of waterways due to the expansion of railways or roads meant for facilitating export trade at the expense of internal consumption of country-made articles. We also see how a government interested mainly in furthering the cause of foreign capitalism spends many times more on its army and police than on education, and how it leaves the people of the land to shift for themselves as best as they can under the buffetings of the world's economic maladjustments. Here and there, we come across small bands of political idealists who aim at rural reconstruction or who try to bring about a more rapid change in the conditions of their toiling brethren; but of such men there never seems to be enough for the needs of the land. This in short is the vision that rises in our mind as we go through the accumulating experiences of the past few years. On every hand, we observe a keener appreciation of the wrongs from which the toilers of India suffer either in the fields or in the factories, and we see growing before our eyes a stronger desire to rescue them from their stifling conditions of life.

This is the reason why one should welcome the small publication entitled *Sons of the Soil*, which attempts to "give an idea of the cultivator as a man, and not as an economic unit." The book is a fine one, the types have been chosen from practically all parts of India; and some of the sketches written with a degree of sympathy and understanding which is rare in official publications. It is not unnatural that many of the accounts should try to present generally the brighter side of the picture; but such pictures are not without their merit even when they are loaded by personal or official bias. The editor was evidently anxious to reduce the personal factor to the least possible quantity, and he has succeeded in presenting to his readers something which is substantially free from intentional warping of facts or from propaganda motivation. If there is any error, some of the sketches seem to err on the side of romanticism.

One way of getting out of the unintentional bias, and of further reducing the personal factor, would have been to get hold of a random sample—an ordinary middle-aged farmer—from each region and gather a very personal and brief autobiographical sketch of that man. Such a method has seldom been tried in India; but where it has, as in Verrier Elwin's study of the Baigas, it does succeed in conveying a clear, realistic and very intimate picture of a people's life which is refreshingly free from the investigator's personal bias. But even the choice of such random samples is beset with difficulties; for one may be led astray in the very act of that choice by one's preconceived ideas or sympathies.

We do hope however that enterprising social investigators and more enterprising publishers will undertake to present before the public a true and comprehensive account of the life of rural India, so that we might know more about the people on whose labours so many others live, and for whose welfare we are morally, though perhaps not legally, responsible.

One remembers with gratitude and joy the picture of the Bengali peasant that was drawn long ago by the Revd. Lal Bihari Dey (*Bengal Peasant Life*, MacMillan), and one only hopes that such stories about peasants from other parts of India would be forthcoming in larger numbers—for that was a picture drawn with deep sympathy, but without praise and without reproach for the subjects concerned.

Nirmal Kumar Bose

Notes and News

SILVER JUBILEE OF BENARES HINDU UNIVERSITY

THE Benares Hindu University having completed its twentyfifth year celebrated its silver jubilee last month. Since the foundation of the University twentyfive years ago there has been a remarkable rise and growth of the institution, much of which is due to the efforts of the great Indian leader, Pandit Madan Mohan Malaviya. Unlike most of the important Indian universities, the Benares Hindu University was started by purely private enterprise and all through its existence it has depended for financial support mainly on private benefactors. With a begging bowl in hand, the 'Prince of Beggars', Pandit Madan Mohan Malaviya worked miracles. Within a short time he raised more than a crore of rupees from the Indian princes, zemindars and commercial magnates, who do not always show much eagerness to loosen their purse strings for the furtherance of higher education in the country. Today the Benares Hindu University is one of the foremost unitary and residential universities in India. In a suburb of the city within an area of two square miles are situated the Arts College, the Law College, the Colleges of Oriental Learning and Theology, the Women's College, the Teachers' Training College, the College of Science and the College of Electrical and Mechanical Engineering, the Institute of Agricultural Research and the University Library. The faculty of technology of Benares University is the only institution in India which imparts training in ceramics, pharmaceutics and glass technology. The College of Engineering has made great progress and has won reputation for itself as one of the leading institutions of its kind in India and attracts large number of students from all parts of the country. From a modest beginning the University has grown to its present stature under the fostering care of its founder, Pandit Madan Mohan Malaviya, who held the office of the vice-chancellor until last year. The University is lucky to get the services of Sir Sarvapalli Radhakrishnan, who has succeeded Pandit Malaviya as vice-chancellor and we hope the University will make great strides in the path of progress and expansion under the leadership of the worthy successor of Pandit Malaviya.

EDUCATION IN BENGAL

THE Report on public instruction in Bengal for 1939-40 records a general increase in the number of pupils in all stages in the province. The scheme of free primary education was extended to certain districts and revised curriculum for primary schools has been adopted. Primary training centres for increasing the supply of trained teachers were opened and short refresher courses were also held for teachers of primary schools. There was an increase in the number of pupils in primary schools in spite of the fall in the number of schools, presumably due to better planning. There was a slight increase in the number of secondary schools and Calcutta University arranged refresher courses for secondary school teachers. Another important change introduced in the educational sphere in the province was the holding, for the first time, of the Matriculation Examination through the medium of vernaculars by Calcutta University. The total number of Arts Colleges in Bengal rose from 51 to 58 of which ten were exclusively for women. So far as expansion of university education is concerned the most important event during the year was the institution of a faculty of agriculture and opening of three new departments, namely, agriculture, biology and soil science, in the University of Dacca.

ROYAL ASIATIC SOCIETY OF BENGAL

THE presidential address of Sir John Lort-Williams delivered at the last annual meeting of the Royal Asiatic Society of Bengal shows a clear appreciation of the immediate necessity for complete reorientation of the activities of the Society by giving up the pretence that the Society is still a society of amateurs and aiming at creating a society of experts distinguished for exact scholarship. During recent years the observations made by some of the former presidents showed a conservative mentality and there was the reasonable apprehension in certain quarters that attempts were being made to turn the Society into a club for wealthy persons of general culture. Sir John has clearly stated that the aim of the Society must be primarily to encourage every kind of scholar-

ship and research within the boundless scope laid down by the illustrious founder of the Society. In the present age of exact scholarship and narrow specialisation it may not be possible for the Society to compete with other societies of specialists. But by limiting scope in certain fields of oriental research and investigation, the Society may yet do valuable work. At the same time the Society may usefully extend the scope of its activities by including the study of social and other problems concerning the peoples and countries of the East. The President warned that unless the conservative mentality is shaken off, the Society will sink slowly and cease to be anything more than care-takers of old books and manuscripts. Sir John pleaded for an expansion of the membership roll and for creating more opportunities for discussion among members. He urged the members to take steps for speeding up the work of reorganization and for setting up a special enquiry committee to deal with the important problem of their cultural activities.

The secretary in his report stated the difficulties created by the war situation and the additional expenditure caused in safeguarding and removing valuable collections of the Society. It is heartening to note that the publications of the Society have for the first time been brought up to date since 1937.

WAR AND WEATHER

IN a recent issue of SCIENCE AND CULTURE (Vol. 7, p. 23, 1941-42) we gave a review of how Germany has profitably used the medium and lon-range weather prediction technique during the present war. When Germany had invaded Poland, it was predicted from various quarters that Germany had chosen a wrong season for initiating a major campaign and that General 'Mud' would soon come to the rescue of Poland. But as subsequent events showed Germany met with an exceptionally fair weather during the Polish campaign. Again during the Norwegian campaign Germany succeeded in landing a large contingent of army by launching operations when there was inclement weather which assured bad visibility. It was not strokes of good luck which helped the Germans during these campaigns but it seems they had made use of long-range weather forecasting methods and calculated when the weather would be on their side to help them in their operations. Another recent event which has upset the mental equilibrium of the military strategists on the side of the Allies also seems to indicate that the Germans are carefully utilizing weather forecasting techniques before undertaking any important military operation. A few days ago the three German battleships 'Gneisenau', 'Scharnhorst' and 'Prinz Eugen' which took refuge in Brest harbour last year, dashed through the Straits of Dover and reached their ports in Heligoland. We do not know what effect the escape of the German Battleships will have on the future war strategy but the fact remains that this was a very hazardous operation and was carried out with great success. The channel route was a run of nearly 24 hours and part of it was made in darkness. But even on the following day their movements were detected long after daylight 'because the weather was such that visibility proved to be very poor'. The Prime Minister in his statement before the House of Commons admitted that the enemies had the opportunity of choosing a weather which was most favourable to them. "The whole way through the channel and along Dutch coast they had advantage of the Straits of Dover under suitable weather conditions." This explains why their movements were not detected before midday and they could not be engaged before the afternoon and that also without any result because of poor visibility. The incident cannot be brushed aside as a mere stroke of good luck for the Germans. It proves clearly that the Nazi warlords are depending not only on their tanks, machineguns and bombers but also on an army of statisticians and physicists who are engaged in the task of forecasting suitable weather conditions before starting major military operations.

REVERSE BLACKOUT

RECENTLY there has been a lot of discussions in U. S. A. regarding the value of blackout as a military measure. It has been pointed out that while creating new problems for the police because of possibility of increased crime and traffic accidents, blackouts have been of questionable value from the military point of view. Nazi fliers, it is said, located English cities with the aid of radio-beams. Moreover parachute flares and incendiary bombs have largely annulled the effect of blackouts. On the other hand, the works of the police, A. R. P. workers and firemen are greatly hindered during blackouts, and continued reduction in social life for long periods tends to affect the morale of the people.

An alternative to hinder the activities of enemy aircrafts has been suggested. Powerful searchlights and wide-angle floodlights directed towards the sky would confuse enemy aircrafts and would aid protecting aircrafts to shoot down the enemy. Preliminary tests carried out by the U. S. army shows that even with a long viewing tube pilots could not penetrate the glare to find important targets.

UPPER AIR DATA OVER THE ATLANTIC

IN the present-day weather forecasting techniques upper air data have proved to be of great value and various devices have been perfected for collection of such data. In recent years the radio-sonde apparatuses have been largely in use for measurement and recording of weather conditions at upper air levels up to a height of several miles. Helium-filled rubber balloons, five to six feet in diameter, carry a light weight radio-transmitter weighing about two pounds and inside the transmitting device is equipment for measuring temperature, humidity and pressure at upper air levels. Such apparatuses have been used by the weather bureau in several countries. Now for the first time the United States Weather Bureau has made arrangements for obtaining daily regular upper air weather records over the Atlantic ocean. Three ships plying between New York and Lisbon on regular schedules have been equipped with radio-sonde apparatus and trained meteorologists will make observations twice daily and send their findings by radio to the Weather Bureau which will thus be in possession of a wealth of meteorological data, which were hitherto unavailable.

INDIAN FISHERIES

THE present colossal war, more than any other, has been drawing out nation's initiative and constructive faculty in more than one field. The article on "Indian Fisheries and the War" in the November number of the *Indian Farming* is a pointer to one such direction. One can neither too much emphasize that 'an army marches on its stomach', nor can one forget that the march of progress in war or in peace, is always continued on sound bowels. President Roosevelt has said, "Food will continue to be a weapon in all efforts towards ensuring a more orderly, prosperous and peaceful world." The role of fish in the solution of the vital problem of nutrition has recently come to be recognised with increasing emphasis. Fish is superior to many other articles of food in that it contains practically all essential nutritive ingredients in an easily digestible form. Biochemistry has revealed the vast vitamin potentialities of fish oils. The importance of fishes to public health is also being realised in regard to the control of mosquito-borne diseases like malaria, filariasis, dengue, yellow fever and encephalites, and helminthic ailments, such as bilharzia infection and guinea worm disease. Inquiries into the utility of air-breathing, mud and mire fishes in the purification of sewage and sullage are also being made since the Mediterranean sea bream, *Box salpa*, was suggested for such use. Nor can one overlook the industrial resources—both cottage and factory—of the commodity, such as fish manure for agricultural purposes, bone for gelatin, air-bladder for icinglass and fish leather of commercial value. The manufacture, transportation and sale of edible fish, canned or preserved in different ways and of other fish products, and public health fish farming, will not only strike at an untapped mine of natural resources but at the present time a co-ordinated enterprise in this direction will also provide sustenance for those engaged in the successful prosecution of the war. For men behind the fighting lines, the developmet of fisheries in India along proper scientific lines will always mean a paying business giving employment to a large number of workers and yielding results of great economic value.

Now that necessity has drawn the attention of thinking men to the organic wealth of the Indian waters, it is for the Government to direct the energies through proper channels to avoid waste and to produce the best results. Fishes do not recognise man-made geographical limits or even provincial boundaries. They breed, develop, feed, grow and wander in accordance with wider hydrographical laws. Hence investigations for the development of fisheries to be sound should be well planned. Duplication of work in different provinces is likely to lead to waste of money and scientific energy, both of which can ill be spared in India at the present day. Fisheries are bound to play an important part in national reconstruction, in the planning of which, it is hoped, due consideration will be paid for the setting up of an organisation on an all-India basis.

NEW UNIVERSITY FOR MAHARASHTRA

THE Government of Bombay has appointed a committee consisting of the Rt. Hon'ble Dr M. R. Jayakar (chairman), Sir Raghunathrao P. Paranjpe, Mr R. P. Masani, Rev. J. Mackenzie, Mr D. R. Gadgil, Mr B. G. Jagtap and Mr G. B. Jathar (secretary), to investigate and report on the question of the establishment of a university for Maharashtra.

The establishment of a university for Maharashtra has been discussed for a long time, and in 1924 the University Reforms Committee recommended the establishment of such a university. Later as a result of representations made by certain leaders of Maharashtra, it was decided to convene a conference of educationists, representatives of the Bombay University and other interests to discuss the policy of the gradual establishment of regional universities in Bombay Presidency. The conference was held in 1933, but due to non-unanimity of opinion in favour of any particular scheme, the question could not be pursued further. In 1937 the Bombay Legislature recommended to the Government that early steps should be taken to establish additional universities to meet the increased demand for higher education and faci-

lities for research. The House was informed that the Government had no objection in principle to the establishment of regional universities and assurance was given that due attention would be paid to the consideration of this important subject. The terms of reference of the committee are to consider whether a university for Maharashtra should be established; if, in the opinion of the committee, such a university should be established, to make recommendations as to what should be its form, constitution and jurisdiction; and to report on the cost of its establishment and maintenance and to make proposals for raising the necessary funds.

THE HINDUSTAN AIRCRAFT GAZETTE

FOR some industries the personnel runs to a very large number and the different processing units are to be scattered over wide areas. In such concerns it is difficult for the members of the staff to meet one another and learn about the other man's job, and to carry out one's work with a proper sense of responsibility. It is therefore a welcome news that the Hindustan Aircraft Ltd., has brought out a monthly journal to provide a medium to ensure intelligent acquaintance with the works in other departments and thus to promote amongst the staff closer co-operation with a view to better production. Readers may remember that the Hindustan Aircraft Ltd., situated at Bangalore is a pioneering Indian concern, which has launched a plan for the manufacture of aeroplanes in this country and, as a preliminary step, has started work on assembling, with American technical assistance, the different parts imported from abroad. The concern is run by the same group who have cried hoarse in national interest for certain concessions from the Government which would have enabled them to launch an automobile industry in India. The authorities deserve praise for including this important item of a journal in their scheme of efficient management. The *Hindustan Aircraft Gazette* not only contains information relating to factory work but there are articles and notes of general interest as well. The gazette is expected to serve not only the interests of education but also of relaxation.

ANNOUNCEMENTS

THE Hon'ble Mr N. R. Sarkar has been appointed pro-chancellor of Delhi University for a period of three years with effect from the 31st January, 1942.

AT the annual general meeting of the members of the Visva-Bharati, Dr Abanindra Nath Tagore was elected president of the Visva-Bharati for three years.

AT the first annual general meeting of the Indian Ecological Society held at Baroda during Science Congress Week, the following were re-elected to the executive Council: *President*—Prof. S. P. Agharkar, *Vice-Presidents*—Dr N. L. Bor and Dr S. L. Hora; *Hon. Secretary and Treasurer*—Dr F. R. Bharucha; *Members*—Mr P. W. Davis, Prof. P. W. Gideon, Dr R. Misra, Dr L. A. Ramdas, and Dr T. S. Sabnis. Mr E. A. Garland has been co-opted this year as an additional member of the executive council.

AT the annual general meeting of the Society of Biological Chemists, India, held in Baroda during Science Congress Week the following were elected to the executive committee of the Society for the year 1942: *President*—Sir Upendranath Brahmachari, *Vice-Presidents*—Lt.-Col. S. L. Bhatia, Dr G. J. Fowler, Dr J. C. Ghosh, Mr R. C. Srivastava and Rao Bahadur B. Viswanath, *Hon. Treasurer*—Mr B. N. Banerjee, *Hon. Secretaries*—Dr B. H. Iyer and Mr G. B. Ramasarma. *Members*—Dr H. K. Sen (Ranchi), Dr K. P. Basu (Dacca), Dr B. C. Guha (Calcutta), Dr S. V. Desai (Delhi), Dr H. Siva Rao (Coimbatore), Rai Sahib J. C. Luthra (Lyallpur), Dr V. N. Patwardhan (Bombay), Dr K. Mitra (Patna), with the following additional members elected by the respective Branches: Dr M. Damodara (Madras), Dr A. Sreenivasan (Indore), Dr H. D. Sen (Cawnpore), Dr V. Subrahmanyan (Bangalore).

A CORRECTION

IN the article entitled, 'Has there been a correct record of religions in Bengal Censuses?" appearing in the last February issue, on page 392, the first two lines of second column should come to the first column just below the table. They should be linked with the lines in the first column at the top and bottom of the table.

SCIENCE IN INDUSTRY

NEW DEVELOPMENTS IN COTTON UTILISATION

DUE to the war, export markets for America's cotton crop has been largely cut off. The U. S. A. Department of Agriculture as a consequence sponsored a special research programme and has announced two new industrial uses for cotton. Smokeless gun powder has so long been manufactured by utilising the short fuzzy fibres left after the ginning process. These fibres were best for the nitrating process. The long staple cotton becomes entangled and obstructs the process. The long fibres have been now successfully utilised by the Bureau of Agricultural Chemistry and Engineering for manufacturing gun powder. Machines like giant lawn mowers now cut off the staple cotton, and each is capable of handling two tons of cotton per hour. This added production of explosive cellulose nitrate has been helpful in the defence programme. The short fuzzy fibres or the cotton linter may now be extensively put to use for the manufacture of rayon, cellulose acetate plastics and nitro-cellulose lacquers. The second development of interest to cotton growers is the possibility of growing an unusual variety of cotton for its wax rather than its cellulose. This variety known as Arkansas Green Lint yields 17 per cent of wax instead of usual one half of one per cent. A chemical company is collaborating with the agricultural department to produce a hard wax suitable for polishing shoes, furniture, automobiles and floors.

AIR-CONDITIONING SPEEDING UP NEWSPAPER PRODUCTION

AIR conditioning has so long been used to increase the efficiency of the working people or to provide comfort at home or during travel. The *Journal* of the Franklin Institute publishes a short note giving an account of how air conditioning has been utilised in a newspaper office. In the photo laboratories of an American daily paper, has been improved the quality of prints, and the old process of developing, printing and block making has been accelerated. The temperature of developing solutions being now controlled, blemishes in newspaper negatives have been remedied. Total time required for the whole processes from exposed negatives to final printing has been shortened by 7½ minutes. In addition to this quick photographic processing, which is a valuable factor in high-speed news publishing, many other up to date scientific devices have been adopted in the office of the paper. Films are dried in a centifuge. Hot air and fumes generated by carbon arcs in the printing room are removed through forced ventilation. The whole cooling equipment of the building is situated in a circular clock tower on the top of the 10-storey building and a unique 'spider-web' foundation of steel supports the installation and prevents vibrations and sounds from going down.

USES OF TEXTILE FIBRES

WOOL, silk and cotton have been the principal textile fibres for a long time. Within the last half century chemists have produced fibres in the factories which have been endowed with additional properties for making them more useful for clothing and upholstery. As a result of statatistical studies in the United States Department of Agriculture it has been found that in spite of rise of new products cotton is having still the highest consumption, the difference being very wide. Compared with wool, silk, rayon and flax, cotton made up 79·3 per cent of the U. S. total in 1939, somewhat less than the average of 85·6 per cent for the period 1920-29. On the other hand, rayon—for some kinds of which cotton is used as a raw material—made up only 1·6 per cent of the total from 1920-29, but reached 10·1 per cent by 1939. The trend shows a decline for cotton goods but it will be a long time before we can do without the natural fibres.

DERIVATIVES FROM PETROLEUM

IN the United States quacks and their agents used to sell "Rock Oil" and "Indian Oil" which were nothing but crude petroleum. To these "oils" they ascribed miraculous healing powers. After some

lapse of time by the ingenuity of chemists, this oil base, namely, crude petroleum, is now furnishing to the medical men a number of curative and sedative pharmaceuticals. Methods of processing the crude base differ for different products. The uses to which they are put will be interesting. Novocaine is used as a local anaesthetic by the dentist. Icthyol made from the crude oil obtained from certain shales and formaldehyde, in itself an antiseptic, when mixed with ammonia and other compounds provide a drug with healing properties. Another derivative, glycol, is used as an anti-freeze chemical in motor cars and in the manufacture of low temperature dynamites. In combination with oleie acid, glycol oleate is used as an emulsifier in the preparation of cosmetics, cold creams, brushless shaving creams and lotions. Some of the perfumes, astringents, theatre sprays, shampoos and even liquid rouge have their sources in petroleum. From petroleum are also derived mild anaesthetics like ethylene, propylene, and cyclopropane. These are used where ether is inadvisable. The most important production of petroleum refinery is glycerin. The old and usual source of glycerin is principally animal and vegetable oils and is recovered in the manufacture of soap.

INDIA'S INDUSTRIAL "BOOM"

THE value of orders placed in India by the Supply Department during the second year of the war amounted to about Rs. 110 crores, or nearly double the figure of the first year of the war. The total for the two years taken together exceeds Rs. 164 crores. Besides the purchasing organisations of the Supply Department, there are agencies operating on behalf of the Defence Services whose purchases also run to huge totals.

A note in an official publication contains the following list of supplies: textiles, heading the list of purchases, jute and jute goods, tent materials, woollen articles, foodstuffs, steel sections, plates, etc., ferrous metals, hides, tanning materials, footwear and leather products, hardware and other stores, motor vehicles and spares, ship-building materials and vessels, engineering plants and machinery, electrical stores, permanent way materials and wagons, huttings and open sheds, camouflage nets, trench shelters, timber and timber manufactures, petrol, oil, lubricants and fuel, soaps and chemicals, tools and components, and scientific, haberdashery and miscellaneous stores. The orders for these articles were placed with firms all over India. Bombay was predominant for textiles and motor vehicle body building.

The gradual expansion in the volume of purchases since the outbreak of war is significant. It reflects the possibilities of India's industrial capacity, and at the same time points out how inefficiently equipped are we in each of the industrial spheres. There have been more diffusive tendencies than concerted efforts at concentration of the possibilities for making a start for an effective industrial development. Some of the supplies enumerated above are mere foreign stock deliveries, and some depend on supply of materials from outside. For textiles we need good cotton from Egypt, and chemicals and dyes from other foreign countries. Motor vehicles are only assembled here and that is also done under the aegis of American interests and the recent press news focussed attention on the fate of Indian enterprise in this direction. As regards engineering plant and machinery, big items are not produced here. The manufacture of soap and chemicals referred to above depend essentially on sources outside.

We have commented frequently (it bears constant reiteration and let us hope there has been sufficient public consciousness) on the right approach in such a crisis as the present, when planned industrialisation can only stand up to support a mechanized warfare. We draw the attention of our readers in this connection to an extract from an English journal published elsewhere in this issue under the heading 'Increased Empire Industrial Production'. The present opportunity has been frittered away and our helpless position becomes clearer as the enemy's boots thump nearer our doors.

The Electric Lamp

Its Development and Principles of Design and Manufacture

C. S. RAO

HISTORICAL

THE total world consumption of electric lamps is more than a thousand million (1,000,000,000) per annum and the electric lamp industry today represents one of the large industries in many of the civilized countries and one of the growing industries in industrially backward countries like our own. The remarkable growth and development of the modern electric lamp may be traced to as early as 1841 when J. W. Star in America did a lot of experimental work and took out patents for "a metallic or carbon conductor intensely heated by the passage of electricity for the purpose of illumination." These early attempts were ultimately crowned with success in the hands of the late Thomas Alva Edison, who, after persistent efforts, finally succeeded on the 21st of October, 1879 in producing the first incandescent lamp with a filament of sewing thread carbonized in an air-tight crucible. Edison had to carry out over 1600 experiments with various minerals and ores and, to quote his own words, "I speak without exaggeration when I say that I have constructed three thousand different theories in connection with the electric light, each one of them reasonable and apparently likely to be true. Yet, in two cases only did my experiments prove the truth of my theory. My chief difficulty was in constructing the carbon filament, the incandescence of which is the source of light." The filament was clamped to platinum lead-in-wires and mounted inside a glass bulb which was subsequently evacuated.

In later lamps, filaments of carbonized bamboo were employed owing to their greater strength and these were subsequently improved as to their luminous output by Sawyer's method of "flashing" the filaments in an atmosphere of gasoline (hydrocarbon) vapour, which deposited a coating of graphite resulting in a smoother and more uniform filament. In the year 1893, a process of producing a cellulose filament from absorbent cotton dissolved in a solution of zinc chloride was discovered. The dense solution was squirted through a die, in the form of a fine thread, into an alcohol bath which hardened it. This filament was uniform in constitution and size, and, after being carbonized in an atmosphere of a hydrocarbon vapour, possessed excellent strength and flexibility. With this filament an efficiency of about 3·3 lumens* per watt could be attained as against an efficiency of only 1·6 lumens per watt obtained with the carbonized bamboo filament.

In 1905, the "GEM" or the "metallized" carbon filament lamp was introduced by the General Electric Company of America by heating the carbonized filament to a very high temperature in an electric furnace to burn out some of the impurities. This resulted in a filament with a positive temperature coefficient of resistance—hence called "metallized"—and gave a lamp which operated at about 4·2 lumens per watt.

The Nernst lamp, a German invention, came into market about 1900. It consisted of a 'glower' of zirconium oxide, operated in air, and preliminarily heated by a 'heater' of platinum wire which was subsequently disconnected and a "ballast' or steadying resistance of iron wire introduced in series with the glower to counteract the effects of the negative temperature coefficient of the latter. This lamp had an efficiency of nearly 5 lumens per watt. It, however, came into disuse by about 1912.

THE METAL FILAMENT LAMP

Coming next to the metal filament lamps, the 'Osmium' lamp was developed by Welsbach and was commercially introduced in Europe in 1905. This lamp had a higher efficiency (about 5·9 L/W) than the carbon-filament lamp, but it did at no time come into extensive use on account of the very great difficulty of obtaining the rare metal as also because of the extreme fragility of the lamp. Tantallum

* One lumen is the amount of light (luminous flux) falling perpendicularly on unit area at unit distance from a source of one international candle, the total light emitted by one candle being 4π or 12·57 lumens.

filament lamps were introduced in the United States of America in 1906, but were soon superseded by the more efficient and superior tungsten filament lamps introduced soon afterwards in 1907.

In the beginning, tungsten filaments were made by mixing finely divided tungsten powder with a binder and squirting the paste through a die producing a fine thread, the binder being removed by subsequent treatment. These lamps were fragile and oprated at an efficiency of over 7 lumens per watt. A process of producing ductile tungsten was discovered by Langmuir in 1911, with the result the process of manufacture was considerably simplified by making it possible to produce lamps with a fairly robust filament of a continuous, uniform, ductile, drawn tungsten wire.

GAS-FILLED TUNGSTEN FILAMENT LAMP

All the lamps so far described were made with their bulbs evacuated to produce as high a vacuum as was commercially possible. It was early realised that the useful life of a lamp was largely dependent on the blackening of the bulb due to evaporation of the tungsten filament, whilst the efficiency of the lamp depended on the operating temperature. The higher the filament temperature the greater is the efficiency attainable, but the evaporation of the filament rapidly increases and its mechanical strength decreases at the same time, thus reducing the life of the lamp. These two desiderata are, therefore, mutually contradictory and a compromise has to be effected by choosing a reasonable length of useful life consistent with as high an efficiency (or operating temperature) as possible. A useful life of 1000 hours is taken as the normal life period of an electric lamp employed for general lighting purposes and the filament is so chosen as to give this normal life at the highest efficiency practicable without undue blackenning of the bulb and weakening of the filament. Although the melting point of tungsten is as high as 3380°C, it was found that in the case of lamps operated in vacuum, the filament temperature could not be increased beyond a practical limit of about 2100°C to give the normal life of 1000 hours. To determine whether a further improvement in vacuum would result in an increase in efficiency and useful life of the lamp, Langmuir studied the effect of small traces of different gases. He found that a trace of water vapour was the most dangerous of all with disastrous consequences. Apparently, the water vapour was dissociated by the heat of the filament, the oxygen reacting with the tungsten of the filament to form tungsten oxide which deposited on the bulb. The hydrogen present reduced the oxide, leaving a deposit of metallic tungsten on the bulb and again forming water vapour which renewed its attack on the filament. This cycle of operations repeated itself resulting in a prematurely short life of the lamp. Langmuir found that the vacuum employed in commercially produced lamps was good enough for all practical purposes and that further increase in vacuum did not materially affect the life. Therefore, he concluded that any further improvement in qualities could be possible only by reducing the evaporation of the filament.

Now, a filament at high temperatures evaporates gradually just as water in a dish evaporates at room temperture. The molecules of water are in constant motion and those moving with a sufficiently high velocity to overcome the forces due to the surface tension of the liquid escape out of the liquid into the space above. If there is vacuum above the surface, there is nothing external to prevent the escape of the water molecules and evaporation under these conditions is more rapid than it otherwise can be. This more or less corresponds to the conditions existent in a vacuum tungsten lamp. If the dish of water is in air or other gas, the molecules of the latter tend to prevent the emergence of the water molecules from the surface of the liquid and so lessen its rate of evaporation. The same might be expected if the bulb of a tungsten lamp were filled at a sufficiently high pressure with an inert gas which does not chemically react with the filament. The idea was not a new one and Edison in fact patented it in 1883 and tried to produce carbon filament lamps filled with nitrogen. His attempts, however, ended in failure, as so much heat was lost by convection through the gas that very little light could be obtained. For, while with a vacuum lamp the only loss of energy is by radiation from the hot filament and conduction through the filament supports, in the case of a lamp filled with an inert gas as above energy is also wasted by conduction and convection through the gas. The problem that confronted Langmuir in 1913 was to find out if the additional loss of energy in the latter case could be more than compensated by the effect of reduced evaporation of the filament, which, for the same life, would allow the filament to be run at a higher temperature.

The amount of heat carried away from a hot body surrounded by a gas depends on the surface area, but with a thin filament the idea requires modification. It was shown by Langmuir that any hot body in a gas is surrounded by a stagnant layer of the gas through which transference of heat takes place mainly by a process of conduction to its outer surface and thereafter by convection through the gas. It is, therefore, the surface area of this stagnant layer of gas surrounding the hot body and not that of the body itself which determines the total heat

loss. Now, for a thin filament, the thickness of this stagnant layer, which is independent of the diameter of the filament, is very great compared with the diameter of the filament for the usual sizes of lamps, with the result that the advantages of a higher operating temperature possible in the presence of a gas are more than offset by the increased convection losses. The use of a thick filament is not always practicable as it is suitable for only large currents, but it was found by Langmuir that a thin filament coiled into a close spiral behaves for all practical purposes, as far as convection losses are concerned, almost like a solid filament of the same diameter as the coil, while the spiral shape of the filament allows the wire to be of sufficient length to give the necessary electrical resistance. Another obvious advantage gained by coiling the filament is by considerably reducing the surface area exposed to the direct influence of the surrounding gas than would otherwise be the case with a straight filament, and this also helps to reduce the heat losses. It is, therefore, possible by this means to cut down the evaporation and also obtain the higher efficiency due to the higher filament temperature. This, in brief, is the principle of the gas-filled lamp. It may be remarked here that at the same operating temperature, a vacuum lamp is more efficient than a gas-filled one on account of the greater energy losses with the latter, although its general increased efficiency over the former is made possible, as explained above, by virtue of the higher filament temperature at which it could be run in the presence of the gas.

The first gas-filled lamp to be placed in the market in 1913 was a lamp of 1000-watt size, manufactured with a tightly coiled tungsten filament and using nitrogen at approximately atmospheric pressure. Later experience led to the manufacture of gas-filled lamps of lower wattages. It was, however, found that in the case of the lowest wattages, *viz.*, 25 watts and below, there was no gain in efficiency at the temperatures at which they could be run even in the presence of a gas, so that, even today, lamps of these wattages are generally made with vacuum.

THE COILED COIL FILAMENT LAMP

In the production of the 'coiled coil' filament lamp, introduced into the market in more recent years, the same principles, as are outlined above with regard to the manufacture of the ordinary gas-filled single coil filament lamp, are further extended to obtain even higher operating temperatures and consequently higher efficiencies in the case of the common sizs, *viz.*, 40, 60, 75 and 100 watt lamps. The coiled coil lamps are invariably of the gas-filled type and the filament in this case is formed by further coiling into a spiral the already once coiled filament as is shown in the sketch below, which shows the appearance of the straight, the single coil and the coiled coil types of filament shapes.

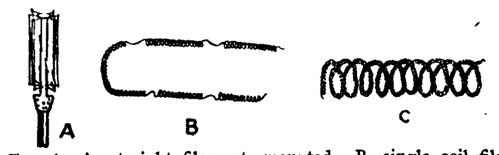

FIG. 1. A—straight filament, mounted. B—single coil filament. The open spaces are for attachment to supports. C—coiled coil filament, more modified than the former.

For lamps of wattages higher than those mentioned above (*i.e.*, above 100 watts), it has been, however, found that the coiled coil shape offers no appreciable gain in efficiency and hence lamps of sizes larger than 100 watts continue to be manufactured in the single coil shape. The following table shows the nominal lumens of lamps of four different ratings with both single coil and coiled coil filaments and the percentage increase of the latter over the former. It will be seen that there is a marked decrease in this percentage difference between the two types as the wattage increases.

Rating of lamp	Nominal Lumens		Percentage excess in lumens of coiled coil over single coil lamp
	single coil filament	coiled coil filament	
230V, 40W ..	345	415	20·3
,, , 60W ..	610	700	14·8
,, , 75W ..	820	930	13·4
,, , 100W ..	1210	1340	10·7

The following table shows the development of the incandescent electric lamp from the point of view of its efficiency:

Lamp.	Approximate watts	Approximate efficiency in lumens per watt
Edison's first incandescent lamp	...	1·4
Carbonized bamboo filament	...	1·6
Squirted cellulose filament, carbonized and treated ...	...	3·3
GEM or metallized carbon filament	60	4·2
Nernst lamp	...	5·0
Osmium lamp	60	5·9
Tantallum lamp	60	5·0
Pressed tungsten filament in vacuum	60	7·8
Drawn tungsten filament in vacuum	60	10·0
Drawn tungsten filament in gas	60—1500	10·5 to 21·5

VARIOUS ASPECTS OF MANUFACTURE OF A LAMP

Perhaps it will not be out of place here if a brief mention is made of the remaining aspects of the manufacture of an electric lamp. In the case of the gas-filled lamp, it is very necessary that the right gas should be chosen. It should be absolutely inactive, should have low specific heat and low normal conductivity and should have little tendency for an electrical discharge to take place. Argon and nitrogen are the two gases most commonly used in view of the above considerations. For all but the largest sizes, argon, mixed with a little nitrogen, is used, as, argon being a heavier gas, comparatively less heat is lost. Nitrogen is, however, added to lessen the tendency for electrical discharge to take place at the higher voltages. In the largest sizes, argon possesses no marked advantage in efficiency over nitrogen. But as the latter has a tendency to react with tungsten, even for these sizes argon-nitrogen mixture is preferred in spite of the increased cost.

Evacuation.—The degree of evacuation of the bulb necessary in the case of the vacuum lamps is 0·0001 m.m. of mercury; and on a mass scale it is not easy to pump to this stage by mechanical means. If the pressure is higher (between pressures of about 0·005 and 1 m.m. of mercury), destructive discharge may take place within the bulb. The requisite degree of high vacuum is, therefore, produced in practice by means of a 'getter', which consists of a coating of red phosphorus mixed with a binder and an additional material like cryolite or aether fluoride. After the preliminary evacuation of the bulb, which is kept heated during the pumping process to about 400°C so as to remove the occluded gases, the 'clean up' operation is carried out. During this operation, the 'getter' is flashed by placing the lamp in series with a resistance and applying 90% of the rated voltage so as to slowly heat the filament to a fairly low temperature to volatilize the phosphorus and then to a higher temperature at 110% of the rated voltage. By this means the remaining gases are arrested and mechanically held between the inside surface of the bulb and the very thin film of phosphorus formed over it in the 'gettering' process. The function of the additional material, cryolite, used in the 'getter', is to keep the phosphorus film as transparent as possible. The lamp is finally burnt at 110% rated voltage for a short time to bring the filament into a steady condition.

In the case of the gas-filled lamp, neither the 'getter' action nor the 'clean up' method is of any use because of the gaseous atmosphere present. The bulb is evacuated to as high a vacuum as possible with all the glass parts heated to a high temperature, and then the bulb is washed several times with *pure, dry* nitrogen before finally admitting the gas. As has been mentioned earlier, it is very essential that both the nitrogen and the gas used should be absolutely free from oxygen and water vapour. Phosphorus is frequently used as it can chemically combine with any traces of oxygen.

Lead-in Wires.—For the lead-in wires to conduct the electric current to the filament, platinum was first employed as it has got practically the same coefficient of expansion as glass, but later on it was replaced by a nickel-iron alloy, copper coated and subsequently sheathed in platinum, so that the amount of platinum used was reduced to a minimum. Even this was in more recent times given up in favour of the simple nickel-iron alloy, plated with copper and then covered with potassium borate. The composition of the alloy and the thickness of the copper coating are so arranged as to give the same coefficient of expansion as the glass. The borate coating is to allow the glass when melted to 'wet' the wire and make a gas-tight seal. The supporting wires for the filament are made of molybdenum (m.p. 2600°C) on account of its better mechanical properties than trungsten.

Glass.—For the bulbs a crown or lime soda glass is employed because of its shorter working range of temperature, but for the internal parts lead-glass is used, as soda-glass becomes partially conducting at higher temperatures liberating by ionization enough quantity of sodium to upset the proper working of the lamp.

Filaments.—The choice of the proper size of filament for a lamp of any particular rating is guided by many considerations. The current through a filament and its operating temperature are dependent upon its diameter. The larger the diameter of the filament the greater can be the operating temperature, as more of the filament material can be permitted to evaporate before the filament fails, and as has been mentioned earlier, a filament can be run at a higher temperature in a gas than in a vacuum. Now, for a lamp of a given rating, the resistance is fixed, but there are innumerable sizes of filament of varying diameters and lengths which can have the same resistance, which, moreover, depends on the temperature. In fixing upon a suitable size, consideration must be taken of the various energy losses, the operating temperature, the filament shape and the evaporation permissible under these circumstances. For a 240 volt, 60 watt., gas-filled lamp, for example, the diameter of the filament wire is 0·030 m.m., its length is 900 m.m. approximately, the spiral length is 56 m.m. and the diameter of spiral about 0·21 m.m.

DESIGN OF LAMPS

The resistance R of a lamp rated at V volts and W watts is $\frac{V^2}{W}$ . . . . . (1)

Of the energy W supplied to the lamp, part of it, W_r, is dissipated by radiation, while part of it is lost by conduction and conviction losses ;

$$i.e., \; W = W_r + \text{losses} \quad . \; . \; . \; . \; (2)$$

For a vacuum lamp with straight filament, the losses due to conduction through the filament leads and supports have been found to be about 7% of the input, whereas for a gas-filled lamp with coiled filament these losses amount to about 3%. In the latter case there are in addition the convection losses which are observed* to depend upon the wattage of the lamp , being, for instance, about 8% for a 100-watt lamp and 15% for a 200-watt lamp.

If J represents the watts. radiated per sq. cm. of filament surface at an operating temperament, then the necessary area, A, of filament surface is given by

$A = \frac{W_r}{J} = \pi d l$ . . (3), where d is the diameter and l is the length of the filament, and

$R = S. \frac{4l}{\pi d^2}$ . . . (4), S being the specific resistance of tungsten at temperature T.

$$\therefore \; d = \sqrt[3]{0{\cdot}405 \times \frac{S.W_r}{J.R}} \quad . \; . \; . \; . \; . \; . \; . \; . \; (5)$$

$$\text{and } l = \frac{A}{\pi d} = \frac{W_r}{J.\pi d} \quad . \; . \; . \; . \; . \; . \; . \; . \; (6)$$

Equations (5) and (6) uniquely determine the size of the filament. If D is the density of tungsten (19·3 gm./cc.), the mass of the filament is D. $\frac{\pi l d^2}{4}$ or 19·3 $\frac{\pi l d^2}{4}$ gm. . . (7) ; and the mass of filament evaporated during 1000 hours of normal life is

$$1000 \times 3600 \times \pi d l q = 1{\cdot}13 \times 10^7 d l q \text{ gm} \quad . \; . \; . \; . \; (8)$$

where q is the quantity of tungsten in gm. evaporated from 1 sq. c.m. of surface at temperature T. The percentage of tungsten that can be allowed to evaporate so as to give the normal life of 1000 hours depends, besides other factors, upon the uniformity of the wire. From the above considerations the maximum operating temperature that will allow of this percentage of evaporation of the filament can, therefore, be fixed and the design of the lamp settled upon.

The following sketch gives the different stages in the manufacture of an electric lamp and is self-explanatory.

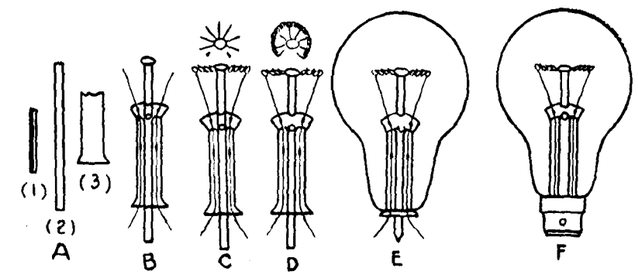

FIG. 2. A—glass rod, exhaust tube and flanged tube. B—parts shown in A are sealed in with the lead-in wires in place. C—molybdenum support wires are put in and bent to shape. D—filament is placed in position. E—glass bulb is put on and sealed in and exhausted (or filled with gas as the case may be) and exhaust tube sealed off. F—finished lamp with cap.

LAMP TESTING

Electric lamps are generally tested to the requirements of standard specifications drafted for the purpose, and comprise, besides the visual examination of the bulb, the checking of

(*a*) the leading dimensions of the lamp,

(*b*) the insulation resistance between the cap and one of the filament contact plates (in the case of bayonet cap lamps only), and

(*c*) the strength of attachment of the cap to the bulb as determined by its ability to withstand a certain amount of torque applied.

* Forsythe and Watson : *Jour. Frank. Inst.*, *213*, 630, 1932.

The tests also include the determination of

(*d*) the initial performance characteristics of the lamp, and

(*e*) the complete life tests.

The life tests consist in carrying out the actual burning test for 1000 hours and the determination of the average efficiency of the lamp during life so as to check that there is no undue drop in efficiency during life. The most important factor that affects the life of the lamp is the voltage at which it is burnt, for, a 1% rise in its value affects the life adversely to the extent of nearly 13 to 14%; and it is, therefore, very important that the test voltage should be maintained very constant during the entire course of any reliable life tests. The following curves indicate the life-test performance of an electric lamp.

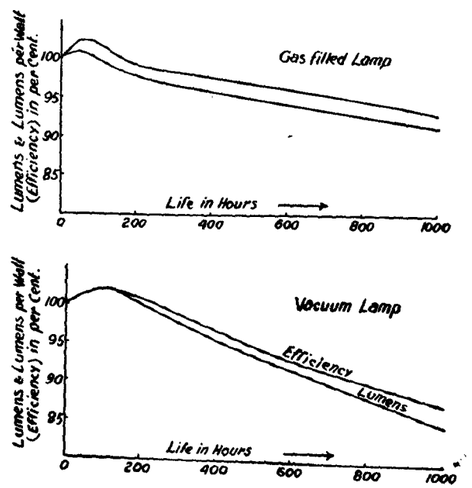

FIG. 3.

SELECTION OF LAMPS FOR USE

Having outlined the principles underlying the design, manufacture and testing of a metal filament electric lamp, it may not be altogether out of place to give a few useful hints on the choice of an electric lamp for general lighting purposes. In the first place, it is always wiser and cheaper in the long run to buy a lamp of reliable make and proved performance. In 25 watt. and lower sizes only vacuum lamps are available, while in the 40 watt. size both vacuum add gas-filled types and among the latter both single coil and coiled coil filament shapes are manufactured. As between the vacuum and the gas-filled single coil filament types, there is no difference in efficiencies although there is some difference in the colour of the light emitted, that with a vacuum lamp being a little yellowish in tint whereas with a gas-filled one it is 'whiter' and hence perhaps of more pleasing appearance. This difference in colour is, as has been mentioned before, due to the fact that, for the same efficiency, the gas-filled has to be run at a higher filament temperature than a vacuum one on account of the additional losses in the former. And, as between coiled coil and single coil filament lamps of the same rating—this applies equally well to the higher wattage lamps—, one should certainly prefer going in for a coiled coil filament lamp, as it gives more luminous output for the same power input.

When selecting the nature of the bulbs, the choice for most purposes should unhesitatingly be in favour of the pearl or internally frosted bulb rather than the clear one, as, while there is no difference in cost, the former gives a far more pleasant appearance due to the diffusing effect of the bulbs and avoidance of any harsh shadows due to the naked filament. The opal bulb is even better in this respect, but there is about 10% loss of light due to absorption by the glass, whereas with a pearl bulb the absorption is almost negligible, being only about 1·5%. Moreover, lamps with opal bulbs are slightly more costly. But in cases where opal glass or other shades are used to completely enclose the bulb, a lamp with clear glass bulb offers the best advantage. Sometimes, for special daylight effects or on account of the soothing effect to the senses and pleasing appearance of objects, the so-called 'day-light' lamp, manufactured with a special blue glass bulb which suppresses some of the yellow radiations, is employed. There is, however, in this case a loss of about 35% of the light due to absorption by the glass bulb and one would acquire a day-light lamp of 60 watts where one of 40 watts of clear or pearl glass would suffice, or one of 300 watts to give the same amounts of light as a lamp of 200 watts of clear bulb. But this particular type has got its special uses, for example, in shop windows, in photographic studios or for any other particular purpose where colour contrasts are to be properly appreciated or its special effects are an advantage. It has also been found by practical tests on a number of observers that, even for ordinary reading purposes, a 60 watt daylight lamp, for instance, has been found to be more conducive to better and easier reading and more generally liked than a 60 watt lamp with clear bulb, in spite of the fact that the latter gives nearly 50% more light than the former.

INDIAN LAMP INDUSTRY

The lamp industry in this country is of comparatively recent origin, in fact, less than a decade

old and as yet undeveloped in all its aspects. Most of the factories were started under the wrong impression that one has only to import the different parts from abroad and assemble them in India. One should not however forget that assembling the different parts of an electric lamp is altogether a different thing from assembling those of, say, a motor car. The manufacture of the parts of a motor car means practically the making of the car itself. But the technique of making a lamp has very little in common with that necessary for making the filament, glass, cap, electrodes etc. This false notion regarding assemblage was responsible for the failure on the part of the organizers to realize the importance of engaging the services of qualified persons in the industry. The consequence was disastrous for many of the Indian lamp making concerns. The foot—the mount for the filament—for instance, is an assembly of two different glass tubes, one glass rod and two electrodes ; it is a very delicate thing though appears to be simple. Most of the lamp failures in early days of the industry in India were due to a lack of appreciation of the improvement attainable by proper heat treatment of these glass and metal joints. The same thing can be said of the mass production of vacuum and treatment of the gas used for gas-filled lamps; the mere possession of good vacuum pumps or cylinders of argon gas is not enough. Both the processes should be carried out with care and understanding if one wants to produce lamps with good light and life. The tungsten wire is another important thing on which depends the life of an electric lamp to a very great extent. Unfortunately, the Indian manufacturers have no control over it and the situation has become still worse after the present war has broken out. No attempt is being made in India even to check the quality of this important item, leaving aside the question of manufacturing the same. This branch of the powder metallurgy is perhaps the most difficult of all, the control of the size of the grains and their orientation requiring insight and specialized knowledge. The highly increased efficiency of the present-day foreign lamps, both singly and doubly coiled is dependent on these factors. The services of experienced metallurgists, engineers, physicists and chemists are necessary for converting the impure ores, of which there are huge stocks in Burma and China, into wires of quality. But to maintain the production during war times and to compete with the foreign products when the international situation becomes normal, the Indian lamp industry will have to make its own filaments. It does not, perhaps, lie within the financial possibilities of the individual manufacturers to undertake the work; but they can form into a ring like their western brethren and shoulder the responsibility jointly. The technique of filament making has been developed by the lamp manufacturers in Europe and America and the parties, who supply this important article to the Indian market, which has limited experience of lamp making, are not likely to produce wires of the very best type and when the competition will be keen, an indirect pressure may be brought to bear upon them not to send the same here. For these various reasons, it is imperative that filament-making is started in India, and the sooner it is done, the better. It is a good sign that a few of the lamp making concerns, of late, started producing some of the parts *viz.*, the glass bulbs, the cap and the cement that binds the cap to the bulb.

There is ample scope for development in the field, not only in the methods of manufacture of many types of lamps which are not yet produced in India, but also in producing within the country all the different individual parts that constitute the finished lamp. The following statistics clearly show the enormous sums of money that continue to flow out of the country for the imports of different types of electric lamps, and forcibly indicate the need and the direction for future development.

Types of lamps.	1935-36		1939-40	
	Number of lamps imported	Their value in rupees	Number of lamps imported	Their value in rupees
1. Gas-filled lamps	2,398,095	19,42,948	1,539,951	12,40,756
2. Vacuum lamps ..	9,271,998	16,58,365	9,532,907	10,38,215
3. Automobile lamps	1,205,027	1,02,079	805,345	95,230
4. Electric bulbs for torch lights ..	12,012,182	2,84,284	12,312,046	2,59,038
Totals ..	24,887,302	39,87,676	24,190,249	26,33,239

Our lamp industry is still in a nascent state. There is ample scope for development, and development should be along right lines. With the ever increasing markets for electrical goods in general and electric lamps in particular with the growth of electrical installations in this country, the lamp industry has a glorious future before it with the right men of vision and foresight at the helm of affairs. Properly qualified and trained personnel are an asset to the industry which cannot be over emphasized, and quality, but not cheapness at the expense of quality, should be the guiding factor in production, and it is worth while remembering by the producer of today as also of the future that quality of product creates confidence in the mind of the user and forms the most stable and surest basis for the growth and prosperity of the industry.

MEDICINE & PUBLIC HEALTH

EFFECT OF EVACUATION AND OF AIR RAIDS ON CHILDREN

SOME interesting studies have already been conducted in England with regard to the effects of evacuation and of air raids on the child population of certain areas.

Psychologists who have carried out these studies are of the opinion that exposure to even a single "harmless" air raid can do great damage to a child's psyche, be he ever so "normal" and "fearless" on the surface. It has been noted that "previously good and intelligent children become suddenly obstreperous, destructive, mischievous, lazy, truant from school, and, in short, unmanageable in the billet to which they have been evacuated". One of the frequent symptoms is the inability to engage in any work during leisure. They are at a loss to know what to do themselves, and seem to fear the responsibility of making any decision. They fail to show perseverance with any playful enterprise and soon begin to prove a nuisance to themselves and to others. The Rorschach test, which gives essentially a personality picture, has been positive in 65% of the observed cases. The effects are more pronounced when evacuation is added to the bombing of air raids. It has been noted that emotional difficulties have been either started or made worse as a result of evacuation. In a large number of cases anxiety syndrome, general nervousness, enuresis, stammering, pilfering, truancy, sleep wailing, accompanied by anxiety and other dreams, which are evidences of mental disturbance develop.

It has been noted that the immediate effect of evacuation, which is separation from parents and from a known and accepted environment, is worse than the immediate effect of raiding. The prognosis seems to be good for cases not complicated by neurotic trends. Removed from the billet, where the problem of "what to do in my free time" creates the main trouble, they tend to become better pupils in a hostel or residential school. Psychotherapeutic interference is unnecessary, and the routine and discipline of a happy life among other boys remove very soon all strain from off their minds.

It is interesting to know that deaths due to air raids have fallen less heavily on children aged 5-15 years than on any other group, largely due to their evacuation.

Let us take a leaf out of these experiences to meet the air raid menace in India.

FOOD AND HEALTH IN WAR-TIME BRITAIN

THE chief medical officer at the Ministry of Health thinks that the health prospects in Britain for the coming year are "extremely good", and Lord Woolton thinks that at the end of this war, unlike the last, the physique of the children there will not only be preserved but also be improved. It is gratifying to note that the public health service and the medical profession are at the head and centre of British effort for civil defence. The prevention of illness and accidents not only among the civil population but in industry, particularly war industries, are given adequate importance. Good results are reported with regard to the protection of the children by immunizing them against diphtheria. Health in A. R. P. shelters is receiving special attention.

In connection with food rationing in Britain, a large amount of research work is being conducted with a view to conserving the health of the nation. For instance, investigations at the Lister Institute in London have shown that the proteins of wholemeal flour show a distinct superiority over those of white flour. It has been shown that the addition of a 2½% of a type of yeast known as *Tolura utilis* to white flour renders the latter as rich a source of vitamin B complex as wholemeal flour and that even twice this amount of yeast does not seriously affect the palatability of white or of wholemeal. It has also been shown that the protein of this yeast is comparable with such a first-class protein as casein in supplementing proteins of low biological

value (*i.e.*, which lack certain of the essential amino acids).

It has also been shown that immature onions are far richer in calcium, iron and vitamins A and C than mature onions. Crystalline vitamins, if they are to be taken, must be used as a supplement to a good diet, as there is something in a good diet which cannot be supplied by any combination of crystalline vitamins or vitamin concentrates.

It is interesting to note that the total supplies of food which are being obtained from the United States under the Lend-Lease Act constitute only 5-6% of the total consumption of home-grown and other imported food, but the foods imported from U. S. A. include concentrated proteins, such as cheese, canned milk, dried milk, eggs, canned fish, and canned meat. As a result of efforts at conservation of foods, less protein and less oil and fat are now finding their way into kitchen waste, as actual analysis carried out in 1941 show that it contains more mineral matter, fibre and carbohydrate but less protein and only half as much oil and fat as in 1940.

Good use is being made of the 350 hot meal vans which Mr Henry Ford and his son, Mr Edsell Ford, have presented to England to bring hot food to people in their homes where the supply services have been cut off, or to bombed out people, war workers, agricultural workers and evacuated children who have difficulty in obtaining hot meals. Each of these vans can carry soup for 800 people, or stew and potatoes for 400 people, and keep them hot for several hours.

HEALTH DRIVE IN U. S. A.

SURGEON-GENERAL Parran of the U. S. Public Health Service estimates that poor nutrition alone accounts for one-third of all rejections for the Services and that dental disabilities among recruits, most of which is preventable and remediable, have been found to be far commoner than they were in 1917-18. He thinks that the conservation of man power and the prevention of its wastage through medical and public health measures is of national importance. He estimates that the time lost through illness and accidents in industry is equivalent to the loss of labour of 1,000,000 men working for a full 12 months and that a reduction of only 10% of this loss would save man power enough to build 5 battleships or 16,407 combat tanks.

He feels it urgent (*i*) to develop means of dealing with the health problems created by sudden movements of large masses of troops and civilians from one area to another ; (*ii*) to ensure an adequate and continuous supply of doctors and to utilise to the best those available ; (*iii*) to secure an adequte nation-wide planning and rationing of all medical resources, bearing in mind that in a total war the health of the civilian population is of equal importance to that of the armed forces ; and (*iv*) to maintain an energetic pursuit of research work directed towards the solution of health problems of prime importance in relation to national defence.

He thinks that fundamentally the problem of this ill-health among young Americans will be solved only by putting all available knowledge to work for the benefit of the nation, that the U. S. Government should offer or, if necessary, require corrective treatment, where needed, for the vast reservoirs of manpower unavailable for the armed services, and that, in particular, the nutrition of the nation should be raised by each and every means, the judgment of success to be judged by the standard of national potentialities in food, technical facilities and scientific development.

Are we thinking along these lines in India at the present moment?

DEFECTS OF HEARING IN CHILDREN

A SURVEY of hearing of children in Edinburgh schools which was begun in 1937 and interrupted by the outbreak of war has recently been resumed and completed. All primary schools were covered. Tests were carried out with an electric gramophone audiometer. Out of 2,000 children tested in 1937, 9% were found to have defects, in 2% of whom the defect was sufficiently serious to cause marked educational retardation and to necessitate either part-time or whole-time instruction in special classes. It has further been reported that (*i*) the examination revealed three times the number of defective children than what was known to the teachers, (*ii*) only 50% of children with defects sufficiently serious to interfere with education were suspected by teachers as being so afflicted, and that (*iii*) among children regarded by teachers as being the slowest pupils in their classes, the incidence of hearing defect was double that among the school population as a whole.

In view of the extent of the problem and the importance of early diagnosis, the Edinburgh Education Committee have instituted a routine hearing test for all children at the age of 8 years and has arranged for the appointment of teachers for the special care of the defectives.

RESTRICTED USE OF DRUGS

A NOTE from the Director-General of Indian Medical Service states that owing to the extreme

difficulty in obtaining supplies of cocainea hydrochloridum it is imperative that stocks in hand should be conserved to the utmost possible extent. This drug is imported in the crude state from South America to the United Kingdom where it is refined and then despatched overseas. The purchase of cocaine involves therefore much foreign exchange and shipping space. Similarly for atropinae sulphas, stocks should be conserved and as far as possible its use should be restricted to opthalmic practice and replaced by tinctura belladonnae B.P., wherever practicable.

The Pharmacy Act, Pharmaceutical Education and Profession of Pharmacy*

K. N. BAGCHI

Chemical Examiner to the Government of Bengal, Medical College, Calcutta

The Indian Pharmaceutical Association which has organised the All-India Pharmaceutical Conference stands for the science and profession of pharmacy but unfortunately no serious attempts have yet been made to develop either the science or the profession to a stage comparable to that prevailing in the West. There is no systematic arrangement for an organised teaching of this science in India except that obtainable at the Benares Hindu University which is certainly the pioneer in this direction. The pharmaceutical industry has, of late, been making rapid headway in this country, particularly in Bengal, but there are very few competent pharmaceutical chemists to run the industry. The medical schools and colleges are multiplying in number and turning out quite a large number of medical men every year, many of whom take, though contrary to the codes of medical ethics, to the trade of chemists and druggists, but there is no arrangement for producing qualified pharmacists to save people from the effects of the dangerous practice of employing unqualified dispensers. Since an efficient system of teaching of pharmacy and the development of this profession go hand in hand, it is the first and foremost duty of the Pharmaceutical Association to exert all its influence in having well-equipped pharmaceutical institutions or colleges of pharmacy established in each province.

In our country the government have afforded facilities for the growth of pharmaceutical industry and equipped medical schools and colleges for adequate training in the medical science but has not yet provided any suitable machinery to ensure that the drug which the doctor prescribes is correctly manufactured and accurately dispensed for the benefit of the patients. The Drugs Act, passed in 1940, if given effect to, will provide only a portion of the machinery, the other portion of the machinery being the Pharmacy Act. The successful administration of these Acts requires competent pharmaceutical chemists to manufacture and standardise the drugs, and qualified pharmacists to dispense the prescribed medicines correctly and scientifically. The production of these two classes of men implies an organised system of teaching on up to date lines in well-equipped and well-staffed colleges of pharmacy.

ORGANISED PHARMACEUTICAL TRAINING AND RESEARCH

By a college of pharmacy it is meant a first class institution for imparting pharmaceutical education in all its stages with a post-graduate course and wide scope for research. There are innumerable herbs in our country and quite a large number of them are used in indigenous systems of medicine as efficacious therapeutic agents, and some of them are recommended even by those who are adepts in the western systems of medicine. Some work has undoubtedly been done to find out their active principles and pharmacological action but considering the magnitude of the work necessary in this direction, what has been done so far is only the proverbial drop in the ocean. The faith of common people in indigenous herbs, no matter whether they have at all been scientifically studied or not, appears to be on the increase. Poverty of the people, expensiveness of the modern systems of treatment and easy approachability of the quacks are perhaps contributing to this trend of mind. It is noticed that quite a large number of pharmaceutical firms in Bengal have taken to manufacturing tinctures and liquid extracts from common herbs without caring to investigate if such preparations actually contain any active principles or possess the therapeutic properties usually attributed to them. For such investigations large research laboratories located in an atmosphere of chemistry for continuous and steady research on a large scale are required. A college of phrmacy with suitable staff and accommodation would be an ideal institution for such work. It will not only help the pharmaceutical industry but would also be an incentive to students of pharmaceutics to take up research work in their post-graduate stage. A modern scientific teaching institution without adequate facilities for research is a misnomer. It will produce only routine workers and technicians who will not be able to take any active part in the industrial regeneration of the country. The question of appointing teachers in pharmaceutical chemistry with experience in research is of supreme importance. We do not want teachers just to help the students to pass examinations. The country requires intensive research in every direction. The pharmaceutical industry is in its infancy in this country and at this stage competent teachers to produce research workers in large numbers are required so that the industry may develop on proper lines and take advantage of the indigenous resources and talents.

The proposed College of Pharmacy in Calcutta, if properly staffed and equipped, is likely to prove to be an ideal institution of its kind in India. It should be provided with laboratories for post graduate training and research with a herbarium of all medicinal plants scientifically arranged for observation and study by the students not only of this college but also of other institutions including those teaching the indigenous systems of medicine, and lastly with a library and museum for the benefit of the students as well as the public interested in this science. The fact that the provision of a museum in a scientific institution specially connected, directly or indirectly, with medicine is an important adjunct to education, is very seldom realised by the educationists of this country. There is no up-to-date public health museum attached to any of the medical colleges in India. There is no forensic museum to help in the teaching of forensic medicine which is an important subject in the medical curriculum. Some of the poisonous plants which grow practically all over the country and are of considerable medicolegal importance, are never shown to the students and cannot therefore be identified by them although they manage to commit to memory all about their descriptions from text books. The plant *Plumbago rosea or zeylanica* (*Chitra*) is one of such examples. It grows wild in Bengal and possibly in other provinces too but it will be no exaggeration to say that none of our students has ever seen it. One could see these things in the forensic museum of the University of Berlin but not in any of the laboratories of any of the Indian medical colleges. This is the state of things prevailing in our country and we shall, therefore, lay special stress on the utility of museums in our educational systems. It may be hoped that the authorities would see their way in making this new scientific institution in Calcutta complete by providing a herbarium, a museum and a library along with other necessities.

The incorporation of pharmaceutical chemistry as one of the subjects in the B.Sc. curriculum, or provision of an optional paper in pharmaceutics in the M.Sc. course, without taking steps for teaching all the subjects, particularly pharmacognosy, as has recently been done in certain Indian universities as a solution of the problem of imparting higher pharmaceutical education, is a move in the wrong direction. The importance of pharmacognosy, especially its practical side, appears to have not yet been realised in this country where adulteration of even the crude drugs is the feature of the day. These minor additions to the existing system of education as a plea for teaching pharmaceutics are simply patchworks which retard the progress in the right line. The scope of the science of pharmacy is so wide and it embraces so many subjects that nothing but an organised system of pharmaceutical education in its various stages, as in medicine or engineering, will be of any good to the country.

TRAINING OF PHARMACISTS AND THE PHARMACY ACT

The system of training of compounders, dispensers or pharmacists as they are called, as distinct from pharmaceutical chemists, is in a chaotic state—the kind of which is never found in any civilised country. The period of training varies from 6 months to 2 years. It is surprising that the Indian Medical Association, the custodian of both medical education and medical profession in India, which has

* Adapted from the author's presidential address at the Second All-India Pharmaceutical Conference, delivered at Baroda on January 2, 1942.

been working so admirably for the improvement of medical education, has not done anything tangible for the education of the pharmacists who are indissolubly connected with meeting the medical needs of the country. But it may be stated at the same time that attempts at establishing order out of this chaos are not likely to be successful if the Pharmacy Act is not passed and enforced either by the local governments or by the Government of India in order to standardise the training required for the pharmacists. In their report, the Drugs Enquiry Committee (1930-31) have stated that the "mere compounders who mechanically carry on the art of dispensing have neither the general education nor the special training to befit them for the efficient discharge of their responsible duties" and that "an investigation into the qualifications and training of those who carry on the onerous and arduous duties of a compounder tells a sad tale. No definite and uniform standard of training and qualifications is enjoined by the State in the different provinces of India. The whole system is in a state of chaos." In this advanced age of systematisation and method, the lack of imparting a systematised course of training to this class of men accounts for serious accidents involving loss of life. Some elementary knowledge in chemistry and toxicology which forms part of the modern scientific training for these men, would prevent them from supplying medicines which have been known to cause death to unfortunate patients. It is high time, therefore, that the Indian Pharmaceutical Association should come forward and create a public opinion both against the disreputble condition of a profession so ruthlessly exposed by the Chopra Committee, and, also in favour of an early introduction of the Pharmacy Act of an all-India character without which no uniformity in training can be expected.

The Pharmacy Act which should have found its place in the Statute Book long before the Drugs Act was passed in 1940 has been put off indefinitely. This unusual procedure has been described by a European member of the legislative council as "putting the cart before the horse to introduce a Drug Bill first". In reply to the criticism on this unscientific procedure adopted by the Government of India, the Hon'ble Member for Education, Health and Lands, stated in one of his speeches made on the floor of the legislative council that "several provinces, for various reasons, had not expressed their readiness to meet or incur the expenditure involved in providing facilities for pharmaceutical education or in establishing the provincial pharmacy boards as recommended by the Drugs Enquiry Committee". He further stated that "the attitude which Government still maintained was that the profession of pharmacy should be regulated and that the co-operation of the Provincial Governments for that purpose should be obtained". The co-operation of the Provincial Governments being the condition precedent for the inauguration of the Pharmacy Act, it is the clear duty of the Indian Pharmaceutical Association to approach the provincial Governments and to impress upon them the necessity and importance of the Pharmacy Act.

NEED OF AN INDIAN PHARMACOPOEIA

The need of an Indian Pharmacopoeia, incorporating both the western and indigenous drugs, is stressed in many quarters, but it is of the utmost importance to decide what would be the scope of the Pharmacopoeia. Would it incorporate only those drugs which have been proved chemically, pharmacologically and therapeutically to be of real value? If this principle is accepted, it will lead to endless controversies, because there are numerous indigenous drugs which have not been tested scientifically but are none the less claimed by qualified medical practitioners to be of great therapeutic value. On the other hand, if the other principle, that is, inclusion of those drugs which are claimed or believed to be efficacious, is accepted, then we will have to compile something like the ancient pharmacopoeia of the Chinese consisting of 52 large volumes. In this connection the statement of the president of the United States Pharmacopoeial Convention is interesting. He says "The question which the framers of a Pharmacopoeia ask themselves is not, is this drug of value, but is there a demand for it by the medical profession? If 5000 doctors in the United States believed brick-dust to be a valuable remedy and habitually used it, brick-dust would have to go into the Pharmacopoeia. Witch-hazel is probably as active and as useful as is brick dust, but witch-hazel is a fad and is enormously called for, and witch-hazel must go into the pharmacopoeia. The Pharmacopoeia exists for the purpose of requiring the apothecary to give, in the first place, pure brick-dust or pure witch-hazel when asked for, and, in the second place, uniform preparations of these remedies."

The fact that a large number of changes are introduced in every new edition of various national pharmacopoeias, indicates that the opinion of the leading physicians of the country plays an important part in its compilation and thus lends support to the example of brick-dust quoted above. The concensus of opinion is in favour of the definition that pharmacopoeia is a book of standards. If this definition is accepted nothing but a feeling of helplessness awaits our decision. Have we worked out standards and

methods of assay for even the most widely known indigenous drugs in the same way as was done by the British Pharmacopoeia Committee? The nature of work required for compilation of a pharmacopoeia will be evident from the composition of the Pharmacopoeial Revision Committee of the U. S. A. which "consists of 15 clinical physicians, 2 serologists, 4 pharmacologists, 11 pharmacists, 15 pharmaceutical chemists and 4 botanists" or that of the United Kingdom for compilation of the British Pharmacopoeia of 1932 which also required services of a large number of clinicians, pharmacologists, pharmaceutical chemists, botanists etc. If such a personnel be the criterion of efficiency of a committee entrusted with the revision of a national pharmacopoeia, it may be partinently asked have we got a sufficient number of efficient pharmaceutical chemists, pharmacists and pharmacologists, and have we got the necessary accommodation in our existing laboratories to undertake the compilation of the Indian pharmacopoeia which is undoubtedly a much heavier task on account of a large amount of spade work to be done in connection with drugs and herbs of which we know nothing or worse still, know the wrong things? The problem is so complex and thorny that it is desirable to put it off for some time more till the country is provided with well-equipped colleges of pharmacy in most of the major provinces where the research workers would take up in earnest chemical and pharmacological investigations on all important indigenous drugs and work out standards and methods of assay and also their therapeutic value by experiments in hospitals under the guidance of sound clinicians. It may so happen that during the course of such investigations many really useful drugs will be discovered, the utility of which will later on be admitted internationally. Pharmacopoeias are undoubtedly national in their outlook but medicine and pharmacy are international and as such any drug of value is likely to find a universal acceptance.

PROFESSION OF PHARMACY AND THE INDIAN PHARMACEUTICAL ASSOCIATION

The Indian Pharmaceutical Association is an infant institution but is not a sturdy growth as it should have been. The reason is not far to seek. The absence of inter-provincial unity and agreement which is the stumbling block of all our movements is again standing in the way of attaining the avowed aims and objects of the Association. Notwithstanding, it will surmount all its initial difficulties and stand vindicated in the fullness of time. If one only looks at the Indian Medical Association and study the history of its growth we shall find the same state of things prevailing in its early stages but in spite of all sorts of difficulties it has raised its head high and occupied its rightful place to have its voice heard by all concerned. To emulate its example, the Indian Pharmaceutical Association must be ready to face the difficulties boldly and to extend the propaganda work all over the country with the help of selfless workers.

The Pharmaceutical Society of India, started in Madras several years ago, is the first organisation of its kind for the welfare of the profession of pharmacy. It is not known what is the actual cause that led them to confine their activities within the limits of that province but it may be presumed that the probable inter-provincial disagreement might have damped the ardour of its sponsors in approaching other provinces with requests to join hands with them and to make the Society a really all-India institution. It is here that the "Pharmacist", the organ of the Pharmaceutical Society of India, made its appearance with excellent prospects for its future and used to be published regularly. But unfortunately it showed in course of time signs of decay and death.

Bengal has also started the "Bengal Pharmaceutical Association" which is modest enough not to claim to be an all-India body. It has got its official organ in the "Indian and Eastern Chemist", a monthly journal with the finest get up, printed and published by a well known firm of printers and publishers of Calcutta. It is not published regularly for sometime past and one need not be surprised if it is consigned to the same fate which has overtaken the "Pharmacist" of Madras. A provincial pharmaceutical association cannot thrive and function properly with its limited scope and membership at the present stage of development of the profession of pharmacy in India. A pharmaceutical journal too, in order to be of any value and interest to the profession, must have contributors from all over India and must not be parochial in any way.

The U. P. Pharmaceutical Association was ushered into its existence in favourable environments and is run by a band of reliable workers on a scientific basis. Notwithstanding, its organisers have soon come to realise the utility and importance of an all-India association and have accordingly changed its name to "Indian Pharmaceutical Association" recruiting members from all over India. The official organ of this Association—the "Indian Journal of Pharmacy"—appears to have been thriving well, getting contributions from authors beyond the limits of the Benares Hindu University. It is high time that all provincial pharmaceutical associations joined the Indian Pharmaceutical Association

as its provincial branches and thus swell the list of members whose only interest should be the welfare of the Association. If the resources of all the provincial branches be pooled together and all the provincial journals merged in the Indian Journal of Pharmacy which would henceforth cater for the interest of all the provincial branches, then and then only the creation of an actual All-India Pharmaceutical Association and an All-India Journal of Pharmacy with a really representative character will be completed. The Indian Pharmaceutical Association, as it stands now, has not been recognised by the Government of India as "a proper organisation of the pharmaceutical profession" and if we go on in this way and do not stand united, our demand for representation in the statutory bodies either provincial or central, for betterment of the profession, education or the industry, however rightful it may appear, will fail to evoke any response.

The membership of the Association should be thrown open to men of all kinds of calling connected with the profession of pharmacy—directly or indirectly. It should not be restricted only to academic people and practical pharmacists but should be extended to those who are engaged in the pharmaceutical trade. A combination of both types of men will produce the desired result. The "bread and butter men" who think only of commercial interests, and the "philosophers" who think much of education and professional qualification must combine and this combination is sure to produce the best result as it has produced in the United Kingdom.

Quack Medicines and Advertisements

The trade in quack medicines and secret remedies constitutes a grave and widespread public danger. The existing law is inoperative and is incapable of checking this growing evil. The extraordinary development of the science of advertising has been the cause of disastrous consequences of self-medication, such as production of addiction, accidental poisoning, exacerbation of the disease, financial loss, etc. In the United States of America, in Continental countries and in the dominions of Australia and Canada "the exploitation of the people by means of proprietory medicines is forbidden" but there is no such law in the United Kingdom, the reason being attributed by Lord Horder to "strong forces of vested interests that stand in the way of any attempt at control." "The manufacturer, the advertising agent and the newspaper each have a big financial interest."

With a view to eliminate the so-called 'remedies' and 'cures' from the market a joint conference of the British Medical Association and British Pharmaceutical Association decided to prepare an approved list of the proprietory medicines but they had to abandon the proposal on financial grounds, in spite of the fact that they were having "constantly augmented flood of circulars (of proprietory medicines) delivered daily by post." What has, however, not been possible in the United Kingdom can be undertaken in this country with a fair chance of success, because, happily for us, neither the combination between the manufacturers and newspapers, nor the development of advertising agencies has yet reached that degree of perfection in this country as it has happened in the Western world. The flood of circulars not only influences the lay public but also affects the judgment of medical men. In the Annual Meeting (1939) of the British Medical Association, a member stated that there were good many doctors who "exhibited just as much suggestibility in this respect as the lay public and their number included consultants as well as general practitioners." The modern scientific methods of advertising take advantage of the inherent weakness of human nature and influences one's judgment in such a way that it is futile to depend simply on the good sense and judgment of the people, whatever their intelligence or position in the society may be. Nothing short of legislation will be of any good to any country for checking the indiscriminate use and unscrupulous advertising of drugs endangering public health. More dangerous are the indecent advertisements of secret remedies which appear in large numbers in most of our daily papers.

The Drugs Act of 1940, provides a section for misbranding drugs "by any statement, design or device which makes any false claim for the drug or which is false or misbranding in any particular", and also for restricting imports of "any drug which by any other means, purports or claims to cure or mitigate any such disease or ailment or to have any such other effects as may be prescribed", but it is doubtful if these clauses of the Drugs Act will be able to stop altogether the menace to national health. It may, however, be hoped that the Drugs Act will be given effect to in the provinces at an early date and the sections quoted above will be utilised to the fullest extent by the State to control this public evil as far as possible. Here again the Indian Pharmaceutical Association has got an important task of educating the public and at the same time bringing to the notice of Government the offenders, both foreign and indigenous, who are out to break the law.

BOOK REVIEW

The Problems of Education in Bengal—by P. C. Sinha. Published by Thacker Spink & Co., Ltd., Calcutta, 1941. Pp. 322.

This is a well-written brochure dealing with the problems of Secondary Education in Bengal from the days of the Education Act of 1837, the Government of India Resolution of 1844, the Wood Despatch of 1854, the Education Commission of 1882, the Indian Universities Act of 1904, the Sadler Commission of 1917, down to the Secondary Education Bill of 1940 which threw the entire educated world of Bengal into ferment: the author has tried to set out in interesting review the progress of English educational aims and methods through a century's groping effort and his analysis of the Sadler Commission's voluminous report is a conscientious and elaborate performance. Set over against this background is the aspiration of India and of Bengal to a more realistic and practical method irradiated by Indian ideals of comprehensive and tolerant culture. The magnificence of non-official educational effort has been displayed as against the paltriness and ideal-less-ness of the Governmental effort: the grandeur of Rabindranath's ideals and methods in the Santi Niketan University and of some of the great savants' ideas about Indian education has also been vividly brought out.

The author is a reformist and a chronicler. As a reformist chronicler, the author has done a distinct service to the cause. He has now and then digressed into the domains of political philosophy and dilated on problems of democracy, on the relation of the State to education, on the perils of a State-controlled education: some of these digressions are relevant, some occasionally mere digressions.

The author has also been liable to many repitions of the same ideas and of the same excerpts from Government documents in the course of his review: the style also is sometimes a little involved and cumbrous.

The author does not appear to have been able to set his problem with relation to the new needs and ideals that loom large owing to the emergence of a new world envisaged by new currents of thought and striving in the new world that is shaping before us. He has not been able to sense the freshness and buoyancy of the Gandhian ideals and methods as embodied in the Wardah scheme of non-violent and productive education nor does he appear to have grasped the vital methods employed by the totalitarian states based on the philosophy of force.

As a chronicle of the past, the book is a success: as a pointer to the future it is not much—but anyway the author has done the nation real service by pointing out the dangers and pitfalls of the now dead Secondary Education Bill of 1940.

Nripendra Chandra Banerji

A Study of Certain Indian Coals—by Mr. E. R. Gee. (Records of Geological Survey of India, Vol. LXXV, Professional Paper No. 11).

In the paper under review Mr E. R. Gee has given the result of research work carried out during 1937-38 at the fuel research laboratory of the department of fuel technology, Imperial College of Science, London. The specimens that were studied were mostly from the Lower Gondwana coals from Damodar Valley coalfields and included both the Barakar Measures and Raniganj Measures coals. The proximate analyses, ultimate analyses, calorific value determinations and coking tests of these coal samples were carried out in the laboratory by known standard methods and the results given in tabular form.

Washability tests were also carried out by the author in order to reduce the inorganic inert matter of the samples under investigation. From the result of the experiments the author concludes that on account of the inherent nature of the ash, the Gondwana coals of India are obviously very difficult to clean economically so as to yield a cleaned product containing less than ten per cent of ash and at the same time a relatively small proportion of residue high in mineral matter.

On comparing the results of these experiments with those obtained from many European coals it is found that none of the data obtained in the case of Indian coals can be regarded as very promising. The question of washability is a relative one and the fact

that a high standard of cleaning is economically possible in certain countries does not necessarily mean that a less efficient standard will not be practicable in another area. In discussing this question of cleaning of Indian coals one has to bear in mind that in a number of instances the coal has to be transported many hundreds of miles from the colliery to the factory or railway where it is consumed. The cost of transport may be more than double or even three to four times the cost of raw coal at the pit's mouth. Mr Gee has very well pointed out that if the ash content could be reduced to some extent a good saving per ton would thus be made in transport charges.

As India possesses a very limited reserve of high grade low-ash coals and as the huge deposits of low grade coals are not extensively worked on account of high ash content the question of washing and cleaning of high ash Indian coals appears therefore to be a very important one and proper attention of the coal industry should be given to this aspect of the problem so that better utilisation of the inferior grade coals may be effected.

The paper also includes comments on the applicability of Hilt's Law in the case of certain of the coals of the Raniganj field, on the lateral variations in composition of the seams of the area with particular reference to their carbon and oxygen contents, on the relationship between the oxygen and moisture contents of the seams and their caking propensities. The swelling property needs also careful examination and study. Though moisture content appears to have some influence in governing the caking propensities of coal the subject of coking is a very complicated one and is intimately connected with the nature and physical condition of the several complex organic constituents present in the coal substance. A more intensive and systematic work in this line should be carried out before any generalisation can be put forward. It seems that addition of powdered hematite was effective in improving the quality of coke but the author has not discussed the subject in detail nor has he mentioned anything about the corresponding increase of the ash percentage in the resultant coke.

N. N. Chatterjee

The Common Grasses of the United Provinces—by DR N. L. BOR. Published by the Manager of of Publications, Government of India, Delhi. (Indian Forest Records (New Series) Botany, Vol. II, No. 1.)

The publication embodies an illustrated account of 92 species of the commonest grasses of the United Provinces, with notes on their ecology and economic uses. The text of 222 pages is illustrated with numerous fine sketches contained in 64 plates. This work has been written, as noted in the foreword, at the request of the Forest Department of the United Provinces who wanted to have a handbook of the common grasses of the United Provinces in order to enable their forest officers to identify and have sufficient knowledge about the utility of the common grasses found in the forests, Taungyas and plantations of the province.

Non-technical as well as scientific descriptions of all the genera and the species and the two keys—one for the beginners and the other for the more advanced students of botany—will be helpful not only to the forest officers but also to the non-botanists in naming U. P. grasses dealt with in the volumes. In the introduction the author has very ably discussed in brief the occurrence of the different species of grasses under different ecological conditions. The grass-lands of U. P. also received his due attention. As an experienced forest officer and field botanist Dr Bor's comments on the problems of rotational and periodical grazing, introduction of exotic grasses and nature of different grass-lands in the province of U. P. give valuable information to those interested in the grasses of U. P. His hints on the practical study of grasses and dissections of the complicated parts of spikelets of the different species of grasses will be very helpful to the forest officers and botanists. The artificial but clear-cut dichotomous keys show that they have been prepared with sufficient care and accuracy. The scientific keys for the advanced systematists indicate his capacity for masterly treatment of the difficult family of Gramineae.

In drawing up the keys and notes on the tribes and the genera the author has adhered closely to his previous work on the grasses of Assam published in Vol. 5 of the *Flora of Assam*, 1940. In the appendix 40 species of grasses recorded in Hooker's *Flora of British India* have been mentioned indicating the recent changes in the names. This list will be of some help to the taxonomists in the study of grasses of the different parts of India. Dr Bor has delineated, as illustrated in the case of the common Sabai grass of U. P., the method of finding out the modern specific names corrected in the light of the latest International Rules of Botanical Nomenclature. The importance of adhering to the International Rules of Botanical Nomenclature has thus rightly been emphasized. It is expected that all systematists and taxonomists in India should follow the example set by Dr Bor. Index to the local names and the list of the important literature on agrostology of India are useful additions.

It may, however, be pointed out that the generic descriptions detached from the specific descriptions necessitated the author to repeat shorter generic descriptions for the genera having more than one species under them. This duplication of generic descriptions might have easily been avoided by describing the genera along with the species. Such a step would not have taken away the mind of the readers from the detailed descriptions of the genera under which the species have been described. The book would have been of considerable value to the Indian systematic botanists and taxonomists if it had contained the majority of the grass flora of a province like the United Provinces, which extends from the plains to the higher levels in the Himalayas and includes within it areas of varying climatic conditions. One feels also the absence in such a work of an index to all the specific names mentioned in the book.

In spite of such negligible failings in the work, the book under review has advanced our knowledge of the grasses of this part of India to a great extent. Such a work is a valuable supplement to the grass volume of the *Flora of British India* where both the genera as well as species of grasses require thorough overhauling with reference to our recent knowledge regarding the habitats and the systematic position of the Indian species of grasses and in the light of the important changes made in the nomenclature of the grass-flora of India. The excellent illustrations accompanying the book have been executed with great care and reproduced faithfully. Such illustrated works on the common grasses of other provinces in India will be welcome additions to the *Flora Indica*.

There are very few typographical mistakes and other errors in such an exhaustive work. The printing is quite good.

K. Biswas

The Travancore Tribes and Castes, Volume III : The Aborigines of Travancore—by L. A. KRISHNA IYER, M.A. Published by the Superintendent, Government Press, Trivandrum, 1941. Pages xxiii+176. Plates 61. One map and three charts.

Mr Krishna Iyer is to be congratulated for the production of this neat volume. So long the anthropologists knew little about the primitive tribes of Travancore who are of great theoretical interest owing to their sojourn in a peripheral area. The author, who has lived and moved with these tribes for over quarter of a century in connection with his duties as an officer of the Forest Department of the State, delineates the manners and customs of these simple folk of the forest, tribe by tribe, in the first two volumes of this work. In the present volume he has collected the more important and interesting facts scattered in the previous volumes and presents them in twelve chapters. He deals with their traditions of migrations and racial affinities. The author lays special stress on the existence of a Negrito strain among several tribes of the State, *e.g.*, Kanikkars Malapantarams, Uralis and Vishavans. Information on the material, social and religious life of the tribe are arranged in different chapters under suitable headings together with an account of the megalithic monuments of the State, especially those of Anjanad. In the last chapter the author discusses the effect of contact with civilized man on the life and culture of the primitive tribes of the State, and shows how they have suffered in every way. He urges revision of the rules drawn up by the Government of Travancore for the treatment and management of the hill tribes and recommends, among other things, the establishment of village councils, direct payment of rent to the Government, organization of credit societies, arrangement for marketing tribal produce, and transference of the primitive tribes to the charge of a trained anthropologist.

Mr Iyer has very ably collected and quoted the opinion of reputed anthropologists of different schools on the controversial topics raised by him and every section of his book unmistakably shows his wide study in the field of anthropology, biology and geography. But some of his assertions may not meet with the approval of all shades of opinion. Mr Iyer seems to be a little dogmatic when he states that shame "is a by-product of modern civilization" (p. 64), or "Clothing seems to have originated in the decorative impulse" (p. 64), or "The earliest form of marriage is marriage by capture" (p. 95), or "Marriage by service is an earlier form of marriage by purchase" (p. 96), or "When the savage passed from the hunting to the agricultural stage, patriarchy developed into matriarchy" (p. 120), or "Hinduism may be defined as animism more or less transformed by philosophy, or to condense it, as magic tempered by metaphysics." (p. 147). But these do not in the least affect the value of the facts which the author has so ably collected and marshalled in this work.

The book is profusely illustrated and has a good index. We hope it will be very useful to scholars and students alike.

T. C. Das

Indian Zoological Memoirs, VIII, *Hirudinaria* (The Indian Cattle-Leech)—by M. L. BHATIA. Published by Lucknow Publishing House, Lucknow, 1941. *Price Rs. 2/-.*

The memoir on the Indian cattle-leech is not only a useful and important contribution to the advancement of knowledge of the Hirudinea (Annelida), but is also of much help to the teachers and students for the study of this animal which is used as the type of this group in almost all the universities of India, Burma and Ceylon. Its publication adds greatly to the value of the excellent series of Indian Zoological Memoirs edited by Prof. K. N. Bahl of the Lucknow University. The description of the various systems is given in a lucid style and is illustrated with clear and instructive diagrams. The account of the coelom, the haemocoelic system and the excretory system may be marked out as the most outstanding part of this work, which shows much originality and thoroughness of study. The detailed account of the haemocoelic system given for the first time in this memoir leaves nothing to be desired. The course of circulation of the haemocoelic fluid as diagrammatically represented gives a clear idea as to how the various channels are interconnected, and how the fluid flows in a definite direction in them, so that there is a circulation and not a mere backward and forward movement. The three beautifully coloured figures of the haemocoelic system are a noteworthy feature.

The discovery that the ciliated organ in *Hirudinaria* consists of the central reservoir with numerous perforations in its walls, in each of which fits a ciliated funnel so that there are innumerable ciliated funnels in connection with each nephridium was made by the author in 1938, when he demonstrated that this organ has no connection at all with the body of the nephridium and has lost all excretory function. Its function now is to manufacture coelomic corpuscles which are discharged into the surrounding perinephrostomial sinus. The ciliated organ has thus become subservient to the sinus system.

The general morphology of the reproductive system is properly dealt with, but little is given of the histology of some of the organs. The term conjugation used for copulation is unfortunate as it is ordinarily used for protozoan organisms. The directions given for practical work are quite helpful. Finally it may be pointed out that the classification as given in the memoir appears to be out of date. The Acanthobdellidae no longer belongs to the Hirudinea. Michaelsen (1928) in the *Handbuch der Zoologie* by Kukenthal and Krumbach includes it along with the families Lumbriculidae and Branchiobdellidae in his Familienreihe Lumbriculina of the suborder Neoligochaeta. It is now high time that the group Clitellata introduced by Michaelsen should be accepted for the Oligochaeta and Hirudinea. The relationships of the two orders have not been dealt with in this memoir probably because they have already been treated in the memoir on *Pheretima*.

H. R. Mehra

INCREASED EMPIRE INDUSTRIAL PRODUCTION

"Mr Guy Locock, Director of the Federation of British Industries, has just returned from his visit to India as a member of the Ministry of Supply mission to that country, and as delegate to the Eastern Group Conference, New Delhi. The recommendations of the commission are naturally confidential, but Mr Locock has no doubt that their effect on war production in the Eastern Group is likely to be considerable. As Board of Trade representative on the mission, he was entrusted with the task of appraising future effects on British industry of the war production expansion now being undertaken, always keeping in mind the necessity for giving priority to vital war needs. There can be no doubt that the present war, like its 1914-19 predecessor, will accelerate industrialisation in India and other eastern countries. At the same time Mr Locock holds the view that no steps have been taken to expand production as a result of the mission's visit which are not essential for war purposes, and that on the whole post-war interests of British industry are not likely to suffer so greatly as was at one time expected. Nevertheless, there can be no doubt that increased industrial production has to be anticipated in the post-war period in India, to a greater extent in Australia, and to a smaller extent in South Africa, and many peacetime problems will arise for the British exporter, once replenishment demands are met ; . . ."

The above extract from the July, 1941 issue of the *Railway Gazette*, London, has been sent to us by one of our readers. We reproduce it with the belief that the position of Indian industries vis-a-vis war production is very candidly stated and it does not need harping on our old tune.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

A GENERAL CLASS OF QUASI-FACTORIAL DESIGNS LEADING TO CONFOUNDED DESIGNS FOR FACTORIAL EXPERIMENTS

We are concerned with an experiment having two factors A and B, each at p and q levels respectively, so that, in all, there are pq treatment combinations of the form $(a_i b_j)$, i varying from 1 to p and j from 1 to q. Our problem is to conduct this experiment in blocks having k plots each, where k is less than pq, so as to reduce the standard error per plot. We desire, in order that the usual analysis of variance may be done with the minimum of complexity, that the non-orthogonality between blocks and treatments or between blocks and the three components of the treatment effects, namely, main effects of A and B and interaction A × B, should be as simple as possible. This simplification can be achieved if the following properties are present:—

Let the r replications of the experiment be such that in the r blocks in which any treatment $(a_i b_j)$ occurs, each treatment of the type $(a_i b_m)$, $(a_l b_j)$ and $(a_l b_m)$ will occur λ_1, λ_2 and λ_3 times respectively. We have then the following relationship:—

$$r(k-1) = (p-1)(q-1)\lambda_1 + (p-1)\lambda_2 + (q-1)\lambda_3 \quad (1)$$

This design will belong to Bose and Nair's system of partially balanced incomplete block designs,[1] provided $\lambda_2 \neq \lambda_3$, or when $\lambda_2 = \lambda_3$ and p=q simultaneously.

The losses of information on each degree of freedom (d.f.) of A, B and A × B are as follows:—

Loss on each d.f. of

$$A = \frac{1}{k}\left[1 - \frac{\lambda_2 + (q-1)(\lambda_1 - \lambda_3)}{r}\right] \quad (2)$$

$$B = \frac{1}{k}\left[1 - \frac{\lambda_3 + (p-1)(\lambda_1 - \lambda_2)}{r}\right] \quad (3)$$

$$A \times B = \frac{1}{k}\left[1 + \frac{\lambda_1 - \lambda_2 - \lambda_3}{r}\right] \quad (4)$$

The total loss of information over all the (pq − 1) degrees of freedom of the treatment comparisons is $\left(\frac{pq}{k} - 1\right)$, or one less than the *average* number of blocks per replication—a property which these designs share with balanced incomplete block designs.

Yates' two-dimensional quasi-factorial design for p^2 treatments in blocks of p plots is a special case of the above design, namely, when p=q=k and $\lambda_1 = 0$, $\lambda_2 = \lambda_3 = 1$, in which case (2) and (3) become $\frac{1}{2}$ and (4) becomes zero. The design in blocks of p plots confounding the interaction of a p^2 symmetrical factorial experiment is also a special case with $\lambda_1 = 1$, $\lambda_2 = \lambda_3 = 0$. The basic design for confounding of asymmetrical factorial experiments, discussed in an earlier note[2], can be deduced from this general class of designs by putting k=p and $\lambda_3 = 0$, in which case (2) becomes zero.

From (2), (3) and (4) it will be clear that, for factorial experiments, it is preferable to have λ_1 greater than λ_2 and λ_3, whereas, for quasi-factorial experiments, the relative magnitudes of λ_1, λ_2 and λ_3 are immaterial, except that, from a practical point of view, λ_1 must be less than λ_2 and λ_3 and preferably equal to zero, in order that *r* may be small.

The design for p × q experiment in blocks of k plots will lead to confounded designs for $p^m q^n$ experiment in blocks of kpq plots, preserving all the main effects.

The extension of the above design, to the case of an experiment with several factors, is straightforward. Thus, if there are three factors A, B and C, having p, q and s levels respectively, we can have designs in blocks of k plots, and with *r* replications such that in the *r* blocks in which $(a_h b_l c_j)$ occurs, each treatment of the type: $(a_l b_m c_n)$, $(a_l b_m c_j)$, $(a_l b_l c_n)$, $(a_h b_m c_n)$, $(a_l b_l c_j)$, $(a_h b_m c_j)$ and $(a_h b_l c_n)$ will occur, $\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6$ and λ_7 times respectively.

The losses of information on each d.f. of the main effects, first and second order interactions have been calculated (and are not given here for lack of

space), but the total loss over all the (pqs − 1) degrees of freedom is $\left(\frac{pqs}{k} - 1\right)$, or as before, one less than the *average* number of blocks per replication.

Yates' three-dimensional quasi-factorial design for p^3 treatments in blocks of p plots is a special case of this design, when $p=q=s=k$; $\lambda_1=\lambda_2=\lambda_3=\lambda_4=0$; and $\lambda_5=\lambda_6=\lambda_7=1$. When $k=p$ and $\lambda_4=\lambda_6=\lambda_7=0$, the main effect of A of the $p \times q \times s$ experiment is preserved; and we get the design discussed in a recent communication to this Journal[3]. Also the p^3 symmetrical factorial experiment in blocks of p^2 plots ($p>2$) confounding the second order interaction comes as a special case when $k=p^2$, $p=q=s$, $\lambda_1=p-2$, $\lambda_2=\lambda_3=\lambda_4=p-1$, and $\lambda_5=\lambda_6=\lambda_7=0$.

The design for $p \times q \times s$ experiment in blocks of k plots leads to confounded designs for $p^l q^m s^n$ experiments in blocks of kpqs plots, preserving all the main effects.

Full details of various practically useful designs, with methods of analysis, will be given in a paper to be shortly published in *Sankhya*.

K. RAGHAVAN NAIR,
C. RADHAKRISHNA RAO.

Statistical Laboratory,
Calcutta, 31-1-1942.

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A NOTE ON THE PHARMACOLOGICAL ACTION OF RAUWOLSCINE.

Rauwolfia canescens is a small shrub growing wildly in Howrah and 24 Perganas in Bengal. *Rauwolfia serpentina*, another member of the family, growing abundantly in Dehra Dun and Behar, has lately acquired considerable therapeutic importance in the treatment of hypertension and is also used as a nervous sedative. The chemistry of *R. serpentina* has been worked out and a number of alkaloids has been isolated by Siddiqui and others[1]. A preliminary report on the pharmacological properties of these alkaloids has been published by Chopra and Chakravarti[2].

Rauwolscine, the chief alkaloid present in *R. canescens*, has recently been isolated and investigated by Miss A. Mookerjee[3]. The alkaloid forms pale yellow plates, m.p. 231-32°, is optically active and has the composition $C_{21}H_{26}O_3N_2$. It shows a considerable amount of similarity in chemical properties and colour reactions with yohimbine, with which it is isomeric.

A pharmacological investigation of rauwolscine hydrochloride has been undertaken with a view to compare its properties with those of the alkaloids of *R. serpentina*. Rauwolscine has been found to be a depressant of the cardio-vascular system in experimental animals. The important feature is that the alkaloid exerts its hypotensive action only when the blood pressure is high. It lowers the blood pressure by depressing the cardiac muscle and reducing the minute output of the heart. This reduction in blood pressure is maintained in most cases indicating an action also on the blood vessels. The alkaloid ranks among the few sympatholytic agents and a suitable dose can completely abolish the pressor effects of adrenaline. It appears from a few experiments that the alkaloid is fairly toxic, but no exact figure can be quoted at present unless further data are collected. As it is chemically related to yohimbine, it is yet to be seen whether rauwolscine shares other properties of the latter. Further investigations are in progress and will be reported in due course.

Medical College, M. D. CHAKRAVARTI
Agra, 7-2-1942.

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[2] Chopra and Chakravarti, *Ind. Jour. Med. Res.*, *29*, 763, 1941.
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COLORIMETRIC ESTIMATION OF BISMUTH.

Dimercaptothiobiazole[1] gives a red precipitate with bismuth, white to yellow precipitates with all the other metals of the sulphide group, except mercury (black). The reagent was used by Dubsky and Okac[2] for the detection of bismuth in dilute hydrochloric acid solution, (sensitivity being 1 part in 28,000 parts), as well as by Rây and Gupta[3] in nitric acid solution (sensitivity 1 in 1,600,000).

Rây and Gupta also used this reagent for the estimations of copper and lead, and their separations from other elements. I have found that the red precipitate of the bismuth compound can be completely peptised by gum acacia of suitable concentration, and the orange-red colour developed can be made the basis of a colorimetric method of estimating bismuth, since the intensity of colour varies regularly according to Beer's law.

With the help of a Dubosque colorimeter, using a very dilute nitric acid solution of bismuth, the

coloration limit reaches one part in 3,000,000, and bismuth up to the extent of 6 γ in 20 c.c. solution has been estimated to a high degree of accuracy.

The details of the method will be shortly published elsewhere.

ANIL KUMAR MAJUMDAR

Inorganic Chemistry Laboratory,
University College of Science & Technology,
Calcutta, 7-2-1942.

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A NEW PLANT IMMIGRANT: *CENCHRUS PAUCIFLORUS* BENTH (GRAMINEAE)

Of the four species of *Cenchrus* occurring in India, *viz.*, (i) *C. setigerus* Vahl (Syn. *C. biflorus* Roxb.), (ii) *C. barbatus* K. Schm. (Syn. *C. catharticus* Del.), (iii) *C. ciliaris* Linn. (Syn. *Pennisetum cenchroides* Rich.), and *C. prieurii* (Kunth) Maire (Syn. *Pennisetum prieurii* Kunth), none is found in Bengal; but a new *Cenchrus*, not known elsewhere in India, has made its appearance at Dacca under interesting circumstances.

Some three or four years ago, a strange-looking object, outwardly resembling a prickly fruit or "bur", came to the assistant fibre expert's section at the Dacca Farm adhering to a bag in which something else had been sent from Mexico. Through the courtesy of Dr S. Hedayetullah, economic botanist to the Government of Bengal, to whom the object had been given for determination and who had sown it for the purpose, the writer received flowering specimens of the plants produced and these proved to be *Cenchrus pauciflorus* Benth. (also called *C. carolinianus* by some authors[1]), a native of the interior of the United States of America, where it extends right across the continent[2] and is known as "Sandbur Grass". In its native country the sharp, stiff, retrorsely barbellate spines on the burs or *involucels* make it a very disagreeable weed to both man and animals[3] much in the same way as the Indian *C. barbatus*[4] which is said to have once held up and baffled an army from Delhi on its way to invade Bikaner[5]; the burs enclosing the spikelets are readily distributed by clinging to clothing and the wool or hair of animals and by blowing sand, and are removed with difficulty from the fleece of sheep; and the spines on the burs have been known to cause swellings and ulcers in the mouths of grazing animals[3].

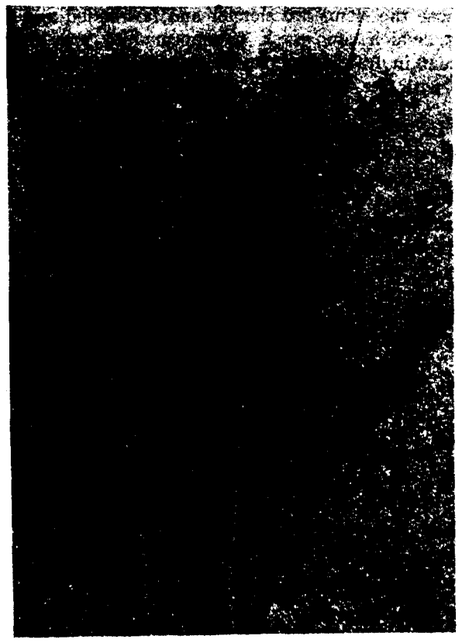

FIG. 1. Flowering and fruiting branches of *Cenchrus pauciflorus* Benth (about ⅔ of natural size).

Experiments carried out by Dr Hedayetullah showed that the grass was eagerly devoured by cattle without producing any ill effects, the immunity observed being apparently due to the fact that the burs swallowed were comparatively young and had not yet become stiff enough to be able to cause injury. It was also found on analysis to be highly nutritious —a description which applies equally to the Indian *C. setigerus* and *C. ciliaris*[6].

High hopes were at first entertained regarding the potentialities of the grass as a fodder crop, if grown under such conditions as would prevent its dispersal, but certain factors which became evident with further experience have ultimately led to their virtual abandonment. On account of their coriaceous texture the burs do not split but merely get flattened on the application of pressure and extraction of seeds by any labour-saving method is therefore out of the question; the prickly burs are by no means easy or pleasant to handle and their habit of cohering in a tangled mass, when collected, renders it impossible to sow them by any method other than slow and

laborious hand-dibbling, which is clearly unsuited to cultivation on a field scale ; and, although roots are freely emitted at the nodes, nothing would be gained by attempting to propagate the plant from cuttings because the stems are slender and few-noded and the burs, which are quick to appear and are always present in full-grown plants, would constantly interfere with the operation.

In America the plant flourishes in cultivated fields, pastures, waste ground, and along lake shores and railroads and is mostly restricted to light, well-drained, sandy or gravelly soils[3]. Similar conditions are not lacking in this country and, in view of the impracticability of turning the plant to economic account, we must now be on our guard so that it may not spread and ultimately become the pest that it is in the country of its origin.

The writer's thanks are due to Dr N. L. Bor, I.F.S., for help received in the determination of the plant and to Dr P. Maheshwari for kindly placing at his disposal much of the literature consulted in drawing up this note.

S. K. SEN

Biology Department,
Dacca University,
Dacca, 5-12-1941.

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["There is a legend that an Indian *Cenchrus* called Bhurat (*C. catharticus* Del.) once upon a time was pitted against an army, and won. An Emperor of Delhi was on his way to Bikaner, when a burr of Bhurat stuck in his arm. He picked it off, and it stuck in his finger; he then tried to bite it off, and it stuck in his lip and gave him intenser pain than ever. When told that the country was full of these things, he ventured no further, and Bikaner was left in peace".—p. 191.]
[6] Blatter, E., and McCann, C., The Bombay Grasses, 1935.

A NOTE ON THE USE OF THE TERMS 'THORN', 'SPINE' AND 'PRICKLE'

Morphologists are not unanimous in their use of the terms 'thorn' and 'spine'. Fitting in Strasburger's Text Book of Botany[1] has defined thorns "as lignified and rigid pointed structures that may either be unbranched or branched. They originate by the modification of leaves (leaf-thorn), of shoots (shoot-thorns), or less commonly of root (root-thorns)". The term thorn (Dorn) has been used in the same sense by Velenovsky[2] and Wagner[3] who have regarded the prickles or emergencies (Stacheln) as superficial outgrowths of the nature of hairs. Willis[4] defines a thorn as a "stiff-pointed outgrowth which may be of various origin", viz., epidermal, branches, flower stalks, leaf, leaflet, petiole, root, stipules and ovules. Troll[5] has termed all sharp pointed woody structures regardless of their origin as thorns under which he has also included the epidermal emergences. Barber[6] has also used the term 'thorn' in a general sense for all kinds of woody pointed structures. All the above authors have not used the term spine.

Goebel[7] has used the term 'thorn' for all rigid and pointed structures; according to their origin he has described them as leaf-thorns (Vol. I, p. 168, Vol. II, pp. 428, 452), shoot-thorns (Vol. I, p. 168, Vol. II, p. 452) and root-thorns (Vol. II, p. 288) and has distinguished thorns from prickles which he has called emergences. Goebel has further used the term spine for the transformed leaves of Cacti: "The spines are transformed leaves which arise upon very much reduced lateral shoots standing in the axil of the leaves." (Vol. I, p. 168). Again at another place (Vol. II, p. 428) he writes, "The transformation of leaves into thorns is seen in a greater degree in many Cacti whose thorns have a varying morphological value." Coulter, Barnes and Cowles[8] describe the hard and rigid pointed shoots and leaves as 'spines'. The same authors again describe some types of bigger emergences (prickles) and the spiny hollow stipules of *Acacia sphaerocephala* as thorns. Asa Gray[9], Bose[10], Small[11], Holman and Robbins[12] regard the two terms synonymous and they describe both modified shoots and leaves as thorns or spines. Jackson[13] describes a thorn as "usually an aborted branch, simple or branched" and a spine as "a sharp-pointed woody or hardened body usually a branch, sometimes a petiole, stipule or other part".

In Hooker's Flora of British India the three terms—thorns, spines and prickles—have been used indiscriminately by various authors. Thus Hooker and Thomson[14] describe the modified stipules of *Capparis* spp. as *thorns* ; whereas J. G. Baker[15] calls the modified stipules of *Acacia* spp. *spines;* in another place M. A. Lawson[16] regards the transformed stipules of *Zizyphus* spp. as prickles. Similar indiscriminate use of the three terms can be seen in other cases. Hooker[17] himself has mostly used the term 'spine' in describing the rigid hard-pointed transformed axillary shoots of many plants, e.g. *Feronia elephantum*, *Aegle Marmelos*, *Crataegus* spp., *Randia* spp., *Hygrophylla spinosa* etc.; he has also used the same term for the transformed leaves and the term prickle for emergences.

Roxburgh[18] and Prain[19] has used 'thorns' and 'spines' both for axillary shoots and leaves ; but the modified stipules of *Zizyphus jujuba* have been described as thorns by Roxburgh and as prickles by Prain.

Green[20] and Priestley and Scott[21] and the authors of certain elementary text books have used the term 'thorn' exclusively for modified shoots and spines for modified leaves only.

The term spine is derived from Latin 'Spina', a thorn (Oxford Dictionary) ; so also the two terms 'thorn' and 'spine' are used synonymously in English language.

Evidently from the above views it can be assumed that there is no unanimity amongst botanists regarding the use of the terms, thorns, spines and prickles. Most authors, however, regard the prickles as different from thorns and spines. They are mostly superficial outgrowths of the nature of hairs and never have any conducting strands ; whereas the modified shoots and leaves (thorns and spines) have always got vascular connection. In most cases the prickles develop not solely from the epidermis, but some cells of the subepidermal region also contribute to their development. In some cases *e.g.*, in *Xanthoxylum* spp., *Bomax malabaricum*, etc. the prickles after their formation continue to grow for a long time and their growth is continued by a subepidermal meristematic tissue; even in such cases conducting strands are absent in them.

There has been a difference of opinion regarding the meaning of the terms thorns and spines and on account of such differences of opinion, average students on plant morphology are often put to difficulty in understanding the nature of woody sharp-pointed structures from descriptions. So, the ambiguous situation that often arises should be clarified by clearcut definitions of the two terms. All such hardpointed woody structures may be described as root-thorns, shoot-thorns and leaf-thorns accordingly as they are modified roots, shoots or leaves, taking the term 'thorn' in a general sense, as is usually done in the case of tendrils. But as both the terms—thorns and spines—are used in descriptive botany to denote different morphological structures, the writer, after considering the views of the different authors agrees with Green and Priestley and Scott that the sharp-pointed woody structures having the nature of shoot should be described as *thorns* and such other structures which are modified leaves or parts of leaves as *spines* ; roots rarely become hard, woody and pointed; and when they become so they may be regarded as root-thorns. The term 'prickle' should always be restricted to superficial outgrowths only.

Botany Laboratory,
Presidency College, B. C. KUNDU
Calcutta, 7-2-1942.

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BASAL METABOLISM IN ANIMALS.

It has been sometimes stated that the basal metabolism which defines the rate of heat production of an animal when in a state of rest is directly proportional to the surface area of the animal.[1] This however is not correct. As recent calorimetric experiments have shown, the metabolism depends on the body-weight as well as the surface-area of the animal.[2] If E denotes the heat production in kilo-calories per 24 hours for an animal of mass M kgm. and surface area S cm.^{2}, we write

$$E = aM + bS, \qquad (1)$$

where a and b are constants. The first term :-

probably for 'internal requirements' and the second term for 'environment'.*

Substituting the approximate empirical relation

$$S = 10^3\ M^{\frac{2}{3}}\ \text{cm.}^2 \qquad (2)$$

which is applicable to almost all animals, we have

$$E = aM + 10^3 bM^{\frac{2}{3}} \qquad (3)$$

The metabolism of animals varying in size from mouse to elephant[2] agrees roughly with (3) when we take $a = 10$ and $b = 60 \times 10^{-3}$, that is E (in kilo-calories per 24 hours) is given by

$$E = 10M + 60M^{\frac{2}{3}} \qquad (4)$$

The heat production for kilogram body-weight is, therefore,

$$\epsilon_B = \frac{E}{M} = 10 + \frac{60}{M^{\frac{1}{3}}}, \qquad (5)$$

and the heat production referred to per square metre of the body-surface is

$$\epsilon_S = 600 + 100M^{\frac{1}{3}}. \qquad (6)$$

I do not know if relation (4) is well-known to physiologists—my excuse in putting it down here is that I have not come across it and the relation is obviously interesting.

Department of Physics,
University of Delhi, D. S. KOTHARI
Delhi, 3-2-1942.

* Possibly, by regarding E as made up of two parts the metabolism in warm-blooded and cold-blooded animals could be linked together.

[1] G. T. P. Tarrant: Mechanics of human and animal activity, *School Science Review*, Dec., 1938, p. 248.
[2] "Science in Progress", (Yale University Press 1939), Chapter X.

MECHANISM OF HYDROCARBON SYNTHESIS FROM WATER GAS ON COBALT AND NICKEL CATALYST.

It is more than a decade that the following appeared in the Proceedings of the Indian Science Congress, 1931.

'It is suggested that a reaction is catalysed by one of the following ways:—

(a) By individual leptons or leptyles of the catalyst.

(b) By two or more of such similar or dissimilar leptons and leptyles, the linear distance between them being the determining factor.

(c) By three or more of such similar or dissimilar leptons and leptyles, the distance and orientation entering into the phenomenon.'

Recently, the above ideas of mine have been revived by Twigg and Rideal in their paper[1] entitled 'The Chemisorption of Olefines on Nickel', where they state that 'The interatomic distance of the catalyst atoms appears to be an important factor in determining the activity of the catalyst.' This view is also in line with the quantum mechanical picture of the activation energy of adsorption.[2]

It has been shown that the activation energy is highly sensitive to the atomic distance. For any particular process it increases whether the distance for which activation energy is minimum is increased or decreased.

Craxford and Rideal[3] have concluded that methane formation from carbon monoxide and hydrogen in presence of cobalt catalyst proceeds through chemisorbed atomic hydrogen in view of the fact that the reaction occurs on the catalyst which also catalyses ortho-para hydrogen conversion and this process is known to involve an atomic mechanism. Reduction by molecular hydrogen leads according to them to higher hydrocarbon synthesis.

The idea of atomic distance as a factor in the mechanism has not been considered by Craxford and Rideal to explain the higher hydrocarbon synthesis from carbon monoxide and hydrogen on nickel and cobalt catalysts.

A hydrocarbon chain is known to possess an angle of 109°28′ between the carbon-carbon linkings and the distance between the nearest odd carbon atoms is equal to $2 \times 1{\cdot}52 \sin \frac{109°28'}{2} = 2{\cdot}481$A, the carbon-carbon distance being 1·52A. The distance between the nearest atoms in a nickel crystal is 2·47A and that in the cobalt crystal is 2·51A and these are almost equal to 2·481A. It is therefore clear that a hydrocarbon chain will fit well on nickel or cobalt surface, the odd carbon atoms being anchored to the nearest atoms. The distance being almost equal, this adsorption can take place without appreciable stress or strain. Assuming such an adsorption it is easy to picture how by reaction of carbon monoxide with hydrogen the hydrocarbon chain is built up on a nickel or cobalt surface. The mechanism postulated however differs from that of Craxford and Rideal to a certain extent.

The view put forward above regarding the hydrocarbon synthesis on nickel and cobalt catalysts hinges upon the assumption that the metal exists in crystalline form in the catalyst mass. The X-ray study of a nickel-thoria-kieselguhr catalyst, efficient for higher hydrocarbon synthesis, has actually shown the crystalline nature of nickel in the catalyst sample in question.

A detailed account of the mechanism postulated will appear with the result of X-ray investigation incorporated.

Chemical Laboratory,
Dacca University, K. M. CHAKRAVARTY
Dacca, 22-1-1942.

[1] *Trans. Faraday Soc.*, *36*, 533, 1940.
[2] Sherman and Eyring, *Jour. Amer. Chem. Soc.*, *54*, 2661, 1932.
[3] *Jour. Chem. Soc.*, *14*, 1604, 1939.

Summaries of some of the presidential addresses at the different sections at Science Congress at Baroda in January last were published as a supplement to the last February issue. The summaries of the remaining addresses will be given in the next April issue.

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Automobile Industry in India

WE are in the midst of "Mighty Happenings", and the four hundred millions of Indians whose united and well-directed effort, organised in time, might have changed the course of history, have been doomed to watch the recent developments in utter helplessness. It is obvious from recent trend of events that if India were able to manufacture thousands of automobiles, tanks, aeroplanes, train the necessary personnel, and send them to the war zone in the hour of need, the present tragic incidents with consequences which we do not yet foresee, would not have occurred. The paradox is that India has the necessary raw materials, and her industrial magnates are willing to come forward with all their financial resources and their business ability, but India is unprepared. The attitude of the Government of India even in the face of grave perils has been one of non-encouragement of Indian initiative and indifference towards any effective plan of industrialization in the country.

A sad story has been told in a pamphlet recently issued by Sir M. Visvesvaraya, and it should be noted by all future historians of the war. The pamphlet contains the correspondence that passed between Sir M. Visvesvaraya as representing the promoters of an automobile industry in India and the Government of India and along with it is a brief report of the progress that had been achieved by the promoters on their own initiative. The project for an automobile industry in this country has been in the air for a number of years. The plan had been first mooted in 1934 and a preliminary report was published in 1936. (For earlier reports please refer to vol. IV, p. 401, 1938-39 and vol. VI, p. 285, 1940-41). After the recent Government communiqué regarding automobile industry in this country, the correspondence revealing the attitude of the Government will be read with interest.

The Government of India was first approached on May 7, 1936 for initial support and help for starting the factory. After inviting attention to the concessions usually made in such cases by progressive foreign Governments, two specific assurances were asked for :—

(*a*) A clear statement by the Government that they welcomed the effort to start the industry ; and

(*b*) A general assurance that Government would be prepared to come to the rescue of the industry if at any time it was threatened by unfair foreign competition.

Government sent a routine reply to this, quoting an old government resolution adopted on the Report of the Fiscal Commission of 1921-22, according to which no industry could receive support without a previous enquiry by a Tariff Board, and no enquiry

by the Tariff Board could however take place unless a factory already started got into difficulties.

The Government of Bombay was approached, and the provincial government offered a guarantee of 3 or 3½ per cent return on invested capital, on condition that the promoters should obtain from the Government of India the following two concessions:—

(a) that the present revenue duty of 37½ per cent on motor vehicles and parts will not be lowered for a term of ten years; and

(b) that a rebate will be granted on the duty paid on any imported special parts used in the manufacture of automobiles.

But the Government of India informed the promoters that it was impossible for the Government to give the guarantees desired. When this refusal became known, the Provincial Government of Bombay, then under a Congress Ministry, agreed to waive the conditions attached to their offer of guarantee.

The Congress Ministry, however, went out of office in November, 1939 and the present Government of Bombay which had come under the personal rule of the Governor, were also willing to ratify their predecessor's promise, provided the Government of India agreed that the industry would help war effort. But the Government of India declared in an official communiqué issued by the Commerce Department on 16th December, 1940 that the industry would not be of assistance to war effort. Upon this, on 4th January, 1941, the Government of Bombay informed the promoters that they could not give the financial guarantees desired and "lend support to a scheme which must so largely depend on the active co-operation of the Government of India . . . When the present obstacles are removed, this Government will be willing to give its sympathetic consideration to a fresh request for support to your scheme".

Having failed to secure the support which they had expected from the Bombay Government, the promoters opened negotiations, in April, 1941, with the Government of Mysore, who at first expressed their willingness to render liberal assistance if the promoters undertook to establish the industry within that State. But the Government of India interfered with and discouraged its establishment on the ground that the starting of the factory would impede war effort. Sir M. Visvesvaraya has revealed that the unusual character of this interference first led to a protest by Sir Mirza M. Ismail, Dewan of that State, and later to the resignation of his high office.

In view of Soviet Russia's entry into the war and the increasing demand for army vehicles, the promoters revised their plans and approached the Government of India with the proposal that during the war they would confine themselves to manufacturing army vehicles according to specifications that may be given to them. The Government of India replied that the military authorities were opposed to the introduction of a new type of vehicle as they expected difficulties in storing and carrying spare parts of different makes. Mr Walchand Hirachand thereupon offered to stock in India all the spare parts required. This offer was ignored. In the meantime the Government of India had begun to place orders with foreign firms for all their military requirements of motor trucks and cars, estimated at Rs. 40 to Rs. 50 crores. While the government were advancing the objection regarding locally produced cars, it is understood that under the "Lease and Lend" policy of the U. S. A., the Indian Army has received and is using several thousand units of Dodge trucks (products of Chrysler Corporation, the firm with which negotiations were successfully concluded by the promoters) and also trucks of another make as against their standard Chevrolet and Ford.

Some have thought that the scheme of the Indian promoters was to erect an assembly plant and it appears from a letter from the private secretary to the Viceroy that such a mistaken idea might have been prevalent in the minds of the Government. The promoters' chief concern from the outset has been to establish a complete manufacturing plant in the shortest time possible. Assembling in the first year or two is a subsidiary effort at the construction stage. It is the usual way to start a new factory in a country and it is done to give experience and practice to the staff and workers while construction is going on and the factory is getting ready. A foreign assembly plant in India which has invested about Rs. 50 lakhs is making now a profit of about the same amount every year. The painful reading of the correspondence reveals that there has not been a single proposal of constructive character from the Government of India, whereas difficulties have always been put forward, and archives of the Government of India have been ransacked for the discovery of age-old resolutions which can be utilised to stifle Indian initiative. The Government was apparently unmoved by the fact that those resolutions were out of tune with present-day conditions of the world, specially in the present period of grave emergency.

Industrial developments in Australia during the period of the present war provide a striking contrast. Australia has been for a long time regarded as the storehouse of Great Britain for food supplies, and manufacturing industries had not been very much encouraged there until the outbreak of the present war, though the Australians never put up with the attitude. But the shackles were completely broken after the war had broken out. In two years Australia has developed complete plants for the manufacture of automobiles and aeroplanes. She is now able to manufacture 1,000 planes a year. There was little production of steel before the war. In these two years of war she developed a productive capacity for an annual output of 2,000,000 tons of steel. In the same two years steel production in India has not gone beyond 1,250,000 tons although the industry has been in existence here for nearly thirty years. And Australia, it may be noted, has less than 2 per cent of India's population and about 5 per cent of India's reserve in iron ores. To encourage the production of complete motor cars in Australia, the Commonwealth Government provided a subsidy of up to £1.5 million. The subsidy was in the form of a bounty on complete engines of 15 h.p. or more produced in Australia. The rate of bounty was £30 for every engine up to the first 20,000 units produced, £25 a unit for the second 20,000 and £20 for the third 20,000. The subsidy was payable to factories equipped to manufacture at least 8,000 units a year, and to companies, whose two-third share-capital was owned and controlled by Australian people themselves.

Referring to foreign competition, the Australian Minister of Customs said, "The difficulties facing those who will undertake the work will be real and complex, not the least will be the competitive method which will be used against them. I am not anticipating developments when I say that Government will safeguard the industry against unfair competition. I say this solely for the purpose of informing all interested parties where the Commonwealth Government stands".

In a recent broadcast, Mr W. R. Campbell, president of the Ford Motor Company of Canada, drew attention to the extent the automobile industry in his country had been helping war effort. "One cannot but feel", he said, "how fortunate Canada has been in possessing at the outset of the war a large, well-established and resourceful automobile manufacturing industry. Without delay and with admirable despatch that industry was able to swing into war work and, through its provision of mechanical transport, to play a vital part in the successes so far achieved by the British and the Empire. Indeed, when the history of the war comes to be written, it would not be surprising to find that Canadian equipment in this category is credited with having turned the tide at a critical juncture in the conflict."

But no situation turned the tide in India. When the war assumed a direct threat to India, the promoters of the automobile industry thought that a change in their original proposals might meet the wishes of the Government of India. They submitted the following proposals: (i) During the period of the war, the Company will manufacture whatever the War Supply Department may want, such as motor trucks, and will place its products at the disposal of that Department to the fullest extent required, (ii) If Government consider that Messrs. Walchand & Co., the proposed managing agents have their hands too full with other large undertakings, the promoters are prepared to entrust the management of the proposed Company to a new firm composed of well-known persons of good financial standing and organising ability, (iii) The factory will be located in Bombay, and the promoters will not ask for any special concessions but will endeavour to work with the minimum of facilities necessary for the establishment and maintenance of the factory during the period of the war. For this purpose they were eager to come to an arrangement with any department or officer of the Government of India whose direct attention would have avoided red-tapism.

The above arrangement in regard to speedy organisation has been forcefully exemplified in the establishment of the aircraft factory at Bangalore. The Hindusthan Aircraft Ltd., came into being because Government made up their minds to start it. The proposal which was placed before the Government remained unnoticed for about 9 months and then all of a sudden Government decided

to encourage the industry. This was done by authorising Mr (afterwards Sir Hugh) Dow to do the needful. That officer was able to make all preliminary arrangements in the course of a couple of weeks by means of personal consultations with the promoters and the departmental heads concerned.

It is understood that the demand from the army has been so heavy that the Government had to purchase all the trucks of American manufacture available in India. But for the Government's attitude, the army would have now got supplies of the country's own motor vehicles as the promoters were confident of assembling motor trucks for war purposes with parts from abroad within seven months of the receipt of the order.

The present helpless situation with regard to a vital war industry has been precipitated in such a manner and during such a period as will be of benefit neither to England nor to India. In the belligerent countries, a large number of motor car factories have been converted into workshops for the manufacture of armaments and general military stores. Britain for two years after the close of the war may not be able to re-equip all her factories for the manufacture of motor vehicles. And when she begins to manufacture on the old scale, she will have to supply her own wants first before she is able to export. Germany and other continental manufacturers for the same reason may not be able to export automobiles for another five years. The United States of America is the only country which will benefit by the present impasse. American manufacturers are increasing their assembly plants in India. A certain truck manufacturing company of America is, it is rumoured, taking steps to set up a plant for the manufacture of commercial trucks in this country. An American firm, the Firestone Tyre Manufacturing Company, has just started a tyre factory in Bombay. There is already the Dunlop Tyre Company with their factory near Calcutta.

The volume of business in automobiles in India is not yet sufficient, and more than one manufacturing plant in India will not be economically justified. Moreover a foreign plant will have the benefit of research and other experimental work at its home office. Government refusal to help has meant not only a distinct economic and strategic loss to the country but also sacrifice of a singularly favourable opportunity for establishing the industry. In normal times motor vehicles are sold in India at more than double the actual cost of production in the country of manufacture. During and for two or three years after the war the prices are likely to soar much higher.

Our Government in the present case of automobile industry has shielded them under the covers of Indian Fiscal Commission Report, dollar exchange and tariff regulations. One of the Government's trusted experts on fiscal and tariff affairs is Sir Padamji Ginwala. He has presided over more than one Tariff Board. During the last 20 years he has had 'opportunities to make a close study of most of the major Indian Industries and of many others abroad'. Sir Padamji has contributed a forceful review of the present industrial situation to the columns of the *'Statesman'*. He has dealt with the oft-repeated objections which have been put forward as the handicaps against a drive for intensive production in India. He has no word for the artificial barriers of customs and trade rules. The boastful but misleading statements from the Supply Department about millions of army combs, boots, pith hats, bamboo poles, and dried potatoes only reflect the industrial inefficiency of the country, content with so insignificant products. The objections referred to above take a threefold form—absence of a long term policy, restriction of machinery and lack of trained personnel. Mr Attlee's explanation in course of a recent debate for the failure of mobilization of Indian resources referred to these.

The necessity of a policy has been forgotten by our rulers when troublous times are gone. The policy need not be a long-term one ; what is wanted is the intensity of feeling for a real drive. The statement of Mr Amery, the Secretary of State for India, that production of automobiles was not desirable at the present moment in India, appears to betray the sentiment that he is more afraid of the manufacture of automobiles in India by Indians than of a foreign aggression. The attitude of the British Government would be amply clear from the following statement by Mr Arthur Moore, editor of the *'Statesman'*. "Last year when I pleaded with him (Lord Beaverbrooke) in London to let us have, or at least to let the Americans send us machine tools and experts to build up belated war industry in the East, and to send us aircraft for training on a large scale, he replied in a short sentence of six words and thirteen letters which I shall never forget. He said, 'I'd be mad to do it!' It sounded like a knell in my ears. I knew then that I was listening to the death sentence of many brave men."

The emphasis on trained personnel is often made without due regard to actual conditions in big industries. Where large tonnage or mass production industries are concerned, the amount of trained labour required is remarkably small and is confined to a few supervisory jobs. Mechanisation can now be carried to such a stage as to require the performance by one man of not more than one or two simple operations at a time.

Regarding machinery Sir Padamji writes: "As we know, plants have been bodily transferred from one part of Russia to another and back again, and the President of the United States of America stated not long ago that some of the new plants are to be transferred from the Pacific Coast, where they are vulnerable, to the interior. Coming nearer home, unless my memory is gravely at fault, a fairly large blast furnace at Batelle in Alabama, United States of America, was during the last war dismantled, shipped to India, and re-erected at Jamshedpur. It is therefore idle to plead that some at least of the plants which can almost immediately be used for the production of war material and eventually converted to peace-time requirements cannot be provided for India because of the war. According to my experience very large plants could be brought into operation within a few weeks after the arrival in India of the last instalment of machinery and plant". India has a continuous land front for the principal theatres of war and her sea communications to these fronts are also relatively short. The huge organisation of convoy with the attending time factor for reinforcing war supplies could have been reduced a great deal, and the shipping and labour could be released for more useful and direct operations, if some of the new plants which are being erected in the United Kingdom, the United States of America and Canada were transferred to India.

This is how people are now feeling. We have been trying in our humble way through these pages to present to our readers a case for the rapid industrialization of the country. Some saw in it more of ardour and unmellowed spirit of nationalism. But now our pleadings are being voiced by many. Let the facts percolate to the stubborn ears and they will steel the hearts and poise the muscles. When the time will come, there will be no doubting Thomases to retard us and we can start with plenty of necessary assistance from all of us armed with the knowledge of what we have and what we can achieve. This belief is the only streak of light in the midst of the present appalling darkness.

A UNIVERSITY OF THE AIR

Those who deplore the loss of a great opportunity for the spread of culture and of mutual sympathy in the radio's debasement to trivial and partisan ends must hail the establishment by the World Wide Broadcasting Foundation of shortwave Stations WRUL and WRUW in the U. S. A., "dedicated to enlightenment," to culture, education and the fostering of international goodwill as a real cultural achievement.

Young Lieutenant Walter Lemmon accompanied President Wilson to Paris and drew from the bickerings and the strife, that helped to make the "Peace Conference" such a sad misnomer, the conclusion that the friction resulted from lack of mutual understanding. His idea of "a university of the air to act as a world culture exchange" appealed to President Wilson but it did not finally materialise till recent years. The objects of the non-profit Foundation include the broadcasting in different languages of cultural, educational, artistic and spiritual programmes —programmes that "will enhance the cultivation of spiritual values and tend to promote the growth of individual character". The achievements of its "Friendship Bridge" and other programmes are solid though intangible. Let us hope that, though the U. S. A. is now in the war, the University of the Air will be able to keep clear of controversy and to pursue its noble aims unhindered. For, as Louis Adamic put it in a letter published in *The Saturday Review of Literature* for 8th November, "V for Victory is all right, but we need also V for Vision".

—With acknowledgment to the *Aryan Path*.

Cosmic Radiation*

H. J. BHABHA

Indian Institute of Science, Bangalore

THE physical processes in nature may be roughly classified in three groups, depending on the energy interchanges involved in them. These three groups may be defined as those in which the energy interchanges involved lie

(1) below half a million electron volts,†

(2) between half a million and one hundred million electron volts, and

(3) above one hundred million electron volts.

Now most of the physical and all the chemical processes which occur most frequently in nature belong to the first group. Among these are the ordinary emission and absorption of light, and the chemical changes on which life depends. For example, the combustion of an atom of carbon to form carbon dioxide yields about 4 e.v. of energy. On the other hand, nuclear phenomena tend to fall largely into the lower energy region of the second group. The most penetrating radiation emitted by the naturally radioactive elements has an energy of 2·6 m.e.v. (million electron volts) and even if the new artificially produced radioactive elements are included, the energy interchanges involved lie in general below 10 m.e.v., although in the recently discovered fission of uranium the liberated energy approaches 100 m.e.v. The third group consists exclusively of cosmic ray phenomena, though there are many cosmic ray phenomena which also fall into the second group.

The energies which have been taken above as the limits of the three groups have a physical significance. The energy of half a million electron volts which separates the first two groups is equal to the mass of the electron measured in energy units.* Hence the second group includes processes involving the creation of matter, such as the phenomena of the radioactive β-decay and the creation of electron-pairs by gamma-rays discussed below, which cannot occur in the first group just because there is not enough energy available for them. Thus the difference between the first two groups is not only a quantitative one but also a qualitative one, and the study of the second group has revealed entirely new fundamental processes which have resulted in a very deep extension of our knowledge of nature.

Similarly, the energy dividing the second group from the third roughly corresponds to the mass of the meson, the new fundamental particle which was discovered only four years ago through the study of cosmic radiation.. This particle does not normally occur in matter, and its discovery has had the most far-reaching consequences in altering our conception of the whole physical world. Thus all phenomena concerned with the creation of mesons fall into the third group and these can be investigated only by the help of cosmic rays, for in cosmic radiation occur the most energetic particles that are known in nature, some having energies as high as a thousand million million electron volts. It is for this reason that the study of cosmic radiation has today become the centre of fundamental research in physics, for it reveals the behaviour and transformations of matter when subjected to bombardment by the most energetic particles, and leads directly to the most fundamental problems about the nature of the elementary particles out of which all matter is composed.

The discovery of cosmic radiation evolves out of researches towards the beginning of this century on

* Being the summary of ten lectures delivered at Calcutta University during the month of December, 1940.

† In all atomic phenomena it is convenient to measure energy in electron-volts (abbreviated to e.v.) which is the kinetic energy an electron acquires in falling through a potential difference of one volt. 1 e.v. $= 1{\cdot}59 \times 10^{-12}$ ergs.

* According to Einstein's theory of relativity, mass and energy are equivalent.

the conductivity of the air. This conductivity depends on the extent to which the air is ionized, and this ionization in its turn is produced by the passage of electrically charged particles through the air. In 1912 Hess sent up in a balloon an apparatus for measuring the ionization of the air and found that after a preliminary decrease in the ionization due to a decrease in the amount of radioactive matter floating in the air, the ionization continued to increase steadily to the greatest heights reached by his balloon, clearly demonstrating the existence of some radiation coming in from above and penetrating downwards to sea level. This radiation was assumed to come in from outer space and hence called cosmic radiation. All subsequent researches have amply confirmed this conclusion about the origin of the radiation in outer space, though the exact place and mode of its origin still remains a complete mystery.

The type of experiment carried out by Hess is still of the greatest importance for giving information about cosmic radiation, and the technique has been enormously improved in recent years by Regener and Millikan and their co-workers. Ionization chambers and cosmic ray counters are sent up with balloons which traverse as much as 98·8 per cent. in pressure of the atmosphere. It will be seen presently that it is of importance to measure these atmospheric absorption curves, as they are called, at different latitudes. Figure 1 shows four absorption curves as measured by Bowen, Millikan and Neher (1938) at the four places given in table I. The abscissa represents the height below the top of the atmosphere, measured in metres of water equivalent (sea level corresponds to nearly 10 metres of water). The ordinate gives the ionization of the air measured in ions/cm³/sec. of air at normal pressure.

TABLE I.

Place	Madras	San Antonio	Omaha	Saskatoon
Geomag. Lat.	3°	38·5°	51°	60°
Energy Flow	0·94	1·81	2·25	$2{\cdot}36 \times 10^9$ e.v./cm²/sec.
Min. Energies	17	6·7	2·9	$1{\cdot}4 \times 10^9$ e.v.

The figure shows clearly that the cosmic ray intensity is not the same at different places, but is smallest for places near the equator. This dependence of the cosmic ray intensity on the geomagnetic latitude of the place at which the measurement is made is

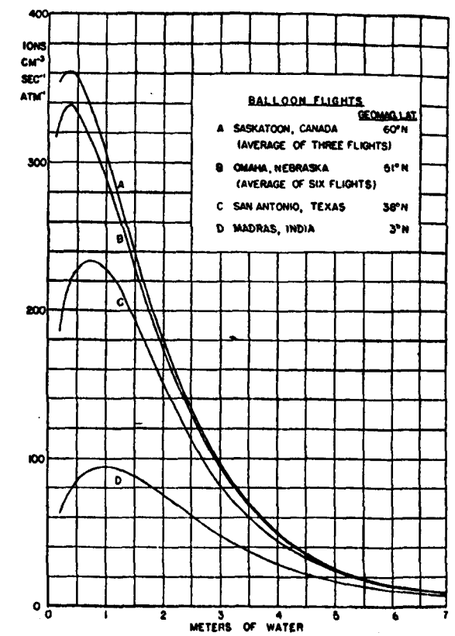


Fig. 1. Results of baloon flights at four different latitudes.

known as the "latitude effects" of cosmic radiation, and was first discovered by Clay (1933) from experiments at sea level. It is due to the effect of the earth's magnetic field, which bends away the less energetic rays from the equator. The general theory of the movement of electrically charged particles in the earth's magnetic field has been developed by Störmer.* It has been shown by him that in order to reach a given point on the earth's surface of geomagnetic latitude Λ in a vertical direction and not be bent away by the earth's magnetic field a particle must have a minimum momentum p given by the formula

$$cp = 1{\cdot}54 \times 10^{10} \cos^4 \Lambda \text{ e.v.} \quad . \quad . \quad . \quad (1)$$

This formula is exact, and shows that it is only the relativistic momentum that matters quite irrespective

* See, for examples, University Observatory, Oslo, Publication 10, 1934.

of the mass of the particle. The theory also shows that at any given place the number of cosmic ray particles coming in in different directions may be different, and indeed, if the primary particles were all positively charged there would be a preponderance of particles coming in from a westerly direction, if they were negatively charged from an easterly direction. The theory has been elaborated in connection with cosmic radiation by Lemaitre and Vallarta (1933) and their co-workers (1935). It yields important results about cosmic radiation when applied to certain experiments, as will be seen presently.

Returning to the curves of figure 1, we notice that since the height of the curves at each point gives the ionization, the total area underneath each curve must be proportional to the total ionization produced by cosmic radiation in the process of its absorption in the atmosphere in a vertical column of air 1 cm^2 in cross-section. From this can be calculated at once the *total* cosmic ray energy that falls on a surface 1 cm^2 at the top of the atmosphere at the place of observation. The figures so found for the total energy are given in the second row of table I. They show that the total energy which falls on the earth in the form of cosmic radiation is roughly equal to the total energy which comes to the earth as light from the stars. It follows incidentally from this that stars of the type of our sun must emit, if at all, an amount of energy as cosmic radiation which is entirely negligible compared with the energy they emit as light.

Now let us apply the results of Störmer's theory to the curves of figure 1. For example, the ionization of curve B, taken at a geomagnetic latitude of 51°N, can be due either to cosmic rays which are uncharged, since these are undeflected by the earth's magnetic field and can reach any point irrespective of their energy, or to electrically charged cosmic rays which have a certain minimum energy. Similarly the ionization of curve C could be due either to uncharged cosmic rays or to charged cosmic rays having some higher minimum energy. As a rough approximation we may take the minimum energy required by a singly charged cosmic ray to penetrate to the top of the atmosphere at a certain latitude to be that given by formula (1), which is true for rays of vertical incidence. These minimum energies as calculated from formula (1) are given in the third row of table I. It follows that the *difference* between curves B and C must be due to electrically *charged* cosmic rays whose individual energies lie between 2·9, and 6·7 × 10^9 e.v., since a ray of energy above 2·9 × 10^9 e.v., but below 6·7 × 10^9 e.v., will contribute to the ionization of curve B but not of curve C. Thus 2·25 − 1·81 = 0·44 thousand million e.v./cm^2/sec. is the energy carried in by charged cosmic ray particles whose individual energies lie between 2·9 and 6·7 × 10^9 e.v.

In this way it is possible by measuring the total energy which comes in as cosmic radiation at the different latitudes on the earth, and combining the results with Störmer's theory to deduce the energy spectrum of the incident *primary* cosmic radiation before it penetrates the atmosphere. Thus from the four curves of figure 1, one can deduce the total energy which must be carried in by particles whose energies lie between the four verticals of figure 2, which correspond to the minimum energies as given by the third row of table I. If the total energy carried in between each pair of limits be assumed to be uniformly spread over particles of all energies in the range, we get the four rectangles of figure 2, whose areas correspond to the second row of table I. It should be noticed that there is no way of knowing to what extent the curve D taken practically at the equator, is due to uncharged rays, or to charged rays with energies above 17 × 10^9 e.v. It has been assumed, rather arbitrarily that this curve is about equally due to charged and uncharged radiation. Naturally, from the atmospheric absorption curves measured at four places one cannot expect to derive a continuous spectrum. The continuous curve shown in figure 2 is therefore but a plausible curve drawn so that the area it covers between each set of vertical lines is equal to the area of the corresponding rectangle. It is therefore very essential to measure the atmospheric absorption curves at a large number of different latitudes in order to obtain with accuracy the actual energy spectrum of the primary cosmic radiation. The primary spectrum is of importance since it is the result of the history of the cosmic rays before they enter the earth's atmosphere and probably bears the impress of their origin.

Some important conclusions can be drawn from the curves of figures 1 and 2. First, we notice that even if the entire absorption curve D at 3°N be attributed to the effect of uncharged cosmic radiation, the total energy of this part could be at most 0·94 × 10^9 e.v./cm^2/sec., whereas the total energy that comes in at 60°N (curve A) is 2·36 × 10^9 e.v./cm^2/sec.

Thus, of the total energy which comes in as cosmic radiation, *at most* a fraction 0·94/2·36 = 0·4 can be due to uncharged radiation. This is an upper limit, and the actual fraction is probably very much less. Now the study of the behaviour of cosmic radiation once it enters the atmosphere shows that the radiation rapidly undergoes a process of transformation, and that after the equivalent of about 1 metre of water the energy is about equally divided between the charged and uncharged rays, with rather more in uncharged rays. It follows from this in conjunction with the result that in the primary radiation at most 40 per cent. of the rays are uncharged, that the primary cosmic rays have not, in their previous history before reaching the earth, traversed as much matter as the equivalent of one metre of water. It is therefore unlikely that their origin could have been inside a star, for then at least half the radiation would have been uncharged.*

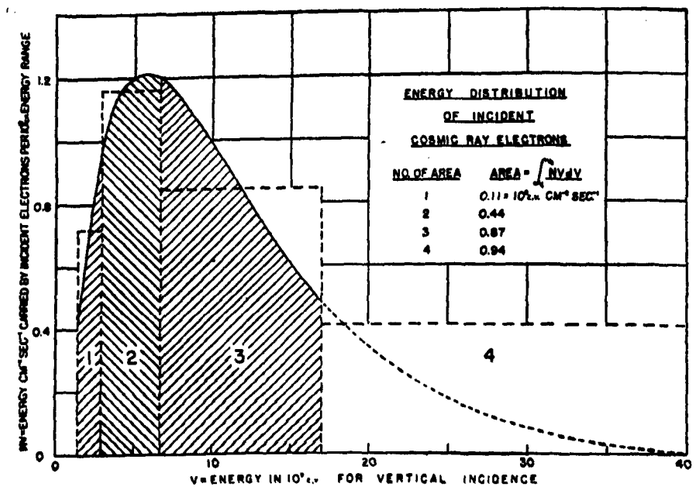


Fig. 2. The areas marked 1, 2, 3 which correspond respectively to the difference of area between curves A and B, B and C, C and D of fig. 1, are plotted between the corresponding values of individual electron energy, V, for vertical incidence. The ordinate thus gives the energy carried to the earth by electrons having energies lying between V and V+dv.

Figure 2 also shows that most of the cosmic ray energy is concentrated in particles with an energy of the order of 5·10^9 e.v., and that the spectrum falls off for energies below this. It has been suggested by Janossy (1937) that this cutting off of the spectrum at the low energy end is due to the blocking effect of a possible magnetic field of the sun, which, if it resembled the earth's and was of suitable magnitude, would exclude rays of less energy from getting near the earth's orbit, and hence from reaching the earth. If this were the explanation, however, then the lowest energy rays would reach the earth's orbit in certain directions only, and hence there would probably be a considerable diurnal variation in the intensity at any given place, which is contrary to observation. This argument assumes that the effect of the earth's own magnetic field is not such as to even out such a diurnal effect. The question needs further investigation before a final answer can be given.

This brings us next to a most remarkable property of cosmic radiation, namely the extraordinary constancy of the average intensity of the radiation at any given place, the variations being of a purely statistical nature, or explicable by local changes in the earth's atmosphere or magnetic field. Measurements show that if a regular diurnal variation with

* This argument assumes that no magnetic or electric fields of galactic magnitude have filtered the radiation by letting the uncharged part escape unaffected while changing the path of the charged part.

sidereal or solar time exists, then it is less than 2 per cent of the total intensity. This remarkable constancy puts great difficulties in the way of understanding the origin of cosmic radiation, for the source of it would have to be distributed uniformly in the whole universe, so that this distribution would not coincide with the general distribution of matter, which is concentrated in the nebulae, and in our neighbourhood in the galactic system. In this connection might be mentioned the recent experiments of Millikan and Neher (1940) who have measured atmospheric absorption curves at other latitudes besides those of figure 1. Their preliminary results based on these curves appear to show that the primary cosmic ray spectrum instead of being a smooth curve as in figure 2 has actually a banded structure with several maxima. This result again shows the need for measuring the atmospheric absorption curves at closer intervals and with greater accuracy than hitherto obtained in order to deduce the primary cosmic ray spectrum in its finer details. Millikan interprets the position of the maxima as coinciding with the atomic weights of the elements found in the greatest abundance in space, and deduces that cosmic radiation is produced by the annihilation of these elements. The difficulty in the way of this explanation, however, is that the energy of some of the most energetic rays is more than a thousand times the total mass of the heaviest known atom.

Returning again to the curves of figure 1, we see that they all have the same general shape. As one ascends from sea level, the ionization increases with height, reaches a maximum at about a depth of 1 metre of water equivalent below the top of the atmosphere, and then decreases rapidly as the very top of the atmosphere is reached. The difference between any two curves of figure 1 also shows the same general shape,* and this difference curve must be due, as has been shown above, to charged particles having energies lying between certain well-defined limits. We conclude, since the ionization at any point is just proportional to the number of electrically charged particles passing through the atmosphere at that point, that the extremely high energy charged primary particles, on entering the atmosphere, produce within a thickness of 1 metre of water equivalent very many times their number of electrically charged particles, which may or may not be of the same nature, and which then suffer a rapid absorption in the atmosphere. This behaviour is characteristic of high energy electrons, and there is no doubt that the main part of the absorption curves from the top to at least half way down the atmosphere is due to the behaviour of electrons, positrons and gamma radiation, as described by the cascade theory which will be developed presently. But it is not possible to conclude definitely from this that the primaries themselves are electrons, if one admits the existence of hitherto unknown processes which allow the production of an electron or gamma ray by a proton or meson within a thickness of atmosphere very small compared with 1 metre of water equivalent.

* These difference curves are given in Fig. 3 on page 858 of the paper by Bowen, Millikan and Neher (1938).

THE CASCADE THEORY

An electrically charged particle, in virtue of its charge, communicates in passing through matter energy to the electrons in the atoms of the material, and thus loses energy itself. This collision or ionization loss, as it is called, does not appreciably depend on the mass of the moving particle, but only on its charge ze and velocity v and is given by the formula of Bloch.

$$-\left(\frac{dE}{dx}\right)_{coll} = 2\pi\sigma Z.\left(\frac{ze^2}{mc^2}\right)^2 \times$$

$$\frac{mc^4}{v^2}\left[\log \frac{mv^2W}{\left(1-\frac{v^2}{c^2}\right)I^2Z^2} + \left(1-\frac{v^2}{c^2}\right)\right] \quad . \quad . \quad (2)$$

where E is the energy of the particle and x is the thickness of matter traversed; W is the maximum energy which can be communicated to an electron in a free collision, and is the only quantity in the above formula which depends on the mass of the moving particle; m is the mass of the electron, Z the atomic number of the substance and σ the number of atoms per unit volume, while $I = 13{\cdot}5$ e.v. This expression increases rapidly as v^{-2} for v much smaller than c. It is a minimum for $v = 0{\cdot}97c$, and increases for higher energies only logarithmically with the energy of the moving particle, since then $v \rightarrow c$. The formula has been checked by Corson and Brode (1938) up to energies of 3×10^7 e.v. In table II are given the figures for the collision loss in water as calculated from (2). The moment the energy of the particle has fallen so low that its velocity is appreciably less than that of light, it comes to a stop in a very short distance since the collision loss then goes up very rapidly. Thus electrons whose energy has fallen to about 10^6 e.v. may be considered as altogether stopped as far as cosmic ray investigations are concerned. For higher energies the variation of the collision loss is only logarithmic, and it may be treated as constant in the range in which it plays an important role. The range concerned lies for air or water between 1 m.e.v. and 150 m.e.v., as will be shown presently. Since the average energy communicated to an ion is of the order of 100 e.v., it follows that the total collision loss of 10^6 e.v. per cm. is made up by some 10^4 individual losses each of the order of 100 e.v. The energy lost by collision is therefore really dissipated in the material, and never travels far from the place of its dissipation.

TABLE II.

ENERGY LOSS IN WATER.

Millions of electron volts per centimeter.

Electron Energy in e.v.	10^6	10^7	10^8	10^9	10^{10}
Collision loss ...	1·93	2·15	2·72	3·29	3·94
Radiation loss ...	...	0·16	2·07	22·5	233

The only other process contributing in an important way to the energy loss of fast charged particles at high energies is the radiation loss. This radiation is emitted, as one should expect from analogy with classical radiation theory, when the electrically charged particle is accelerated, and this may happen whenever the particle passes through the electric field of an atom. Since the radiation loss depends on the radiating particle being deflected by the electric field of the atom, it is important in the calculations not only to consider the electric field of the bare nucleus of the atom, but the screening of this field by the surrounding atomic electrons. In fact, for a neutral atom the electric field of the atom is only appreciable inside the atom, and hence radiation takes place when the radiating particle passes through the atom itself, though it may still be far from the nucleus. The quantum mechanical formula for the radiation loss per unit length of a particle of mass M and spin $h/2$ and of such high energy that the effect of screening is complete, is*

$$-\left(\frac{dE}{dx}\right)_{rad.} = \sigma\frac{Z^2}{137}\left(\frac{e^2}{Mc^2}\right)^2 E\left[4\log 183\frac{M}{m}Z^{-\frac{1}{3}} + \frac{2}{9}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The formula (3) shows first that the radiation loss is proportional to Z^2, whereas the collision loss was proportional to Z, so that the radiation loss will be relatively more important in materials of large atomic number. It is proportional to the inverse square of the mass of the radiating particle. It is therefore most important for electrons but quite negligible for protons even up to energies as high as 10^{12} e.v. The most important feature of formula (3) is that the radiation loss increases proportionally to the energy† E, so that at high energies it completely overshadows the collision loss, whereas at low energies it is quite negligible, as the figures in table II show. It has therefore been found convenient to define a critical energy characteristic of each substance, this being the energy at which the collision and radiation losses of an electron are equal. Dividing (3) by (2) and putting in appropriate numerical values for the expressions in square brackets in (2) and (3) we find that the ratio of the radiation to the collision loss of an electron is approximately

$$\frac{-\left(\frac{dE}{dx}\right)_{rad.}}{-\left(\frac{dE}{dx}\right)_{coll.}} \sim \frac{ZE}{1600mc^2}, \quad . \quad . \quad . \quad . \quad . \quad (4)$$

so that the electrical energy E_c, namely the energy at which this ratio is unity, is roughly given by $E_c \sim 1600\ mc^2/Z$.

In problems concerning the behaviour of electrons at very high energies where the radiation process dominates, it is therefore convenient to measure all lengths in a substance in terms of a characteristic unit of length l, which is so chosen as to eliminate the physical constants in formula (3). If we define a length l by

$$l^{-1} = 4\frac{\sigma Z^2}{137}\left(\frac{e^2}{mc^2}\right)^2 \log 183\ Z^{-\frac{1}{3}}, \quad . \quad . \quad (5)$$

* Bethe and Heitler (1934) and Bhabha (1938). (*In this article, please note h stands for Planck's constant divided by 2π.*)

† For a particle of spin h the theory of which has been given by several authors, Booth and Wilson (1940a) find that the energy loss increases as E^2 and not as E.

and denote all lengths measured in terms of this unit by t, so that $t = x/l$, then formula (3) takes on a very simple form, namely (the 2/9 in square brackets is less than 5 per cent of the other term and may be neglected)

$$-\left(\frac{dE}{dt}\right)_{rad.} = E \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Since at the critical energy the radiation and collision losses are equal, it follows that the collision loss when the length is measured in the unit (5) is just

$$-\left(\frac{dE}{dt}\right)_{coll.} = -\left(\frac{dE}{dt}\right)_{\substack{rad. \\ E=E_c}} = E_c \quad . \quad . \quad (7)$$

(6) therefore shows that the critical energy can also be interpreted as the collision loss of an electron in a distance of one characteristic unit l. It follows from this that an electron whose energy has fallen as low as the critical energy will never travel more than a distance of one unit. Adding (6) and (7), the total energy loss of an electron is

$$-\left(\frac{dE}{dx}\right) = E + E_c$$

from which it follows by integration that the mean range R of an electron of initial energy E is

$$R = \log\left(\frac{E}{E_c} + 1\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

When the collision loss is treated accurately in the theory, as in a recent paper by Bhabha and Chakrabarty, it is convenient to denote the collision loss measured in the characteristic unit of length l by β, and to take β as the definition of the critical energy. The figures for the critical energy β and the characteristic unit of length l are given in table III for different substances.

TABLE III.

Substance.	Air.	H_2O	Al.	Pb.
Critical energy β in millions of e.v. ...	103·0	114·6	55·56	6·93
Characteristic unit of length l in cms. ...	34200	43·4	9·80	0·525

The radiation loss also differs from the collision loss in another important way, as the following formula shows. The probability that in travelling a distance dt an electron of energy E_0 emits a quantum of energy $k = E_0 - E$ is given for extremely high energies to within 6 per cent by

$$\left(E_0^2 + E^2 - \tfrac{2}{3} E_0 E\right)\frac{dk}{E_0^2 k} \quad . \quad . \quad . \quad (9)$$

The chance of the emission of large quanta with energy comparable with that of the original electron is therefore quite large. The total radiation loss (6) is obtained by multiplying (9) by the energy of the quantum k and then integrating from O to E_0. Large quanta contribute very appreciably to it. Thus the energy lost by radiation is lost in a few quanta each having an energy comparable with the energy of the electron, whereas the energy lost by collision is lost in a large number of small fragments. For example, according to Bethe and Heitler, an electron of energy 137 mc^2 emits before it has lost practically its whole energy by radiation a distribution of quanta given by table IV.

TABLE IV.

Energy of quanta in mc^2	50	20-50	10-20	5-10	2-5	1-2
Number	0·5	1·5	1·5	1·5	2	1·5

In all about 8 quanta are emitted in this case and many of them have energies which are comparable with the initial energy of the electron. Unlike the case of the collision loss, therefore, the energy lost by the electron by radiation does not remain localised since the quanta being of high energy travel far from their place of emission. Calculation shows that these high energy quanta travel in very nearly the same direction as the electron, so that although the electron loses its energy and is stopped in a small distance by radiation loss, as given by (8), the quanta themselves carry the energy forward.

(*To be continued*)

Anthropological Approach to the Study of Indian Sociology*

G. S. GHURYE

University Professor of Sociology, Bombay University

I propose here to consider the significance of the general intellectual correspondence between anthropology and sociology upon the problems of Indian sociology. From this point of view it is necessary first to give some thought to the origin and development of the general character of the anthropological outlook in sociology.

The term "Sociology" was first used by August Comte just a few years over a century ago, about the year 1837. This usage of a new term, with more or less precise connotation, alone may not have been enough to make Comte the father of sociology. What earned for him the claim to this great and unique title was something far more distinctive than this. It consisted primarily in the way which he was led thither, in the outlook in particular which, when brought to bear on the studies of human phenomena, found its natural culmination, as it were, in this comprehensive and potent linguistic signification.

Comte indeed was a great synthesizer. In his Positive Philosophy he endeavoured to embody a philosophic comprehension of the intellectual treasure of his age, particularly of the hundred years which preceded him. He strove to bring about this unification of his intellectual past mainly as a propaedeutic for the proper perspective of his contemporary life, perspective which, he hoped, may, in its turn, lead to an accurate grasp of the prospective trend of the world forces. Comte's hopes were, as it proved, well founded. The results of his novel attempt helped a good deal to throw quite a new light on the complex constitution of human nature and the intricate structure of human society. That aspect of Positive Philosophy, which brought forth this new light, Comte designated "Sociology".

After Comte, the next great figure which stands before our eyes cannot but be that of Herbert Spencer. Undoubtedly Herbert Spencer was the first systematic writer on the subject of sociology. And the one outstanding and noteworthy feature of his work consists in the consistent use of anthropological material which he regarded as the scientific foundation of his conclusions. Even in his general conception of "progress" we are able to discern the great value he attached to the knowledge of the past. 'The limit towards which we progress', he tells us in his 'First Principles' (ed. 1908, p. 223), 'is an expression of the whole past and the whole future of each object and the aggregate of objects'. The recognition of the importance he attached to the anthropological approach to sociology is evinced by the great trust in his name for collecting and publishing anthropological data in a tabulated form, called Descriptive Sociology.

Similarly we find that L. T. Hobhouse, the next great writer on this subject in England, drew on anthropological data. 'The Material Culture and Social Institutions of the Simpler Peoples' by Hobhouse, Wheeler and Ginsberg is a fine example of skilful use of anthropological material towards the understanding of social institutions. To state, by the way, the principal purpose of this work, it is to find out whether there exists any correlation between the economic conditions on the one hand, and social institutions on the other; and, if such a correlation is found to exist, to try to grasp its nature and significance. The scientific utility of such studies is being increasingly realised.

Other social sciences most intimately related to sociology, like politics, ethics and psychology use

* Adapted from the author's presidential address to the members of the Bombay Anthropological Society, delivered on February, 11, 1942.

nowadays what is called the comparative method, method which derives its main strength from anthropological data. In politics Harold Laski has put forward a strong plea for what he rightly calls the historical method. In his inaugural address to the London School of Economics and Political Science, (Oct. 22, 1926), he, having indicated the wide scope of politics, declared: 'I stand here to plead for the study of politics in the terms of history. To know how our traditions and institutions have been moulded, to grasp the evolution of the forces by which their destiny has been shaped—that, I am anxious to persuade you, is above all the key to their understanding'. What "history" is here to "politics", "anthropology" is to "sociology".

Philosophy too could not remain immune to the powerful infection of this anthropological outlook. It is well known that philosophers have for some time past recognised the relativity of moral judgments and standards. And since the work of Sutherland and Westermarck on moral ideas and sentiments, the anthropological approach in ethics may be said to be fully recognised as an essential aspect of it. This reference to what may be called evolutionary ethics cannot fail to remind us of that great treatise, 'Morals in Evolution', by a sociologist, to whom I have already referred, L. T. Hobhouse.

This wide range of anthropological field could not certainly leave uninfluenced perhaps the youngest of the biological sciences, psychology. The contribution of anthropology towards psychological studies may clearly be witnessed in the work of Wundt, Freud, James Frazer, R. R. Marett, W. H. R. Rivers, Malinokski and Bartlett. It is the study of culture which provides the most fruitful meeting place for these two great branches of knowledge—sociology and psychology.

In America, wherefrom the first students of sociology pursued general sociology much more than special branches of sociology, one branch of sociology, called social origins by the American sociologists, has been nothing else but social anthropology. Among the principles which they have been able to lay down, a recent writer in the *American Sociological Review* (June, 1941) finds that eighteen of them are such that, though they are not the only ones nor the most important ones, they occur in the books and writings of so many sociologists that one may assume a general concensus about them. A large number of them are concerned with the cultural process. The most profitable point of view which helps to disentangle the otherwise almost inscrutable intricacies of the various culture configurations, that are to be found over the face of our globe, is without doubt anthropological. And the corresponding method which alone may be said to repay commensurately the labour of this endeavour is the method of the archaeologist and the anthropologist.

It remains now to mention the anthropological significance of the problem of race. Though the concept of race is in essence biological and was and has been handled by zoologists and anatomists, the anthropologist has long made it his special field of study. Physical anthropology, the anthropologist's study of the human body as distinguished from his study of the human mind and society—cultural anthropology as it is called, is today an important sub-head of anthropology. Let it be remembered here, however, that like all distinctions of this kind, this distinction between physical and cultural anthropology too is made as a convenience. In actual practice the two aspects overlap, and the physical anthropologist has to co-operate with the cultural anthropologist and *vice versa*, if they are to make proper progress in their respective branches. What we have to note here is that from the ethnological field and the anatomical museum the concept of race has made its inroads into psychology, sociology and politics. National characters are constantly probed into. Judgments are boldly pronounced regarding their stability or mutability. As we know now, the stability of such characters may be entirely due to social tradition and cultural pattern or to this cause and biological heredity. As Ginsberg has pointed out (*Nature*, July, 1941) one has to attribute some role to race in this fixity. We also know further that part of the phenomena of social differentiation is based on the popular concept of race which also is responsible for a number of unhealthy attitudes in our social and political activities. Race in this way becomes an important concept in sociology. It has to be studied with the help of the anthropologist's technique and in the light of anthropological facts.

Thus, from this brief review of the anthropological approach to sociology in general, we see how sociology for its proper study has to take up the anthropologist's technique and utilise the anthropologist's facts for a fairly large and important province within its purview. We may now be able to grasp the significance of this approach to Indian sociology.

For Indian sociology the anthropological approach is even more important than for other sociologies.

The complexity of Indian culture is baffling. Indian culture appears to be either a synthesis or a medley of many cultures. The least that we can say about the character of these cultures is that all of them have not been autochthonous. And to be able to distinguish the threads of the various units which enter and get so assimilated at times that they lose their identity into this apparently incoherent mass of cultures, which we comprise under the singular name, Indian culture, is itself one of the toughest problems of Indian sociology. To differentiate between the various traits one has to be conversant not only with the ancient Greek and Roman civilisations but also with the still older ones of Mesopotamia, of the Ægean Sea and perhaps also of Egypt. Nay, we have to go further beyond this. We need the knowledge of the Palaeolithic stage of Europe. And yet even such a study, which has been mainly the province of archaeology and latterly of history, cannot be said to equip an Indian sociologist fully for his task of differentiating between the various traits of the present culture complex.

To understand the contribution of other culture or cultures we have to go further afield to Burmah and Indonesia, to Malayasia and Australasia on the east and to Africa in the west. All these regions have been very largely studied by anthropologists. We have to take their facts and follow their technique so that we may be able to see the contributions of other cultures of India, to determine whether they were indigenous or like the other culture immigrant. After getting at the facts too we have necessarily to follow the anthropological method in our attempt to explain how the synthesis came about or how and why it turned into a medley.

If we take a review of the problem of social reform in India as understood and formulated by our early reformers, we find that it was for them a question of pruning what they regarded as the rank growth on an original stem, which was held to be more or less pure. The appeal here evidently lay to the hypothesised original. Social reform as sociology understands it today is something radically different from this. It depends, for its scientifically satisfactory progress, directly on the solution of the ever-present social problems. This solution does not necessarily lie in the past, which is thought to be pure. The variety of our customs and beliefs is so embarrassing that it is impossible to see them in their proper perspective unless and until they are studied as the anthropologist studies them. Their comparison with similar customs and beliefs in societies which have proved to be cultural backwaters as well in those highly civilised is the best eye-opener.

To refer only to a problem or two which strike us as particularly in urgent need of anthropological knowledge, we may mention the special problem of the so-called criminal tribes in Indian sociology. It is virtually impossible to envisage this problem without an adequate knowledge of the curve of social evolution. And for this knowledge we have of necessity to turn to the progressive achievements of anthropology. As is well known, at least some of these tribes are constituted by so-called criminals, who, owing to the rapid change that has come about during the last century and a half in the conditions of life, have lost their old means of subsistence. It is one of the major problems for the Indian sociologist to devise ways and means of making life healthy and soulful for this dismal section of humanity struggling to live betwixt us, who pride ourselves on being the torch-bearers of India's precious and progressive civilisation. And even for a proper social equilibrium, the rehabilitation of this down-trodden class is quite essential. This rehabilitation cannot be achieved without first fully understanding them, understanding which, as I have already said, is possible only when one takes the aid of anthropologist's technique and his scientific findings.

Another equally important special problem of Indian sociology is the problem concerning the progress of the inhabitants of what are called the 'excluded areas'. The upward march of these inhabitants along the path of culture is again of fundamental significance directly to the life of the cause of Indian sociologist. And thus if we are consciously sincere about leading them on along with us towards the cherished goal, we must do our best to understand their culture and its affinities in the noble spirit of scientific humanist. Such understanding, and nothing else, would lead us on to undertake with a confident heart the further all-important task of discovering the nearest next step which these our own living companions, who have as much claim to reap the harvest of life as we, may take. Here again we find ourself at the rich door of anthropology.

Artificial Induction of Polyploidy

with Special Reference to Colchicine

REAYAT KHAN

Department of Biology, Dacca University

THE usual methods of plant improvement consist of selecting desirable varieties from nature and improving them by inbreeding or crossing them with other suitable forms with a view to combining in one variety characters occurring separately in the others. But intervarietal hybridisation and pure line selection have their own limitations in the availability of the desirable characters or 'genes', and modern breeders seek to introduce them from the existing related species, wild or cultivated by *'distant hybridisation'* and also by changing artificially the architecture of the nucleus. Artificial induction of chromosome changes resulting in polyploidy* is of special importance in this respect, not only because it has led to the production of many better forms of plants but also because valuable hybrids which are often sterile can be rendered fertile by a simple doubling of their chromosomes. A number of interspecific and a few intergeneric sterile hybrids of economic importance have already been made fertile (Amin, 1940; Britten and Thompson, 1941). It has been found that in cotton (Harland, 1940; Stephens 1940) polyploidy is often accompanied by longer lint, and in *Ocimum canum* (Holubinsky, 1939) by higher camphor content. Induction of polyploidy in *Lolium perenne* (Sullivan and Myers, 1939) has resulted in an increase in sugar content and the tetraploid forms of *Petunia* (Levan, 1939) have produced large, in some cases "enormous" flowers. These experiments indicate that there is sufficient justification for expecting fruitful results from further investigations of this type.

* Polyploidy means an alteration in the number of chromosomes in the cells of an organism resulting in the addition of at least one set of chromosomes to the two (in the diploid generation) or one (in the haploid) originally present, the organism or its part in which this occurs being known as polyploid.

Plants with doubled chromosome number hav sometimes appeared spontaneously in nature as well as under experimental conditions but now they can also be produced artificially. It must, however, be remembered that although artificial induction of polyploidy has led to the production of many better varieties, the polyploid plants do not always possess the desired qualities and may sometimes be inferior to the existing diploid ones; at least the first symptoms of treatment appear in most cases as deformities, and the investigator who is over-enthusiastic about producing polyploids with the object of obtaining better varieties may sometimes be faced with difficulties.

Tetraploids may be produced by inducing either somatic or gametic doubling of chromosomes. In somatic doubling the chromosomes which would normally be distributed to the two sister nuclei are included in one. If the diploid plant in which this occurs is not a hybrid, it gives rise to an autotetraploid with four identical haploid sets of chromosomes; if, on the other hand, the diploid plant is a hybrid, somatic doubling gives rise to an allotetraploid with two identical diploid sets. Doubling of chromosomes in the gametes results from irregularities in chromosome behaviour such as the arrest of the 1st or 2nd meiotic division. Many hybrids are sterile because the chromosomes they receive from one parent differ from those contributed by the other and being consequently unable to mate and form pairs, give rise to inviable gametes. If the number of chromosomes in such a hybrid is doubled, each chromosome is provided with an exactly similar partner or a homologue to pair with and the difficulty is thus overcome so that the hitherto sterile hybrid becomes fertile.

MECHANICAL AND PHYSICAL METHODS

(*a*) *Decapitation.*—The discovery of this method of inducing chromosome changes was made in 1916 by Winkler. It was the result of his attempts to produce graft-hybrids or burdons in the genus *Solanum*. The method was subsequently developed by Jörgensen (1928) and others, chiefly using the tomato which appears to respond more readily to this treatment than most other plants.

Greenleaf (1938) has recently employed the decapitation method with 2 *Nicotiana* hybrids (*sylvestris* × *tomentosa*; *sylvestris* × *tomentosiformis*) and succeeded in inducing polyploidy. The treatment which gave the best results, was the application of a thin layer of lanolin paste containing 1 per cent indole-acetic acid to the cut surface of the stem immediately after decapitation. The plants were decapitated in spring and new shoots began to come up from the callus after a period of about 6 weeks. The shoots were mainly peripheral and were removed when about 2″—3″ long and rooted in sand. 13·7 per cent of the shoots were found to have the chromosome number doubled.

As pointed out by Greenleaf, much of the success of this method depends upon the good condition of the plants used. The more vigorous the plants, the better are the chances of obtaining a large number of callus shoots, and the longer will be the life of the decapitated plants. Disbudding, regular watering, and the application of some good fertiliser at frequent intervals are absolutely necessary for the best results. The hormone-treated surface must be protected from strong sunlight until shoots appear as otherwise the callus tissue and the shoots may not develop; this is easily done with a manila paper bag or with cheesecloth. Plants which produced no shoots in the intense sunlight of summer produced them later when brought into a white-washed green house.

Holubinsky (1939) has recently induced polyploidy in *Ocimum canum* by the decapitation method. A tetraploid obtained in this manner differed from the diploid in the greater pubescence of its leaves and shoots, which emitted a much more pronounced odour and are believed to have a distinctly higher camphor content.

(*b*) *Centrifuging.*—Bynov (1938) centrifuged germinating seeds of *Triticum vulgare* at the moment of the bursting of the seed coat, at 3,000 revolutions per minute for varying periods of time. The resulting plants contained various mutants. Duplication of chromosomes by centrifuging has been induced in sterile hybrids of *Nicotiana tabacum* × *N. sylvestris* and *N. glauca* by Bartolucci (1939).

(*c*) *Heat.*—Heat treatment has been shown to induce genetic changes including polyploidy and if the heat is applied at the seedling stage, it is not improbable that fertile tetraploid shoots may be developed by this simple method. Seeds kept for germination under various temperatures may also give rise to new forms. Low and high temperatures during meiosis can induce irregularities leading to the formation of diploid gametes.*

Randolph (1932), working on maize, applied the heat treatment at the time of the first division of the zygote. The temperature was increased to a range of 38°-45°C. A maximum of about 5 per cent of the treated embryos developed into tetraploids. Müntzing and co-workers (1936-37) made use of a technique similar to that of Randolph and induced polyploidy in barley. Cooper (1939) applied the heat treatment to *Medicago sativa* at an early stage in the development of the proembryo. One tetraploid individual (2n = 64) was obtained from a group treated at 42°C during the interval between the 47th and the 48th hour after pollination.

(*d*) *Electricity.*—Bynov (1938) has succeeded in inducing mutations in *Triticum vulgare* by the action of electric current. Germinating seeds at the moment of the bursting of the seed coat were placed in a tube at the end of which electrodes were placed and currents of varying intensity were passed, special precautions being taken to prevent heating of the seeds. Mutations appeared in all the progenies. The frequency of mutations tended to increase with the exposure and this tendency was more clearly defined in experiments with direct than with alternating current.

(*e*) *X-Radiation.*—Muller's work on the artificial induction of mutations by the use of X-rays is too well known to be mentioned here. The application of particular doses of X-rays and gamma rays of radium and of artificially radioactive isotopes produced by the modern cyclotrons may induce changes in chromosomes and cause mutations.

* It is necessary in this method to ascertain the exact size of the bud at which reduction division proceeds. This can be done by the smear method.

Câmara (1939) subjected young seedlings of *Triticum monococcum* to X-ray treatment and observed haploid cells and sectors in some of the root tips. Many tetraploid cells were also met with and it is thought probable that haploid and tetraploid individuals may also be produced by this method.

CHEMICAL METHODS—A. COLCHICINE TREATMENT*

(*a*) *General remarks.*—The discovery of the polyploidizing property of colchicine which has proved to be the most effective of all the agencies inducing polyploidy and which is also the most convenient to use, is remarkable both as an aid in genetical investigations and as an instrument in the hands of the practical plant-breeder. Though the discovery is quite recent, the chemical has already been successfully employed to produce polyploid forms of a large number of plants belonging to widely separated divisions of the vegetable kingdom.

Colchicine, which is prepared from the dried corms and seeds of *Colchicum autumnale* L. has long been used as a specific for gout. It is a poisonous drug and its continual use (even in very small doses) is liable to cause derangement of the central nervous system. 3 mgs. of the pure drug are sufficient to kill a mouse. Even dilute solutions should not be allowed to touch the skin and, should this occur, it should be washed immediately. The editor of the Journal of Heredity wrote in a note in his journal (May, 1939) that he had a painful and alarming experience when he accidentally got a small quantity of amorphous colchicine into his eye. A violent inflammation set in, which some hours later resulted in virtual blindness for over 2 weeks; fortunately, however, the injury proved to be only temporary.

That colchicine interferes with the normal course of mitosis was discovered by Dixon as early as 1905. In 1934 Lits and Dustin studied its action on animal tissues and observed an increase in number of mitoses in a tissue after colchicine treatment. Ludford in 1936 and Allen and associates in 1937 obtained similar results. At about the same time Havas (1937) and Nebel and Ruttle (1938) were investigating the effects of colchicine on plants, while Blakeslee and Avery (1937) were busy in experimenting with a number of chemicals to find out one that could produce polyploid plants. At the suggestion of Dr Eigsti who had observed polyploid cells in roots after treatment with colchicine, they added this chemical to their list and were successful in producing tetraploid forms of a number of plants by its use.

Although there are several theories as to the exact manner in which colchicine brings about somatic doubling, the investigations of Levan (1938) who studied the root tips of *Allium* fixed after immersion in aqueous solutions of colchicine, show more or less conclusively that colchicine acts by inactivating the spindle mechanism and delaying the division of the centromere (see also Ludford, 1936; Nebel and Ruttle, 1938). The daughter chromosomes do not pass to the poles remaining where they were and instead of two nuclei each with 2n chromosomes, there is formed a single, large nucleus with 4n chromosomes. This doubling may be repeated several times. In *Allium* Levan (1938) obtained values as high as 32n or even more. In addition to polyploids, a number of other forms such as 4n-1, 4n-1-1 etc., may also be produced.

Usually colchicine acts specifically on the spindle mechanism without producing undesirable symptoms in any part of the cell. The spindle mechanism begins to recover some time after treatment. The immediate effect of colchicine is the production either of tetraploid cells and tissues mixed with the diploid ones resulting in the formation of various types of chimeras or of tetraploid shoots borne on diploid plants. Cuttings and seeds from these tetraploid shoots can produce pure tetraploids in the next generation. In some cases pure polyploids may be obtained in the treated generation itself.

The only sure way of detecting polyploidy, *viz.*, an actual chromosome count, is also the most tedious. Some easier methods are, however, available. It is sometimes possible to recognise polyploid plants or parts of plants on the basis of *gigas* characters such as larger flowers and seeds, stouter fruits, thicker or more hairy leaves with a darker green colour etc., but these are not always reliable. A useful character is pollen-grain size. Within a given form, the volume of the pollen grains is usually proportional to the number of chromosomes it contains, the volume of diploid grains (produced by tetraploid plants) being approximately twice that of the haploid ones (produced by diploid plants). In the absence of flowers, measurements of the guard cells of the stomata often give helpful evidence.

There are various methods of applying colchicine, the underlying principle being either to bring it into direct contact with or to make it diffuse rapidly into growing tissues containing dividing cells. It can be used either in aqueous or in agar solutions. With lanolin it may be applied in the form of a paste or emulsion prepared in the following manner (Blakeslee, 1940):—

Stearic acid	...	... 1·5 gms.
Morpholine	...	... 0·53 c.c.
Tap water	...	... 20·00 c.c.
Lanolin	...	... 8·00 gms.

Add the water to the stearic acid and morpholine and heat the mixture until the stearic acid is melted. Then stir to a creamy soap solution. Add lanolin and continue heating without stirring until it is melted and the mixture is just below boiling point; add colchicine to make up the required concentration, stir the mixture until a thick creamy emulsion results and continue stirring intermittently until it has cooled to room temperature. This emulsion is stated to be a smooth and lightly coloured cream of excellent stability which may be applied directly to the growing tips of plants with a camel's hair brush. For spraying a more dilute solution should be used, which can be obtained by mixing one part of the emulsion (minus colchicine) with 4 parts by volume of water containing the desired quantity of colchicine in solution. Generally a strength of 0·4% is convenient but it may be varied from 0·1 to 1·0%. Such an emulsion is sufficiently fluid to be sprayed without difficulty and will remain stable over long periods of time if kept in a cool place. Other formulae comprising glycerine and "Santomerse" (a preparation supplied by the Du Pont Co.) are given by Dermen (1940). Some workers recommend the addition of small quantities of alcohol since this improves penetration.

Colchicine can be sterilized in solutions in the autoclave, remains unaffected by light, and keeps for considerable time. The same solution may be used several times in succession.

While some of the methods may prove to be of general application, others may be of use only with some particular material. Even related species sometimes differ in the degree of their sensitiveness to colchicine treatment and no definite rules can therefore be formulated as regards the concentrations to be used. While treatment with low concentrations and for short duration may be ineffective, application of high percentage or for long periods may seriously check the growth or even cause death. When working with a new material, the best way would be to perform a preliminary experiment with various percentages of colchicine and for different durations and then select those giving the best results for further investigations.

(*b*) *Treatment of seeds and tubers.*—The effect of colchicine treatment of seeds first manifests itself in slow germination and the seedlings, the growth of which is retarded, show a characteristic swelling of the hypocotyl, more noticeable in some species than in others. Many distortions occur, each characteristic of a particular species.

The seeds may first be soaked in water and then in dilute solutions of colchicine varying in concentration from 0·1 to 1·0%. The influence upon the seedlings depends upon such factors as the concentration of solution, period of soaking, nature of testa and the rapidity with which the seed germinates. In some cases it has been suggested that the seeds should be stripped of their coats before soaking or that they should be germinated before treatment. With *Datura stramonium* (Blakeslee and Avery, 1937) an effective method is to soak the seeds in 0·2% to 0·4% solution for 4 to 10 days before sowing. Seeds of *Portulaca* (Blakeslee and others, 1938) have been found to respond to a treatment lasting for 2 days with a concentration as low as 0·0002% by producing seedlings with swollen stems. Myers (1939) treated seeds of *Lolium perenne* by placing them in petri dishes on blotting paper moistened with 0·1, 0·2 and 0·4% aqueous solutions of colchicine. Sufficient solution was used to provide moisture conditions that seemed optimum for germination. For this purpose about 55 c.c.s of the solution were used for each petri dish. Treatment was continued for 6, 24 and 96 hours for each concentration of colchicine, after which the seeds were transferred to blotting paper moistened with tap water. For control, seeds were germinated in petri dishes on blotting paper wet with tap water. Treatments for 24 hours with 0·2 and 0·4% solutions of colchicine were found to be the most satisfactory; approximately 40% of the plants

* Special attention in this connection is drawn to two papers, viz., "Methods of inducing doubling of chromosomes in plants" by Blakeslee and Avery (1937) and "Colchicine polyploidy and technique" by Haig Dermen (1940).

developed 4n tissue and some of them were completely tetraploid. Pal and Ramanujam [(1939) see also Pal, Ramanujam and Joshi, 1941] obtained numerous tetraploid plants of *Capsicum annuum* by immersing the seeds in colchicine solution of various strengths from 0·05 to 0·4% for 1-8 days. Lutkov (1939) got many tetraploid plants of flax by treating germinating seeds or growing tips of plants of different varieties. Polyploidy in spring rye was induced by treating seeds from 2 to 5 days with 0·02 to 0·04% colchicine solutions and was found to be accompanied by an increase in the size and weight of seeds (Breslavetz, 1940). Richharia and Persai (1940) induced tetraploidy in *Sesamum orientale* by treating seeds with 0·06% colchicine solution for 2 hours. Ramanujam and Joshi (1941) have produced tetraploid gram with bigger leaves, flowers, pods and seeds than those of the diploid by immersing germinating seeds in 0·25% aqueous solution of of colchicine for ½ hour.

Johnstone (1939) induced chromosome doubling in potatoes both by seed and tuber treatment. The seeds were treated with a 0·5% aqueous solution during germination and the tubers with 0·1% colchicine in lanolin paste in such a way that the germinating sprouts had to grow through the paste. Levan (1939) treated 2,000 seeds of *Petunia* with solutions from 0·1 to 2·0% for 20 hours. The treatment proved to be too strong and only 93 seeds germinated. Among the 36 specimens that were studied 6 octoploid branches were obtained while the number of tetraploid ones was much larger. The octoploid specimens, however, were found to be inferior to the diploid ones. In *Sequoia gigantea* Jensen and Levan (1941) induced tetraploidy by germinating the seeds in petri dishes on filter paper moistened with 0·1 and 0·2% colchicine solutions.

(*e*) *Treatment of seedlings.* (*i*) The Immersion method.—Freshly germinated seedlings may be immersed in colchicine solution in a shallow dish or placed on filter paper, moistened with the solution, for 3 to 24 hours. When the seedlings are to be treated at the time of transplanting, a bundle of them may be placed upside down in a beaker containing the colchicine solution in such a way that only the shoots are submerged. To prevent the roots from drying up the beaker containing the plants and the solution should be placed in a moist chamber. In treating potted seedlings the soil should be covered, with a piece of cardboard, in order to prevent the soil from falling when the pot is inverted. Immersion periods of one to six hours have been sufficient in many cases. Tang and Loo (1940) have obtained tetraploid plants of soya bean, pea, wheat and rice by soaking young seedlings in 0·05% to 0·1% colchicine solutions. The plants exhibited the normal morphological characters associated with polyploids. Rybin (1939) has induced tetraploidy by this method in *Helianthus annuus*, hemp and *Vicia faba*.

(*ii*) Watering the Soil with Colchicine Solution.—Dermen (1940) states that he was able to induce polyploidy in *Cosmos* by moistening the soil over and around the seedlings with 0·02 to 0·1% aqueous solutions of colchicine just as they were pushing the soil up. This method has the advantage of not disturbing the seedlings and, therefore, entails less mortality.

(*iii*) The Drop Method.—Another method of treating the seedlings is to put a drop of colchicine solution on the growing point, the process being repeated as the drop dries up. Blakeslee and Avery (1937) treated three squash plants in the cotyledon seedling stage with 4, 12 and 30 drops of 0·4% solution and all the three plants gave positive results varying in magnitude according to the number of drops applied. The more the drops applied, the less was the growth. The same workers induced tetraploidy (as indicated by roughened leaves) in one specimen from *Nicotiana tabacum* × *N. glutinosa* by applying 4 drops of 4% solution. The editor of the Journal of Heredity (1938) states that tetraploidy was induced in *Zinnia* resulting in the production of larger flowers by using the drop method to newly emerged seedlings. Newcomer (1941) treated seedlings of *Cosmos bipinnatus* variety "Early sensation" with a 0·2% solution of colchicine in emulsion and found that the tetraploid form produced was larger in every morphological comparison made, with the exception of height, than its diploid progenitor.

(*iv*) The Capillary Method.—"A capillary string with one end immersed in solution and the other end wrapped around the buds has been found to be an effective way in which to bring the active agent in contact with the meristematic tissue" (Blakeslee and Avery, 1937).

(*v*) The use of Colchicine-agar.—Levan (1939) treated a large number of *Petunia* seedlings with 1% colchicine-agar consisting of equal parts of 2% colchicine solution and 3% agar solution. Shortly after the first transplanting 2500 seedlings which had developed only the first two leaves, were treated. The plumules were thoroughly covered with a layer of tepid colchicine-agar applied with a small brush, and a large number of tetraploids and two octoploids were thereby obtained. The effect became visible soon after the treatment. The treated plants ceased growing and entered upon a resting period. This condition lasted for one to two months, after which signs of new growth were discovered and the specimens were transplanted in the field. The apical growing point swelled and often spread into a tumour like formation. The tetraploids were almost always giant-forms with larger leaves and flowers, the entire habit being coarser and more vigorous. It is remarkable that all the tetraploid flowers maintained the characteristic qualities of their line and hardly ever differed in any qualitative properties. It is also to be noted that the flowers from the octoploids, though larger than those from the diploids, were smaller than the flowers of the tetraploid forms.

With a similar method of treatment *Beta* proved to be a difficult subject as the new tetraploid cells could not compete successfully in development with the normal diploid ones. But when the treatment was applied immediately before flower development so that the diploid cells did not get sufficient time to overtake the tetraploid cells until the latter had already participated in the formation of the sporogenous tissue, purely tetraploid "side-branches" were obtained and these subsequently gave both triploid and tetraploid progeny (Rasmusson and Levan, 1939).

(*To be continued*)

The Late Sir Arthur William Hill

BY the tragic death of Sir Arthur Hill, director of Royal Botanic Gardens, Kew, in a riding accident on the 3rd November 1941, botanical science has lost one of its distinguished votaries.

Mr A. W. Hill, M.A., fellow and dean of King's College, Cambridge and university lecturer in botany, was appointed assistant director of the Botanic Gardens, Kew in 1907. He was admitted to the Fellowship of the Royal Society in 1920, and perhaps in that year (1920) he received a commission in the Army as Captain. On the 19th January, 1921, he was deputed, with the concurrence of the Ministry of Agriculture and Fisheries, by the Secretary of State for the Colonies to visit and report on the Botanical Gardens of Victoria, Cameroons and Nigeria.

Dr A. W. Hill, F.R.S., assistant director, succeeded Lt.-Col. Sir David Prain as director of the Kew Gardens on the latter's retirement on the 28th February, 1922. In 1922 Hill received the honour of the Companionship of the most Distinguished Order of St. Michael and St. George, and the Knight Commander of the same order in 1931.

On the invitation of the Commonwealth Council for Scientific and Industrial Research, Melbourne, Dr Hill left England in November, 1927, to visit Australia. He also visited New Zealand at the request of the Dominion Government with a view to studying the various botanical and allied institutions in the States on behalf of the Commonwealth. He returned through Java, Malaya and Ceylon to London in February, 1928.

Hill was appointed a corresponding member of the "Sociedad Argentina de Ciencias Naturale" in 1930, and was president of the Imperial Botanical Conference, held in London in the same year. He also visited the Union of South Africa between October, 1930 and March, 1931, at the invitation of the Union Government. He was an honorary life member of the Botanical Society of South Africa and California Academy of Sciences and was also a corresponding member of Deutsche Bot. Gesselschaft. He became the editor of the 'Botanical Magazine' after the death of Dr O. Stapf and was elected corresponding member of the Botanical Society of New York and honorary member of the Pennsylvania Horticultural Society. He was awarded Victoria

Medal of Honour of the Royal Horticultural Society. He was also a member of the Orchid Circle of Ceylon and corresponding member of the Netherlands Botanical Society. In 1937 he was awarded the Veitch Medal of the Royal Horticultural Society. In 1940, Sir Arthur was awarded the George Robert White Medal of Honour by the Massachusetts Horticultural Society.

Sir Arthur was one of the distinguished delegates who came to attend the 25th Session (Silver Jubilee) of the Indian Science Congress in January, 1938. His visit and activities in India have been described at length in Kew Bulletin, 1937 and 1938. During his stay in Calcutta he was fully engaged attending the various meetings connected with the Congress. He read a paper on "The Seedling Structure of the Gesneriaceae" before the botanical section of the Congress and took part in discussions on papers presented to the section. He also broadcasted an address on the Royal Botanic Gardens, Kew, and its connection with India, and addressed the annual meeting of the Indian Botanical Society. He took part in the discussion on "A National Herbarium for India" in the botanical section of the Association in co-operation with the Botanical Society.

Sir Arthur attended the 150th anniversary meeting of the Royal Botanic Garden, Sibpur, held on 6th January, 1938, with the Nawab Bahadur of Dacca, Minister for Industries and Agriculture, Bengal, in the chair. His address to the gathering is being published in the 150th Anniversary Volume of the Royal Botanic Garden, Calcutta, which is now passing through press.

As the Ripon Professor, Sir Arthur delivered three lectures before the members of the Indian Association for the Cultivation of Science; the first related to the history and functions of botanic gardens and to Kew's connection with India in particular, while the other two dealt with matters connected with seedling structure and the germination of certain abnormal types of seed. The lectures* have now been published with illustrations.

Detailed discussion was carried on with Sir Arthur by the present superintendent, Royal Botanic Garden, Calcutta, in connection with the policy to be adopted regarding return of some valuable botanical specimens which were presented to the Kew Herbarium and acquisition of rare specimens for the Calcutta Herbarium in order to fill up many lacunae in the collection of Indian and Asiatic plants. Recently Sir Arthur was kind enough to make several gifts of hundreds of specimens to the Herbarium.

At the close of the Congress Sir Arthur visited various places in South India including Puri. He took full advantage of the opportunities for studying the vegetation and the various cultivated crops in the country and visited important centres for research work. After spending 2 months in trains during the Indian tour, Sir Arthur reached Kew on February, 13.

"The Histology of the Sieve-tubes of Pinus" (1901) and "The Histology of the Sieve-tubes of the Angiosperms" (1906) are two of his most important papers. Sir Arthur published numerous scientific papers dating from 1906 in the 'Annals of Botany', 'Journal of the Linnean Society', 'Kew Bulletin', 'New Phytologist', Engler's 'Botanische Jahrbucher', 'Nature', and in many other journals.

At a meeting held on the 6th November, 1941, at the Herbarium, Royal Botanic Garden, Calcutta, the following resolution was adopted:—

"The Staff of the Royal Botanic Garden, Calcutta, Lloyd Botanic Garden, Darjeeling, and Calcutta Gardens and the Scientific Officers of the Botanical Survey of India at the Herbarium express their heartfelt sorrow at the sad and sudden demise of Sir Arthur W. Hill, K.C.M.G., M.A., Sc.D., D.Sc. (Adelaide), F.R.S., F.L.S., V.M.H., Director of the Royal Botanic Gardens, Kew.

"The connection between the Royal Botanic Garden, Calcutta, and the younger garden—Royal Botanic Gardens, Kew—is of very long standing and has become traditional. The Royal Botanic Garden, Calcutta, has profited enormously by the generous gifts and exchange of herbarium specimens, seeds, plants, bulbs, etc., received from the Directors of the Royal Botanic Gardens, Kew, since its first Director, Sir Joseph Dalton Hooker. In various scientific matters regarding botanical, horticultural and arboricultural sciences the two Empire institutions are intimately connected. The help and guidance in various scientific matters that Sir Arthur Hill offered to this institution during the period of his career is very much appreciated. We all offer our sympathy and condolence to Miss Hill, sister of the late Sir Arthur Hill and to the rest of the members of his family."

The Herbarium and the Garden offices remained closed for one day in respect of the memory of the late Sir Arthur Hill.

K. Biswas.
V. Narayanaswami.

* The Indian Association for the Cultivation of Science, Special Publication No. 8, Calcutta, 1939, price 2s.

Notes and News

STONE AGE CULTURE IN GUJARAT

THE Archaeological Survey of India recently organised an expedition for the study of the prehistory of Gujarat with the co-operation of a number of institutions and scholars. Although the archaeological department has hitherto organized systematic work on a large scale at sites belonging to the historic and prehistoric periods, particularly in Northern India, the occurrence and sequence of the earlier Stone Age cultures were not brought within the purview of its activities. Much interest has now been taken in this subject, particularly since the British-American expedition led by Dr de Terra of the Yale University, worked on the Ice Age and connected human cultures in North-West India and other areas. The archaeological department has in hand a bibliography of South Indian prehistory, which is expected to serve as the basis of future work. The pioneers of research in India's Stone Age were geologists, particularly R. Bruce Foote, who over 50 years ago found palaeolithic implements in Peninsular India so far north as Gujarat. One of the problems stated by Bruce Foote concerns the age of the palaeolithic culture in the Sarbarmati valley and the gap or distance in time between that and the neolithic or later Stone Age culture. This has now been investigated by the Gujarat Prehistoric Expedition organized by the Archaeological Survey.

The area chosen for this year's work is the Baroda State, and part of the Sarbarmati valley which lies in the Vijapur Taluka of the Baroda State has already been surveyed. Here, the examination of the river bed for a length of nearly 25 miles has yielded hundreds of specimens of quartzite implements, mostly found embedded in the pebble conglomerate formation. The age of these deposits is indicated by the fact that nearly 80 feet of alluvial deposits and blown loess overlie the original river bed forming the habitat of early Stone Age man. This roughly indicates the age as some 50,000 years. Besides these early Stone Age finds, a number of microliths or tiny stone implements left by man have been recovered from the top strata of the loess hills. It is now proposed to extend the work to the valley of the lower Narmada and its tributaries, where Bruce Foote recovered other Stone Age finds.

Thanks to the ample facilities afforded by Sir V. T. Krishnamachari, the dewan of Baroda, it was possible for the archaeological department to extend this expedition to Baroda State. Two scholars especially trained in prehistory have been engaged by the department, and the Deccan College Post Graduate and Research Institute, Poona lent the services of its professor of ancient Indian history. The Baroda Archaeological Department, the Gujarat Sahitya Sabha and the Gujarat Research Society have also co-operated. The results obtained so far have considerably advanced the scientific knowledge of early man in India, and it is hoped that if this enterprise is continued on a systematic basis the story of India's earliest inhabitants would be better known and a chapter of human endeavour in its earliest form will be unearthed from the fruitful banks of India's rivers.

REPORT OF THE INSPECTOR OF MINES IN INDIA

THE annual report of the chief inspector of mines in India for 1940 gives an analysis of serious accidents in Indian mines due to explosion, suffocation and haulage etc. The activities of the Mines Board of Health, of the Mining Boards in Bengal, Bihar and the Central Provinces and of the various scientific and technical associations have also been reviewed. During the year under review there were 261 fatal accidents and 1,410 serious accidents involving injuries to 1,483 persons in the mining industry in British India. Of the fatal accidents, 75·48 per cent were due to misadventure, 8·05 due to fault of the deceased, and 4·21 due to fault of management. There were 17 dangerous occurrences underground during the year. Two of these were due to outbreak of fires at old fire areas underground, 13 to spontaneous heating underground, one to a fire in a coal stack on the surface and one was caused in an underground return airway, presumably due to an open light.

Falls of roof and sides accounted for the largest number of persons killed in and about the mines and electricity caused the least number of deaths. Causes of several important accidents which occurred during the year were investigated and recommendations were made for minimising such accidents in future.

Great difficulty is experienced, according to the report, in working thick seams of coal at great depths due to "bumps" or falls as the pillars of coal are extracted. From experimental work so far carried out, it has been found that bumps can be eliminated by working the thick seam in sections by sand-stowed longwall faces. This is preferable to the system of driving galleries to form pillars and then extracting the pillars.

Health conditions in the major coalfields of Raniganj and Jharia during the year under review were at a higher level than that of the general population and there was a decline in the death rate. There were 17·8 deaths per thousand in 1940 as against 21·4 per thousand in 1939 in Raniganj coalfields. The death rate in Jharia coalfields fell to 13·85 per thousand in 1940 as against 15·05 per thousand in 1939. Intensive anti-malaria and anti-leprosy measures were carried out in both the coalfields during the year. In Jharia, the five-year housing programme, enforced by the Jharia Mines Board of Health in 1936, was completed during 1940.

During the year under review, 3,227 separate inspections of 1,181 mines were made. The causes and circumstances of nearly all fatal accidents and serious accidents of importance and all complaints of breaches of regulations and rules were investigated. Inspections were also made at the invitations of the mine-owners, superintendents and managers, desirous of obtaining advice on safety matters.

In the major coalfields, inspectors were largely occupied in investigating causes of actual or threatened damage to dwellings and roads by reason of the underground working of coal mines, in dealing with underground fires and in examining protective works against risk of inundation. Inspections of sanitary conditions of mines were made by medical officers as ex-officio inspectors of mines.

INDIAN CENTRAL JUTE COMMITTEE

IN pursuance of its policy of associating the universities in research work on jute, the Indian Central Jute Committee has sanctioned a grant of Rs. 16,580/- for 1942-43 to be distributed as follows:

University of Calcutta—Schemes for X-ray research on jute fibres by Prof. M. N. Saha—Rs. 5,060/-; Investigation on the chemical utilisation of jute and the jute waste by Prof. B. C. Guha—Rs. 2,800/-; Bio-chemical investigations of the processes involved in the retting of jute by Prof. B. C. Guha—Rs. 2,300/-; Reseadches relating to the growth and development of jute fibre by Prof. B. C. Kundu at Presidency College—Rs. 3,120/-.

University of Dacca—Scheme for impregnation of bleached fibre with suitable resins by Prof. J. K. Chowdhury—Rs. 3,300/-.

The total approximate financial liability of the Committee in connection with these schemes, spread over three years, is expected to be Rs. 46,980/-.

SOLAR PHYSICS OBSERVATORY, KODAIKANAL

STUDIES of the periodic phenomena connected with solar activity, such as, the number and dimensions of spots, prominences, bright and dark markings, have been continued at the Solar Physics Observatory, Kodaikanal. The present solar cycle, which began in 1933, reached its maximum intensity in 1937, remained at the maximum all through 1938 and is now on the down grade and may be expected to reach its minimum in 1943-44.

Some of the short-lived, sporadic phenomena studied are the eruptions which present a variety of appearances and effects. On several occasions eruptions on the sun were found to cause radio "fade-outs" and general dislocation of radio communications. Particularly, when vigorous eruptions in the neighbourhood of sunspots close to the central meridian were observed, magnetic and electric disturbances invariably occurred on the earth. A remarkable instance of such solar influencs on terrestrial conditions was the great magnetic storm and auroral display of March 24, 1940, when a great eruption affected several hundred million square miles of the sun's visible surface.

During the last few years research work in this Observatory has continued on several lines, and interesting results have been achieved.

REPORT OF THE LIBRARY OF U. S. CONGRESS

THE annual report (1939-40) of the Library of Congress, Washington, gives an account of the development of Indic studies and the contact established with different universities and academic centres in India. Dr Poleman, the director of Indic studies, went out for a year's tour of India and the Middle East and among other places visited

Philippine Islands, Java, Indo-China, Malay, Ceylon and India. He spent nearly eight months in India where he visited the seats of the important universities which are now including in their curricula new and rigorous study of India's culture and of her achievements. Exchange of publications and mutual use of resources were arranged with a large number of institutions. Some of the large museums also expressed their willingness to co-operate with Indic studies at the Library. Many of the cultural organizations in India where the director paid visits, showed appreciation of the activities of American scholars and educators in the Indic field. Libraries owning valuable manuscript collections were enlisted. These manuscripts will be gradually microfilmed, which will give American scholars easier access to these valuable research sources than they had in the past. The library purchased some more books of antiquarian value representing a notable addition to the Indic collection. Several old manuscripts in Sanskrit, Pali, Hindi and other Indian vernaculars have also been purchased. Dr Poleman made motion pictures of some of the old Vedic rituals on the Malabar Coast and microfilmed, while in India, 6000 pages of rare Indian manuscripts in Sanskrit and other dialects. As a result of Dr Poleman's efforts microfilm facilities now exist in different parts of India and microfilm copies of all important manuscript may be easily secured if desired by foreign scholars. The microfilm service will not only make those research materials easily accessible but also help in preserving old and valuable documents from extinction. Upon his return to the Library in November 1940, Dr Poleman has busied himself in integrating the results of his Indian tour.

NATIONAL INSTITUTE OF SCIENCES OF INDIA

IN his presidential address delivered at the last annual meeting of the National Institute of Sciences held at Baroda in January last, Dr B. Prashad gave a review of the activities of the Institute during last year. The number of fellows at the end of the year was 179 ordinary and 23 honorary fellows. With a view to maintaining and extending the activities of the Institute some changes in the rules have been effected which have made it possible to increase the number of annual elections up to 15. Two ordinary meetings were held during the year and a symposium on "Heavy Chemical Industries in India" was held in the physics lecture theatre of Delhi University on the 19th April, 1941. Three numbers of the *Proceedings*, one number of the *Transactions* and one number of *Indian Science Abstracts* were published during the year. The president emphasised that it was not possible for any one person to run the publications of a learned society like this without the active help of a number of editors and workers and the question of having a permanent staff for looking after the preparation and publication of *Indian Science Abstracts* was becoming more and more patent. He expressed the hope that the Council would undertake next year a preparation of a quinquennial review of progress of science in the country.

Dr Prashad stressed the necessity of having in India a central co-ordinating and directing agency for organisation and development of scientific studies and research in India. He strongly urged the authorities to consider the constitution of a truly representative National Research Council in India on the lines of the bodies which have been rendering such useful service in Great Britain, Canada, South Africa and Australia. Such a body will be helpful in not only defining scientific policy but may also act as an expert advisory body for planning and co-ordinating all scientific research in the country and may help in bringing about the necessary reforms in the existing system of scientific education. Dr Prashad regretted that hitherto all efforts of the Institute for the establishment of a National Research Council for India have been unsuccessful; but the Institute will be failing in its duty if it does not continue to press for the constitution of such a Council at an early date.

MOBILIZATION OF SCIENTISTS IN BRITAIN

A MODERN war can be only fought by countries with a large number of trained physicists and engineers. Even countries like Great Britain, Germany, Russia, U. S. A. etc., which are adequately equipped in this specialized man power have to see that all these existing scientists are used to the best of their capacities and have to make proper arrangements to train a large number of young men in the key sciences. The British Government's ministry of labour started a register of men with high scientific qualifications on a voluntary basis. About a year after the war started scientists with a honours degree were compelled by law to register. The register helps to see that every scientist is playing his fullest part in the war. Thousands have been engaged in research laboratories and ordnance factories. They have been appointed to technical commissions in the land, naval and air forces and many others are doing essential research, development and production work in industry. At the same time the authorities have not forgot to keep sufficient qualified men in the universities and schools to do

the equally important task of maintaining the supply of scientific men. To fill the gradually increasing demand of scientists it has been arranged that all boys with higher school certificates in scientific subjects will be paid for at the universities at the expense of the State. This scheme of State bursaries shows Britain's appreciation of the fact that the present war has to be fought by scientists and she must have more of them.

How the inventive faculty of the people has been excited by the needs of war is apparent from the fact that in 1940 the war office received 34,540 suggestions. About one out of every four hundred suggestions is found to be of practical use and occasionally useful suggestions come from those who had no previous interest in or experience of military inventions. A boy of twelve sent to the War Office interesting suggestions accompanied by excellent drawings for innovations in tank design.

DEVELOPMENT OF THE BRITISH BROADCASTING SERVICE

SIR Noel Ashbridge in his presidential address to the Institute of Electrical Engineers gave a review of the growth of broadcasting in Britain from when the public service began in 1922 up to the present time. Prior to the war, the British Broadcasting Service utilised transmitting stations operating on wavelengths in the long and medium wavebands, agreed upon at various international conferences for the use of all European broadcasting stations. These wavebands could at most accommodate 126 transmissions whereas in practice 340 stations were provided for, thus necessitating a considerable amount of sharing of wavelengths between two or more stations. As a result of constant attention and research, in 1939, the B. B. C. had achieved the position whereby 90 per cent of the public could obtain good reception of two programmes and more than 98 per cent of one programme. The number of British wireless licences has uniformly increased at the rate of half a million a year from 1922 up to 1939 when nine millions licences were issued. In 1927 overseas broadcasting service on short wavelength was started and considerable extension and development have taken place since then. At the present time, broadcasts in some forty languages are transmitted from Great Britain. In the field of television, Great Britain was the first to inaugurate a regular service for reception by the public in their own homes. Commenting on the recruitment of young engineers from technical colleges and universities Sir Noel expressed the opinion that there is room for closer collaboration between teaching and industry and some amount of business and administrative instruction should be given to technical students. Referring to difficulties arising in the past concerning international aspects of broadcasting, Sir Noel expressed the hope that after the war a sound wavelength plan would be built up on national principles and with due regard for technical facts and free from much of the politics which have coloured may of the international conferences in the past.

BOTANICAL SURVEY OF INDIA'S ANNUAL REPORT

"INDIA is a country abounding in varieties of medicinal plants and there seems to be no reason why India with such abundance of raw materials for the manufacture of drugs should not be self-sufficient as regards medicines", says the annual report of the Botanical Survey of India for the year 1940-41. During the year the Industrial Section of the Indian Museum, Calcutta, has been of great assistance to the public and the commercial community by furnishing notes and reports on economic plant products and by giving advice on substitutes for imported commodities.

The Industrial Section has particularly helped in a thorough study of developing an essential oil industry, in investigating possibilities of cultivating a number of perfume-yielding plants and in finding out sources of several indigenous vegetable dyestuffs, of certain resin, gum and tannin-yielding plants and of several industrial products.

Among enquiries dealt with by the Botanical Survey are possibilities of manufacturing agar-agar and iodine from sea-weeds, the nature and remedy of black and brown patches on the canvas supplied to the military, possibilities of the cultivation of Tung oil (Chinese wood oil) plants, sources of oil-yielding grasses and methods of cultivation of large number of medicinal plants.

Nearly 3,900 specimens were identified and revised during the year. Only 1,075 specimens could be distributed and the loan of herbarium specimens for purposes of critical study was restricted to Indian workers. Among a large number of exhibits added to the already rich collection of specimens in the public gallery of the Indian Museum are samples of some important commercial fibres, certain crude drugs, common Burma timbers and plywood.

The number of publications relating to several branches of Indian botany increased during the year to 127 as against 77 in the previous year.

A bulk purchase of quinine sulphate from Java enabled the Government of India to resume distribution of quinine to the provinces and Indian States. The total of cinchona products distributed during the year was 52,303 lbs. The stock of quinine sulphate at the end of the year was a little over 267,700 lbs. and stocks of bark and cinchona febrifuge were 207,872 and 8,943 lbs. respectively.

ANNOUNCEMENTS

DR B. C. Roy, M.D., M.R.C.P., F.R.C.S., has been appointed vice-chancellor of the University of Calcutta in succession to Sir Mohammad Azizul Haque who is shortly leaving for London as High Commissioner for India. In addition to being a distinguished member of his profession, Dr Roy has actively associated himself with all social, civic and educational activities in the province during the last 25 years. He has been a member of the senate and syndicate of Calcutta University for many years. We hope his wide experience of the educational and other problems of the province will be of great benefit to the university during this troublous times.

THE following awards of medals have been made by the Council of the Royal Society.

Copley medal to Sir Thomas Lewis, University College, London, for his researches on the heart and the circulation.

Davy medal to Dr H. D. Dakin, director, Merck Institute of Therapeutic Research, New York for his contributions to the study of intermediate metabolism.

Hughes medal to Prof. N. Mott, Melville Wills professor of theoretical physics, University of Bristol for his contributions to the fields of nuclear physics and collision theory and theory of metals etc.

Two Royal medals were awarded to Prof. E. A. Milne, professor of mathematics, University of Oxford and Prof. E. L. Kennaway, professor of experimental pathology, University of London for researches on the internal constitution of stars and production of cancer by synthetic substances respectively.

IN connection with the fiftieth anniversary of the University of Chicago which was celebrated a short time ago, the sum of 9,200,000 dollars has already been subscribed by the citizens of Chicago towards an anniversary fund of 12,000,000 dollars. It is planned to raise the balance over a period of five years.

WITH the object of promoting scientific horticulture and advancing the knowledge of horticultural science in India, it has been proposed to organise a Horticultural Society of India. The activities of the society will be directed to publishing an horticultural journal as Proceedings of the Society and also suitable horticultural literature, organising meetings at various horticultural centres by rotation to facilitate intercourse among members; and to create facilities for horticultural work in the country.

An *ad hoc* organising committee with representative of workers from all over India has been formed with Dr G. S. Cheema, horticulturist to the Government of Bombay, as chairman and Dr P. K. Sen as the secretary. Full details may be had from Dr P. K. Sen, horticulturist to the Government of Bihar, Sabour P.O., Bihar.

SCIENCE IN INDUSTRY

AUSTRALIA'S PROGRESS WITH POWER ALCOHOL SCHEME

SOME time ago we published news from Australia that arrangements were on foot by the Commonwealth Government for producing alcohol from wheat to blend with petrol for the purpose of augmenting the national supplies. The Government Committee of Enquiry recommended expansion of the country's production of power alcohol to 52½ million gallons per annum mainly from wheat, with sugar cane as a supplementary source. The wholesale price was fixed at 2s. per gallon and it was stipulated that all motor fuels should contain alcohol from 12½ to 20 per cent. It was found that this range of proportion gave the highest efficiency. Bearing in mind the quantity of petrol withdrawn from the public due to rationing, an annual production of 22 million gallons has been aimed at as the first step towards utilising the surplus stocks of wheat and sugar. Seven millions will be produced from existing anhydrous distilleries, five millions from rectified spirit distilleries and for the remaining ten millions new wheat distilleries will be erected. The first output of seven millions from the existing distilleries will be produced from molasses supplemented by 44,000 tons of raw sugar.

The whole surplus stock of sugar has not been taken up for use in this direction, but more attention has been paid to stock of wheat as it is a commodity of greater national importance in Australia. Costs of producing alcohol from sugar juices are generally less than that required with any other material. An alcohol distillery, as a part of a sugar mill, is much cheaper to construct than a wheat distillery, which requires in addition a complete boiler plant and crushing, cooking and melting apparatuses. But in Australia the extra transport charges for sugar from Queensland to the distilleries at the other and of the country have enabled wheat to compete with sugar.

The Committee of Enquiry appointed during the first stage of the war had issued its report in June 1941 last and the Government action on its recommendation as described above was reported in October 1941. But in our country where surplus sugar cannot be exported under the International Sugar Agreement and molasses are wasted, the situation, which had became grave long before the war, could not move the sluggish wheels of the authorities. Protection stimulated a phenomenal growth of sugar industry but now it faces ruin. Production of power alcohol has not yet merited the serious consideration of the Government, excepting a small beginning in one province, where again the arrangements have been disfavoured by the commercial community.

TOWARDS A 'BETTER' WOOL

FUNDAMENTAL research on the structure of cellulose, the basic constituent of cotton, resulted in the artificial silk industry. News comes from America now that wool fibre has engaged the attention of the research staff of the Textile Foundation. The warmth of wool is due to its ability to regain its original length or shape after it has been stretched, crumpled or stepped on as over a carpet, and this has made it possible to retain air layers between the fibres. The loose porus structure filled with minute insulating air spaces is the characteristic of the woollen fabric. In wool the linear chains of molecules, the common feature of all fibres, are connected together by short cross chains at frequent intervals in all three dimensions. When a tension is set up, the molecular chains of wool unlike those of the other fibres do not slip against each other into a new equilibrium, but the cross chains restore the wool to its original twisted shape when the external force is released.

These cross chains are disulphide or cystine bonds, and have been found to be responsible for the weak features of wool, viz., shrinkage in laundering, edibility by moths, and sensibility to alkalies. Research has enabled chemists to remedy these defects.

The chemists have used thioglycollic acid as the tool to break the bonds and build up stabler links. In order to reconstitute the whole fibre, the rupture of the links is made up by treatment with methyl or ethyl dibromide. The reagent reacts with the broken ends of the cross chains and produces chemically stable links. If only half the links are reconstituted, the desired change in the properties is obtained. The final product retains all the good old properties and gains resistance to attack by moths, alkalies, etc., and to shrinkage. More work will be necessary to choose suitable reagents for speeding up the reactions and improving the processes.

As the present work shows, the high cost of this better wool will make its use very limited. The first use will be in felt for paper machines. Later, people may feel inclined to pay more for ultimate economy to be ensured by the chemically treated wool.

FOREST RESEARCH INSTITUTE

THE present war has thrown its demands on all available organisations and the Forest Research Institute at the first stage of the war had to arrange for actual supplies. The Institute is essentially a research organisation with some pilot plants recently established to help and guide the commercial exploiters of forest products. The abnormal burden of supplying to government demands was a great strain on the machinery and organisation of the Institute. The annual report of the Institute for 1940-41 states that this diversion of work has been remedied. During the year under review it concerned itself with the solution of problems encountered by the supplying agencies and by the ordnance department, thus indirectly remedying defective supplies and ensuring long life and full worth of materials used by the army.

At the same time research work has been continued for industry and trade to find local substitutes of imported articles. The utilisation branch has to bear the major weight of the war demands. The chemical branch has progressed in its investigations on drugs, oils and fats from forest produce and is continuing its work on analysis of forest soils. The silvicultural and botanical branches have proceeded with their regular programmes. The entomological branch was specially asked to identify the insects pests of timbers and bamboos employed in military work and necessary methods for their eradication will be now easy. The timber strength figures collected at the Institute have been helpful to effect economy in wooden sections of the different structures being put up. A perusal of the report convinces one of the immense potentialities of the forest wealth of the country and the present output of the Institute gives promise of a flourishing trade in the country which can be built up to supply our own requirements for which we had been accustomed so long to look outside.

The paper pulp section of the Forest Research Institute has been successfully engaged for the past few years in finding out raw materials of suitable quality out of Indian forests. The experimental factory has also turned out paper on which the report of the Institute has been printed for a number of years. A few other government departments also are reported to have utilised the Institute paper. Production of newsprint has now engaged the attention of the staff and more tests will have to be carried out to decide on the five species of woods so far found useful for the purpose. Experiments were undertaken to devise means of using jute cuttings for the manufacture of better varieties of bleached paper. These cuttings are used extensively in the mixture for brown wrapping paper. Considering the price to be paid for this additional ingredient and for the chemicals for pulping it, the present conditions however, do not warrant any prospect of jute cutting as a staple raw material in the paper industry. Jute dust and waste jute fibre are now being handled at the Institute to see if these can be made into a cheap raw material for paper along with bamboo, sabai grass and waste cotton rags.

NEW AVENUES FOR UTILISING BAGASSE

THE Imperial Council of Agricultural Research gave a grant to the Forest Research Institute to investigate how an economic utilisation of bagasse can be made. The report of the investigation has been recently published. Bagasse is used in the United States for manufacturing insulation boards, sold under the names of 'Celotex' and 'Canec'. Following this lead, the investigators began work to evolve out of the patented processes a suitable and economical method of converting bagassee into insulation and pressed boards. Demands for heat insulation and acoustic corrections in big halls and public buildings are growing in the country, and in addition uses as ceiling and floor linings, plaster bases and partitions offer a further scope for consumption.

Boards have been produced with the desired properties and the investigators expect that difficulties to be encountered during a large scale manufacture will not be formidable. But it has been found that the whole process can be economical only on the minimum annual output of 1600 tons, (600 of insulation boards and 1000 of pressed boards) requiring 2400 tons of air-dry bagasse. A mill located near

the sugar mill centre will have little difficulty in getting this supply of the raw material. The immediate work for commercially exploiting the results of these investigations is to stimulate an increase in the present demand. The present import statistics give a consumption figure at half the production of the smallest economic unit.

Experiments on the production of wrapping paper and straw boards were also included in the programme of the work. Successful utilization of bagasse for both purposes has been made on a semi-commercial scale. But the smallest economic unit for each requires bagasse in such quantities as are not at present available, and if made available the prices may not be competitive. It now rests with the entrepreneurs of our country to provide the atmosphere to make use of these profitable experiments.

DAM ACROSS COLUMBIA RIVER

THE United States have been harnessing water power in gigantic scales. The recent Bonneville dam on the Columbia river has many interesting features. The Columbia river rises in Canada, and after a course of 465 miles it crosses the border into United States and meets the sea after a long flow of 745 miles. In this latter course the river falls through some 1300 ft. Already three dams have been built and others are in contemplation to take advantage of as much of its power as possible. Bonneville dam is built 140 miles from the sea and controls water which is tidal. The dam is built in two sections connected by an earth dam across the island separating the two structures. One is the spillway dam across the main channel on the north of the island and the other is the powerhouse dam on the south. Alongside the powerhouse dam a navigation canal has been excavated and a ship-lock constructed which allows ocean-going vessels many miles upstream. The dam has thus eliminated dangerous rapids and improved the waterway for shipping. The total electric power available with four generating units is about 200,000 kw., two sets are yet to be built.

A large number of fishes pass through the river and the fish industry is valued at £200,000, the chief catch being salmon. These after spawning descend to ocean and again come up for laying eggs. A dam right across the waterway would have ruined the fishery. There are fish locks and fish ladders creating pools higher and higher which make it easy for the salmon to climb from one pool to the next and follow the river in its course. The whole project has linked up fishing, navigation and power generation, the three advantages secured from riverways.

CHLORINE AND SALT CAKE FROM SALT AND SULPHUR

THE demand for chlorine today exceeds the existing capacity for production. It was reported in an earlier issue of this journal that of the total production of chlorine 60% is used for the preparation of organic chemicals, 21% for paper pulp, and 5% only for sanitation purposes. Even under normal conditions, present electrolytic chlorine processes are not economically suited for expansion to meet requirements because of the fact that caustic soda produced by these has yet to find a wider market for easy and quick disposal. The demand for chlorine has enormously increased due to the war. Consequently search for economic methods for the production of chlorine without parallel production of caustic soda has assumed unusual importance.

With the above object a new process has been developed at Columbia University for the production of chlorine by the anhydrous reaction of sulphur trioxide on sodium chloride. Anhydrous sodium sulphate is also produced along with chlorine, for which there is an extensive market in U.S.A. in the kraft paper industry. More than one third of the total quantity of sodium sulphate required in the country used to be imported from Germany before the war.

A brief outline of the process is as follows. Sulphur is oxidised to sulphur trioxide and allowed to react with sodium chloride. Below 115°C, SO_3 combines with NaCl forming $NaCl(SO_3)_2$ which decomposes to $NaSO_3Cl$ between 115° and 120°C. Between 225° and 300°C. three molecules of this sodium chlorosulphonate liberates sodium pyrosulphate ($Na_2S_2O_7$), sodium chloride, sulphur dioxide, and chlorine. On heating this mixture of sodium pyrosulphate and sodium chloride to a temperature above 300°C. sodium sulphate, sulphur dioxide, and chlorine are obtained. The overall chemical changes required by the process and the stoichiometric relations between raw materials and products can be understood from the following equations,

$$2S(rh.) + 2O_2 \rightarrow 2SO_2 \quad \ldots\ldots\ldots\ldots (1)$$
$$2SO_2(g) + \tfrac{1}{2}O_2 \rightarrow 2SO_3 \quad \ldots\ldots\ldots\ldots (2)$$
$$2SO_3(g) + 2NaCl \rightarrow Na_2SO_4 + SO_2 + Cl_2 \quad \ldots (3)$$

SO_2 recycled to Equation 2.

The reaction kinetics, reaction orders, and rate constants of the various steps of the process have been determined by laboratory investigations. From these thermodynamic data possibilities of applying the process to a manufacturing scale is being considered.

N. K. S. G.

Revival of Cottage Chemical Industries in the Punjab

J. L. SARIN

Industrial Chemist, Government of the Punjab, Lahore

IN the economic life of India, cottage industries still play an important part. The establishment of a number of large scale industries in the country has no doubt killed many cottage industries, and the few remaining have been so adversely affected that they are existing just in name. But the fact that some of these cottage industries have withstood all this onslaught shows that there is something inherently good in them. In the present war, it has been amply demonstrated that if given some encouragement and impetus, some of them can flourish and meet our requirements for a number of articles. The industries of blanket-making (which has in a short period of two years supplied more than 20 lakhs of rupees worth of goods in the Punjab alone), leather, wood and metal working, are meeting war requirements with a variety of articles. But such emergent demands are not possible in normal times and it appears essential that if these industries have to survive and thrive, concerted effort should be made to remove some of their most inherent defects. Working from very old times, most of these industries have been running with practically antiquated tools, following rule-of-thumb methods, and practising almost primitive techniques of manufacture. The quality of their output is poor, and the cost of production is comparatively high. They are seldom able to stand any competition from factory industries. Most of these defects can be removed, if we can bring home to the cottage workers the achievements of science, specially in the sphere of tool and plant manufacture, and the modern technique of processing. Since most of the discoveries of modern science have been made in the realm of mass production, they cannot be applied easily to the needs and requirements of cottage or small scale industries and it is essential that some investigations and exploratory work should be undertaken to adapt new methods to the needs of cottage industries. Some work in this direction had been done and is still in progress at the Government Industrial Research Laboratories, Punjab. The principal industries which have received attention so far are pottery, vegetable oils, sal-ammoniac, borax, tanning, perfumery, glue and starch, while industries of paper (hand made), lime, gut and fibre, etc., are included in the future programme of work.

POTTERY

This is one of the more important industries that have been followed in Indian villages. The potter is to be found practically in every village, but lately this number has considerably decreased. In the Punjab the number of potters and their dependants in 1911 was 2,40,000, while it has been reduced to 1,30,000 in 1931, and it is feared that a further loss would be registered in the 1940-41 census. A systematic survey carried out into the working of this industry showed that the goods produced by the potter were hardly of any artistic and commercial value, and with the rising standard in the Indian homes, these goods were gradually being replaced by those of foreign make. The first thing necessary, therefore, was to improve the quality of the goods, and for this purpose some modern appliances were required, and above all a furnace was essential which could be fired by the potter right throughout the year. The present furnace of the potter can only work for about six months in the year. All this was done, and a demonstration party was organised to work among the potters. The pottery central agency has also been established, which aims at producing for the potter new designs of finished goods, and to supply them with ready-mixed body mixture and corresponding glazes. Attached to this central agency is a training class to which potters from all over the province are admitted for training in the improved methods.

VEGETABLE OILS

This industry was practically dwindling out. The entire requirements in oils and cakes were met by the factory industry and the village *teli* was almost disappearing. Wherever he existed he was invariably supplementing his income by taking to agriculture. In the Punjab so late as 1922-23 it was estimated that he crushed as much as 93 per cent of

the seed, while during 1939 he crushed only 35 per cent. As regards numbers, there has been a decline of about 75 per cent during the period of the last 10 to 20 years. Samples of the raw materials and the products made by the *telis* were collected from all over the province and they were examined for their quality, purity and oil content. This gave insight into the causes which were responsible for the decay of the industry. An expert staff consisting of oil demonstrator, assistant oil demonstrator and a mechanic was sanctioned by Government and these men are touring all over the province removing defects of the existing *kohlus* and demonstrating working of the improved ones, as well as introducing the manufacture of such articles as soap and hair oils from the locally produced vegetable oils. As a result of the work of the staff, a number of *telis* in the villages have started producing better quality of oils and have taken to soap, as subsidiary line of manufacture.

GLUE

Glue has been made from very old times and there were engaged in its production a number of families at a place known as Rewari. The workers engaged kept the process of manufacture a guarded secret, but the glue produced by them was of very inferior quality, which had no keeping power, developed fungi and mould, became awfully smelly on standing, specially during rainy days. A process has now been worked out to produce on cottage scale glue free from all defects. Its shear strength *i.e.*, the strength required to rupture a joint made between two surfaces of wood by a film of glue of known thickness, has not been up to the specifications desired by the I. S. D., but glue produced is meeting the demand of the market as required by cabinet makers, hat makers, book binders, match makers, etc. The Government of the Punjab has recently provided a sum of Rs. 2½ lakhs for the establishment of a modern glue factory which would produce glue of I. S. D. specifications.

TANNING

Tanning is a widely distributed industry in the province. It is carried out in most of the districts by men (*chamars*) who have been engaged in the industry from very ancient times. While in most of the other provinces of India, these people have given up their caste profession due to the competition of large tanning concerns of the city, in the Punjab they are holding out, and have kept rural tanning still alive. Once they have been prosperous as is amply seen from the look of the houses in which they carry on their profession, but their condition is now deteriorating, and it will be a difficult task to revive them. Their craft has lived because it is producing a cheap quality of leather which is essential for the poorer people of the village, and which so far has not been made available to them by the factory industry. This, however, cannot continue very long. With a view to bettering the condition of these people, the Punjab Government ordered a thorough investigation into the present state of the industry. An expert was also invited to look into it, and as a result thereof, the Government Tanning Institute at Jullundur has been reorganised. Eight demonstration parties have also been established under an expert supervisor to work in conjunction with this institution. These parties tour the province teaching *chamars* better methods of tanning. Investigations have also been taken in hand to find out new tanning materials which can give better leather at a cheaper cost.

PERFUMERY

The manufacture of perfumes and essential oils had been once a very flourishing industry in the country, but with the introduction of synthetic perfumes the industry has practically died out. There remained a number of isolated places, where some attempts were made to carry on the industry even under adverse conditions, and of these the most important was the distillation centre for rose flowers at a place known as Choya Saidan Shah in the Salt Range. Study into the working of this industry showed that flowers were chiefly distilled for the manufacture of rose water, and the precious otto of roses coming along with it, was mostly allowed to go waste. The introduction of new methods of distillation and preparation of marketable perfumes from rose otto appeared desirable. A modern type of still was installed in this locality to teach these methods to persons engaged in this industry. As a result of the work done the yield and quality of the rose water has improved and the extraction and collection of pure otto of roses has started. Another perfume, which has received attention is the well known *khas* oil (vetivert oil). *Khas* is grown abundantly in the province, and in the past it was practically wasted. Now it is being distilled to produce the *khas* oil, which finds employment in a number of industries used in the manufacture of costly perfumes.

BORAX

From very old times raw borax imported from Tibet *via* Kotgarh (Simla) and Hoshiarpur in the Punjab, and Nainital in the United Provinces has

been refined at Jagadhari near Ambala (Punjab) and Ramnagar near Muradabad (U. P.). In 1924 there were at Jagadhari seven refineries, and at Ramnagar about the same number producing in all about 50,000 maunds of borax every year. Most of the refineries had the peak production of the salt during the last Great War. The industry worked steadily till 1924, when it started showing signs of decay, mostly due to competition of foreign borax, and in the year 1933 it practically disappeared, leaving only one man who continued refining the salt. Some work was done at the Government Industrial Research Laboratories, Shahdara, and scientific methods were introduced for refining of borax, with the result that recently some improvements, have been effected in the industry, and there is promise of its revival.

STARCH

Wheat starch was produced by a large number of small-scale workers all over the province, by the process of fermentation. The process was however declared offensive by the municipality and most of them have stopped working. The production of wheat starch direct from wheat flour was introduced and now the once extinct industry has been revived. Besides, four factories have been established for the production of starch on a commercial scale. They are at present meeting all the requirements of the textile industry at Bombay and Ahmedabad.

SAL-AMMONIAC

Work done in connection with the development of sal-ammoniac has already formed a subject of a separate article published in the columns of this journal (vol. vii, pp. 107-109, 1941-42).

Cottage industries will exist as long as India lives in villages. Most of them may be mere relics of the past industrial greatness of the country, but they cannot fail to remind us of the times when they were the marvels of the whole world. They have lived all these long years, and they are still capable of further existence, if only we give them that attention which they so well deserve. Indian scientists can play an important part in their revival, and it is hoped they will not fail to do so.

REFUELLING THE STARS

What keeps the stars shining? Within the last few years astronomers have answered this question by saying it is the transmutation of hydrogen into helium by means of the carbon cycle, a process which releases radiant energy. But suppose a star uses up its supply of hydrogen? Drs R. A. Lyttleton and F. Hoyle, of Cambridge University, England, have studied the problem and find that the average star's hydrogen supply is inadequate to keep it shining unless it can acquire more hydrogen from the outside.

The space between the stars contains about as much matter as the stars themselves. Although a large proportion of this interstellar matter is calcium and sodium, some hydrogen molecules have been detected. According to the Cambridge scientists, the sun sweeps up some 110,000 tons of hydrogen every second as it rushes through space, and it and the other stars can find all the fuel they need.

—*Sky and Telescope*

MEDICINE & PUBLIC HEALTH

LOCAL APPLICATION OF SULPHANILAMIDE TO WOUNDS AND ULCERS

SINCE the discovery of prontosil, various allied preparations have been made and used in the treatment of different infections. The local application of solutions, powders and pastes has also been studied.

Recently Frank Hawking of the National Institute of Medical Research, Hampstead, England (*Brit. Med. Jour.*, Nov. 15, 1941, p. 685) has made a valuable contribution by studying the efficacy of the local application of sulphanimlamide: (*a*) as a powder to open wounds; (*b*) as tablets or on gauze to deep sinuses; and (*c*) as various kinds of paste to treat inflamed surfaces, burns and wounds which require packing. Formulae for three types of paste in different types of lesions have been recommended.

The powder is more suitable for shallow open wounds. It can be sterilised in packets or bottles by dry heat at 150°C for one hour. The powder can be incorporated on to gauze and used in cases of narrow deep sinuses. The method of impregnation is described in the paper. In the case of a deep sinus, comprssed tablets containing about 0·2 gramme and measuring 8 mm. across may be introduced into the sinus by means of a sinus forceps and crushed there. In case of sulphathiazole, it is necessary to mix an equal quantity of glucose with it, in order to promote the disintegration of the preparation in the tissues. The surface of the tablets can be sterilized by dry heat at 85°C for one hour; heating to 115°C causes the tablets which contain glucose to turn brown.

In making a paste, the following points are to be borne in mind: (*a*) the preparation should be pharmaceutically stable, non-odorous, non-rancid, etc., (*b*) its physical consistency should be suitable for the required purpose, (*c*) the chemical should be liberated from the paste at the optimum rate, (*d*) it should be suspended in a suitable vehicle, and (*e*) the paste should be non-irritant to the tissues and innocuous to leucocytes and it should stimulate healing. Three different types of paste have been recommended to suit three different types of lesion:

1. Sulphanilamide—30%, oleic acid—1·4%, triethanolamine—0·35%, cetyl alcohol and beeswax—each 1·4%, and water to 100%. This is suitable for being spread over inflamed surfaces, such as impetigo.
2. Sulphanilamide—30%, cod liver oil—49%, oleic acid—3·5%, triethanolamine—1·05%, cetyl alcohol, beeswax and other ingredients to diminish rancidity—3·5%, water to 100%. This is specially suitable for burns.
3. Sulphanilamide—30%, cod liver oil—60%, beeswax—10%. This is suitable for gauze packing of wounds.

CENTRAL ADVISORY BOARD OF HEALTH

THE fourth meeting of the Central Advisory Board of Health met at Calcutta from the 26th to the 28th January 1942. Among subjects discussed by the Board were (1) leprosy and its control in India, (2) the control of the incidence of cholera and other bowel diseases, (3) the medical inspection of school children and the teaching of hygiene in schools, (4) the zoning of industrial areas, (5) the improvement of the standard of training of nurses in India, and (6) the control of mosquito breeding in rural areas by the use of pyrethrum insecticide, compulsory revaccination against smallpox and the work of health units in India.

A comprehensive report on leprosy was presented to the Board, which emphasized that "the control of leprosy was the inescapable responsibility of the Government concerned". The Board also emphasized that each provincial Government should lay down an anti-leprosy policy within its budgetary capacity, that leprosy surveys should be conducted in selected areas according to the principles laid down by the Leprosy Survey Committee of the Indian Research Fund Association, that medical

students and doctors should receive special training in the subject and that all categories of the disease should be made notifiable and that the existing laws for the transport of lepers to leprosy institutions should be modified. The Board recognised that the isolation of infective cases still remained the most important measure against the spread of leprosy and that, in view of the susceptibility of children to infection, special steps should be taken to prevent infection among them. The Board further expressed the following opinion with regard to the admission of leprosy cases in hospitals: "There is no adequate reason why, if needing hospitalisation, non-infective cases should not be admitted to general wards and infective cases to infectious wards. It is essential that the attitude of the medical profession as well as of the public should be modified and liberalised in this respect."

As a result of investigations carried out into the epidemiology of cholera, under the auspices of the Indian Research Fund Association, it has been found that the infection is permanently present only in certain restricted areas and that it spreads from such areas into other areas in India. The Board, therefore, considered that a concentrated scheme of sanitary improvements in these endemic areas of cholera, with a view to the elimination of the factors responsible for the incidence of the disease, should prove to be the most effective practical method of controlling the spread of cholera in the country. The prevalence of bowel diseases, such as enteric fever, dysentery, cholera and infection by worms, can be controlled by the provision of protected water supplies for the rural population of the country. The Board emphasized the necessity of planning by governments for the provision of rural water supplies and for creating a rural water supply fund in each Province and State in order that the orderly development of a water-supply programme may be facilitated and proper provision for maintenance may be ensured.

The Board agreed with the opinion of its School Health Committee that satisfactory arrangements for school medical inspection and treatment formed an essential part of an efficient system of education. It was essential not only from the medical but also from the educational point of view that steps should be taken to ensure that children, both boys and girls, attending schools were healthy and kept healthy. It was unanimously agreed that any scheme of inspection must not only include treatment and follow-up but also the provision of supplementary nourishment for undernourished children. The Board recommended that all children attending schools should be given a midday meal whether brought from their homes or provided at the school. The necessity of employment of the right type of teachers who could undertake these tasks, so long as doctors and nurses could not be provided for, was pointed out.

With a view to preventing the haphazard growth of factories and other industrial concerns in residential localities resulting in the production of slums, the pollution of air by smoke and the nuisance caused by the effluents of factories, the Board recommended the zoning of industrial areas in cities and towns, the enacting of a Town Planning Act, the appointment of a director of town planning and the establishment of an expert committee to offer technical advice to Government, local authorities and industrial concerns regarding their housing schemes.

Regarding the question of nursing in India, the need for improving the standard of training and for co-ordinating the activities of the different provincial Nursing Councils was emphasised. The Board also recommended the establishment of a central nursing council and of a central post-graduate school of nursing.

PROPAGANDA LITERATURE ON HEALTH

The following pamphlet issued by the British ministry of labour and national service has drawn our attention. The simple but forceful way in which information about health and hygiene is being disseminated as evident from the following is worthy of emulation by organisations concerned with the health of our people, particularly by their propaganda departments.

BLOOD POISONING

WHAT IS IT? HOW DOES IT BEGIN? HOW CAN IT BE PREVENTED?

The Way is Open.—A wound may be described as an injury which produces a break in the skin surface, with more or less damage to the deeper tissues, depending upon the type and severity of the injury.

Wounds may be classified under four main headings:

(1) Puncture wounds, such as those caused by nails, splinters, etc.

(2) Incised wounds, such as are produced by a sharp knife or broken glass.

(3) Lacerated wounds, resulting in ragged tearing of the skin.

(4) Contused wounds, where the surface damage may be slight but deeper tissues are bruised and crushed.

Three different types of injury all present their own particular hazard with relation to infection.

The Germs Invade.—Infection is produced by the invasion of the body by living organisms known as germs or bacteria. An open wound presents an easy route for such an invasion.

Bacteria are microscopic living organisms which exist almost everywhere. Fortunately, only a few types are disease-producing.

Disease-producing bacteria require three factors for their growth and multiplication—warmth, moisture and nourishment. These three fundamentals are all supplied by open wounds.

When bacteria invade a wound, they immediately settle down and begin multiplying by the simple process of dividing in two about every half-hour. If you are mathematically inclined you can work out the increase over a 24-hour period. This multiplication is in itself of no great importance, but, in so developing, germs produce poisons which irritate the tissues and invade the blood stream, producing the symptoms by which we recognize wound infection or "blood poisoning".

The severity of these symptoms depends, first of all, upon the type of germ producing the poison; in other words the strength of the poison and secondly and most important of all, the power of the body to resist and overcome the infection.

Two kinds of Infection.—Wound-infection bacteria may be classed in two main groups, those that grow in the presence of air and those that will not grow in the presence of air. In the first group we have the pus producing germs while in the second class are the lockjow or tetanus bacillus and the bacillus of gas gangrene. Fortunately these last two types are much less common than the pus germs but they must always be guarded against.

Having briefly considered types of wounds and types of infection we may now ask, "How are these related?" but before going further we should study the structure of the skin and deeper tissues.

First Line of Defence.—The skin forms the first line of defence of the body and acts as a tough protective covering. It consists of layer upon layer of flattened cells somewhat similar to roof-tiles, held together by an elastic cementing substance. This makes the skin pliable and capable of bending and stretching. Beneath this covering is a spongy layer of tissue containing fat, blood vessels, nerves, lymph vessels, etc. supported in a fibrous meshwork.

In an open incised wound or superficial lacerated wound, the elasticity of the skin tends to open the wound and make it gape. An infection in such a wound will probably expend itself more or less harmlessly if the body resistance is on the job.

Dangerous Wounds.—On the other hand, a puncture wound—be it only a pin prick—has very much more dangerous possibilities. Here that same elastic quality of the skin tends to contract the opening and dam up the dirt and germs and force the poisons back into the tissues.

Also, of course, it is in the deep wounds away from the air that the tetanus and gas bacillus develop without producing pus or other symptoms until it is too late to overcome them.

A contused wound presents another factor. We have mentioned that one of the necessities for bacterial growth is food. Now in a contused wound, while the surface injury may be very tiny, beneath this is a mass of bruised blood and damaged devitalized flesh which makes an ideal soil for the development of germs.

It will be readily seen that the dangerous wounds, as regards infection, are not necessarily the ugly, gaping cuts, but the smaller, less painful and less obvious nicks and punctures which are so often overlooked or disregarded.

Repelling the Invader.—There is no doubt that a great many wounds, possibly the majority of wounds, in which infection occurs, become infected after they are caused rather than at the time of wounding. Healthy tissue in a normal individual with good resistance can overcome a certain amount of infection. Our treatment should be chiefly directed towards the preservation of the vitality of the tissue and the prevention of entry of further infection. This can best be accomplished by the prompt treatment of all wounds, even the most minor scratches.

The whole thing can be summed up in a few words. Get 'First Aid' at once even for the smallest wounds and go on getting treatment until the wound is healed.

Every year thousands of factory injuries causing three or more days' absence from work, become septic. In many of these, sepsis is the prime cause of inability to work.

Chemotherapeutical Investigations of some Organic Compounds of Sulphur

TEJENDRA NATH GHOSH

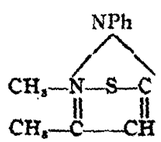
Standard Pharmaceutical Works Ltd., Calcutta

99394

THE study of organic compounds of sulphur presents many points of interest and in at least two directions its importance is being felt more and more strongly—the field of chemotherapy and the field of industry. It is, therefore, not surprising that the number of researches dealing with these substances is on the increase. In recent years the synthesis of organic compounds of sulphur has received a new orientation, and attempts are now being made in several laboratories to prepare pharmacologically valuable synthetic products.

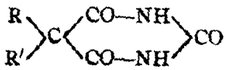
The relation between chemical constitution and physiological action has a significance in the discovery of new drugs similar to the relation between chemical constitution and colour in the discovery of new dyes. Since the commencement of synthetic chemistry in the last century, the chemist and pharmacologist have striven continuously to correlate chemical structure with physiological action. The object of this article is to describe the chemotherapy of some organic compounds of sulphur, so that the present position of the subject may be valuable as a means of opening up new channels of research and of discovering new types of organic compounds of sulphur of pharmacological importance.

Michaelis[1] prepared a series of thiopyrines of the type (I). Their physiological action resembles that of antipyrine, which is a pyrazolone derivative and lowers the body temperature.

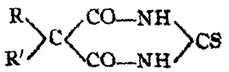


(I) Thiopyrine

Many organic compounds of sulphur have been found to be useful as hypnotics. Baumann and Kast[2] discovered that sulphonal, $C(CH_3)_2(SO_2C_2H_5)_2$, when administered to animals, produced a strong hypnotic effect. Sulphonal and trional, $CH_3—C(C_2H_5)(SO_2C_2H_5)_2$, are of great practical importance, as they are amongst the most widely used hypnotics. The report of the hypnotic action of a series of barbituric acid derivatives by Fischer and Mering in 1903 led to the introduction of barbituric acid compounds into medicinal practice. Miller, Munch and Crossley[3] have prepared a number of thiobarbiturates and have found that they show promise as sedatives. These compounds produce quiet, natural sleep and are free from side actions and after-effects observed following the use of their oxygen analogues. This observation has been confirmed by Tabern and Volwiler[4] who have found that certain thiobarbiturates are definitely more active as hypnotics than the oxygen analogues.



Barbituric acid derivative



Thiobarbituric acid derivative

Hunt and Renshaw[5] have found that acetylthioformocholine produces a very marked lowering of the blood pressure (muscarine action) and that this action is not complicated, as is the case with most of the choline derivatives, by the evidence of any stimulating nicotine action.

The physiological action of p-thiol-β-phenylethylamine, $SH-C_6H_4-CH_2-CH_2-NH_2$, was investigated by Burn[6]. Its power to produce transitory rises of blood pressure was compared with the similar action of p-hydroxy-β-phenylethylamine and has been found to have about 1/6th the pressor activity of the p-hydroxy compound.

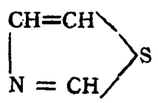
Successful results have been claimed for a sulphur compound in the treatment of syphilis by

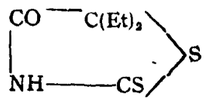
[1] *Annalen*, *331*, 197, 1904.
[2] *Z. physiol. Chem.*, *14*, 52, 1890.
[3] *Science*, *81*, 615, 1935.
[4] *Jour. Amer. Chem. Soc.*, *57*, 1961, 1935.
[5] *Jour. Pharm. Expil. Therap.*, 25, 315, 1925.
[6] *Jour. Chem. Soc.*, *107*, 225, 1915.

Am 2, N35 N42.7

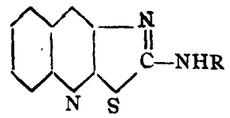
McDonagh[7]. This is di-*o*-amino-phenyldisulphide, NH_2-C_6H_4-S-S-C_6H_4-NH_2, known as intramine. It is administered by the intramuscular injection of a suspension in olive oil. Amberg and Brunsting[8] recently investigated the use of dibenzoyl disulphide, C_6H_5-CO-S-S-CO-C_6H_5, and found it of considerable value as an antipruritic (relieving itching). A synthesis of dibenzoyl disulphide has recently been described by Shelton and Rider[9].

Reference should be made to the chemotherapeutical investigations of thiazole derivatives. Diethylrhodanine (II) has been found to have a narcotic effect slightly greater than that of veronal but with a quicker recovery[10]. On account of its low solubility in water, it can have no practical therapeutic value.


Thiazole

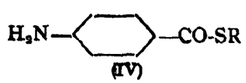

(II) Diethylrhodanine

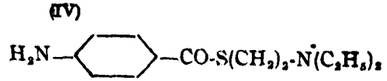
Suter and Johnson[11] have synthesised several thiazoles containing the catechol grouping, $C_6H_4(OH)_2$. These compounds, so far examined pharmacologically, have been found to possess definite analgesic (relieving pain) and anaesthetic action. Ballowitz[12] observed local anaesthetic action in 2-amino-6-ethoxybenzthiazole hydrochloride, although Bogert, Anchel and Husted[13] found the parent compound, benzthiazole, inactive. Some aminophenyl thiazoles and dihydrothiazines, recently synthesised by Babcock and Adams[14], have been found to possess pronounced local anaesthetic action. Some quinoline derivatives have been found to possess pronounced local anaesthetic property[15]. Bovet[16] found that 6-ethoxy -(γ-diethylamino -β-dimethylpropyl) -amino quinoline has marked local anaesthetic properties. He studied the action of other compounds of this series and concluded that the quinoline ring seems to be essential for the local anaesthetic action of compounds of this series. With the object of preparing a very efficient local anaesthetic, some thiazole-quinoline derivatives (III) have rcently been synthesised by Ghosh[17], which, however, have very feeble basicity and do not give stable salts.

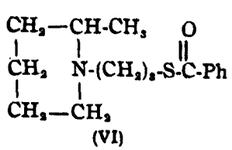

(III)

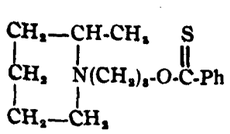
Thiazole ring has been found to be present in vitamin B_1[18], which is built up of a thiazole ring and a pyrimidine ring. It has recently been announced by Science Service of Washington, D.C. that sulphathiazole, which has been developed in the Squibb Institute for Medical Research, New Brunswick, for the treatment of penumonia, has been found to be even more efficacious against this disease than sulphapyridine (2-*p*-amino-benzene-sulphonamidopyridine).

Hansen and Fosdick[19] reported the synthesis of several alkyl esters of *p*-aminothiobenzoic acid (IV) and β-diethylaminoethyl-*p*-aminothiobenzoate which they named thiocaine (V). Thiocaine has an anaesthetic efficiency 4-6 times that of procaine and toxicity only about half that of cocaine. Karjala and McElvain[20] reported the synthesis of 2-methylpiperidinopropylthio-(VI) and -thionbenzoates (VII). All these compounds have been reported as efficient local anaesthetics.


(IV)


(V) Thiocaine

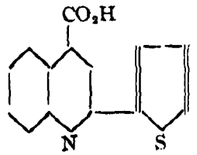

(VI)


(VII)

Many sulphur compounds have been suggested as useful antiseptics, but few have kept their place in therapeutics, the chief exception being ichthyol.

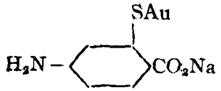
[7] *Lancet*, *190*, 238, 1916.
[8] *Proc. Staff Meet. Mayo Clinic*, *8*, 443, 1933.
[9] *Jour. Amer. Chem. Soc.*, *58*, 1282, 1936.
[10] Leonard, *Medd. K. Ventens-Kapsa-Kad. Nobel. Inst.*, *4*, No. 141-13, 1922.
[11] *Jour. Amer. Chem. Soc.*, *52*, 1585, 1930.
[12] *Arch. Exptl. Path. Pharm.*, *163*, 687, 1932.
[13] *Proc. Soc. Exptl. Biol. Med.*, *26*, 721, 1929.
[14] *J. Amer. Chem. Soc.*, 59, 2260, 1937.
[15] Keyes and McLellan, *J. Am. Med. Assoc.*, *96*, 2085, 1931.
[16] *Arch. intern. pharmacop.*, *41*, 103, 1931.
[17] *Jour. Indian Chem. Soc.*, *14*, 113, 1937.
[18] Williams, *Jour. Amer. Chem. Soc.*, *58*, 1063, 1936. Williams and Cline, *ibid.*, *58*, 1804, 1936.
[19] *J. Amer. Chem. Soc.*, *55*, 2872, 1933; *U. S. Pat.*, 2090, 756, Aug. 24, 1937.
[20] *J. Amer. Chem. Soc.*, 55, 2966, 1933.

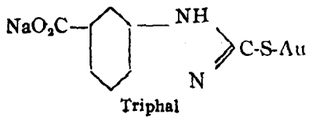
The therapeutic value of ichthyol oils has been attributed to the presence of alkyl thiophens[21]. The influence of the thiophen radicle in increasing the therapeutic activity has been demonstrated by Hartmann and Wybert[22] who have replaced the phenyl group in the cinchophen molecule by the thiophen radicle and have found that the resulting product (VIII) possesses marked antiphlogistic (relieving congestion) and analgesic properties.

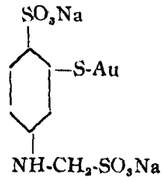

(VIII)

In view of the above findings, 4-hydroxythiopheno-2 : 3-(3′ : 4′)-2′-hydroxyquinoline-sulphonic acid has been synthesised by Ghosh[23], which has been found[24] to be toxic to paramoecia (lower form of vigorous organism) in a dilution of 1 : 5,000.

A great interest has been found in the application of organometallic compounds of sulphur to therapeutic uses. Amino-metal mercapto compounds, such as the sodium salt of 4-acetylamino-2-argentomercaptobenzene-1-carboxylic acid, are useful in spirochete infections[25] (syphilis, etc.). Therapeutic use has also been made of the metallic compounds of thioglucose[26], $C_6H_{11}O_5$-SH. The application of compounds of gold to the treatment of tuberculosis starts from an observation of Koch that inhibition of the growth of tubercle bacilli by gold cyanogen compounds occurs at a dilution of 1 in 2 millions. Two organic compounds of gold and sulphur have attained considerable prominence in Germany for the treatment of tuberculosis, namely, the sodium salt of *p* - amino - *o* - auromercaptobenzenecarboxylic acid (Krysolgan) and the sodium salt of aurothiobenzimidazocarboxylic acid (Triphal). The quesion as to the chemotherapeutic efficiency of these organic gold compounds in tuberculosis is still an open one[27]. Organic compounds of gold and sulphur have also been used in the treatment of relapsing fever. Steiner and Fischl[28] have used di-sodium *p*-sulphomethylamino-*o*-auromercapto-benzene sulphonate (Solganal) in the treatment of relapsing fever. According to Paldrock[29], solganal, in association with the local application of carbon dioxide snow, has some curative action in leprosy.


Krysolgan


Triphal


Solganal

Randall[30] introduced sodium antimony thioglycollate and the triamide of antimony thioglycollic acid, $Sb(S\text{-}CH_2\text{-}CO\text{-}NH_2)_3$, in the treatment of granuloma inguinale (warty growth with glands in loins). These compounds were used with success by Shattuck, Little and Coughlin[31] in several cases of the disease. Sulphoform (Triphenyl-stibine sulphide), $(C_6H_5)_3SbS$, is employed in treatment of skin diseases, such as eczema and psoriasis (skin disease with scale formation). Thio-bismol[32] has been found to be effective in the control of therapeutic malaria. The antimalarial property of thio-bismol, $Bi\ (SCH_2\text{-}CO_2Na)_3$, cannot be directly attributed to either the bismuth element or the thioglycollate radical; both prove to be ineffective when given separately in other chemical combinations. It is established by this study that thio-bismol possesses at least mild anti-malarial properties. Waugh and Heering[33] have suggested that thio-bismol injected subcutaneously is satisfactory for clinical use in the treatment of patients with syphilis. Carbarsone is extensively used in the treatment of amoebic dysentery. The substitution of an atom of sulphur for oxygen in the carbamido radical of Carbarsone with the production of $AsO_3H_2\text{-}C_6H_4\text{-}NH\text{-}CS\text{-}NH_2$ produces a consider-

[21] Scheibler, *Arch. Pharm.*, *258*, 84, 1920.
[22] *Helv. Chim. Acta*, *2*, 60, 1919.
[23] *Jour. Indian Chem. Soc.*, *14*, 713. 1937.
[24] Ghosh, SCIENCE AND CULTURE, *6*, 308, 1940-41.
[25] *Brit. Pat.*, 201,302.
[26] *Brit. Pat.*, 293,363.
[27] De Witt, *J. Inf. Dis.*, *23*, 426, 1918.
[28] *Klin Wchnschr.*, *8*, 582, 1929.
[29] *Arch. f. Schiffs-u. Trop. Hyg.*, *31*, 459, 1927.
[30] *Am. J. Med. Sc.*, 729. 1924.
[31] *Am. J. Trop. Med.*, *6*, 307, 1926.
[32] Schwartz, *J. Pharm. Exptl. Therap.*, *65*, 173, 1939.
[33] *Hosp. News*, 5 :27. 1938.

able reduction in toxicity. Amoebicidal activity, however, is likewise decreased.[34]

Until a few years ago no real advance had been made towards the effective treatment by chemotherapy of diseases due to bacteria. A whole new field has been opened up by the discovery of Domagk[35] that certain azo-dyestuffs (commercially called "prontosil") containing a sulphonamide group exert a remarkable curative action on animals infected with streptococci. An important advance was made by Trefouel, Nitti and Bovet[36] when they discovered that the curative action was possessed not only by azo-dyestuffs but by the simple parent compound, *p*-aminobenzene-sulphonamide, NH_2-C_6H_4-SO_2NH_2. In a study of related azo-compounds they discovered that those in which the sulphonamide group was not attached to one benzene nucleus were inactive. Furthermore, if the sulphonamide group was nuclear, a variety of substitutions could be made in the other benzene ring without greatly influencing the antistreptococcal activity. The successful employment of *p*-aminobenzene sulphonamide in the treatment of diseases caused by diverse pathogenic micro-organisms constitutes a remarkable advance in chemotheraphy in recent years. Whitby[37] has recently found that 2-*p*-aminobenzene-sulphonamidopyridine possesses outstanding anti-pneumococcal activity. Similar results have also been obtained with certain derivatives of diphenyl-sulphide.[38]

The ramifications of research and the practical results of laboratory and clinical investigation become more significant with each passing year. The future will undoubtedly bring still greater development of research and the enjoyment of its practical results.

[34] Leake, Koch and Anderson, *Proc. Soc. Exp. Biol.*, N.Y., 27, 717, 1930.
[35] *Deutsche Med. Woch.*, 61, 250, 1935.
[36] *Compt. rend. Soc. Biol.*, *120*, 756, 1935.
[37] *Lancet*, *234*, 1211, 1938.
[38] Whitby, *Lancet*, *232*, 1517, 1937.

BOOK REVIEW

An Introductory Course in Quantitative Pharmaceutical Analysis—by M. L. SCHROFF. Published by Indian Pharmaceutical Association,—Benares. Hindu University, Benares, 1941. *Pp. 312.*

The author has taken considerable pains to provide for the students of pharmaceutical chemistry a good guide for elementary quantitative analysis. Up-to-date quantitative methods and the principles involved in such methods have been incorporated. The analytical methods employed have been classified under the following heads:—(1) acidimetry and alkalimetry (2) oxidation and reduction methods: (*a*) potassium permanganate method (*b*) dichromate method (*c*) ceric sulphate methods (*d*) titanometry (*e*) iodometry (*f*) mercurous nitrate methods (3) precipitation methods and theory of adsorption indicators (4) gravimetric estimation (5) gasometric analysis.

There are also chapters dealing with the technique of analytical procedure, calibration of apparatus and errors in quantitative analysis.

An appendix gives general information useful in analytical calculations.

As will be evident from the above, the book is quite exhaustive for the beginners, and will also be useful for advanced students. The analysis described have their application to different aspects of pharmaceutical chemistry.

H. N. D. G.

Magnetism in Relation to Chemical Problems—by K. N. MATHUR. (Lucknow University Studies, No. VIII. Edited by B. Sahni, Sc.D., F.R.S.) Published by the authority of the University Executive Council, 1940. *Pp. 182.*

The book deals in a short compass with most of the chemical problems to the solution of which magnetic methods are applicable.

After giving a short account of the magnetic properties of substances and the various methods of their measurement, Langevin's theory of diamagnetism followed by Van Vleck's treatment of the same on the basis of quantum machanics, has been described.

Additivity of magnetic susceptibility and the application of Pascal's law for the determination of the structure of organic compounds have been discussed in some detail as it ought to have been. Recent work in this connection by Gray and Cruickshank, Claw and others have also been noted.

The next section of the book deals with paramagnetism and the chemical problems relating thereto. A description of Langevin's theory of paramagnetism, Curie-Weiss equation and quantum theory of paramagnetism is followed by a discussion of the magnetic moments of the ions of the iron group elements and of the complexes formed by them.

An account of the quantum mechanical interpretation of the angular distribution and the energy of covalent bonds, as developed by Pauling and applied to co-ordination compounds with a view to account for their magnetic properties, has also been added.

Finally, a short chapter has been devoted to the magnetic properties of alloys and amalgams.

Though the book is written in a rather summarised way, as its size indicates, yet it furnishes a wealth of references on the subject.

The author in the preface states that the book has been written with a view to meet the requirement of the chemists. He has certainly succeeded in his attempts though the mathematical treatment of the theories of dia and paramagnetism will not, without special preparation, be easily intelligible to an average chemist.

The reviewer can unreservedly recommend the use of the book to advanced students, teachers, as well as research workers in chemistry.

Some mistakes and misprints in the book, which have come to the notice of the reviewer, are referred below.

On p. 41, l. 2 from top,—in place of Cl- it should be I-.

On p. 57, l. 7 from the bottom, the expression "multitude of valencies" is rather novel and unusual. The author evidently means variable valencies.

On p. 87, l. 6 from the top, it is written that "The mixed halides were prepared by precipitation from silver nitrate solution with an excess of silver ions." This sentence conveys no sense at all. The author probably means "by precipitation with an excess of silver ions".

On p. 88, l. 8 from the top, "large size" should be replaced by "small size".

On p. 99, l. 7 from the bottom, $\nu = \omega a_0^2$ should be $\nu = \omega a_0$.

On p. 130, there are no such compounds known nor have ever been prepared as noted by the author against Nos. 5, 6 and 7. These non-existent compounds could never have been studied by Rosenbohm as stated by the author. It is certainly a misquotation.

On p. 138, l. 4 from the bottom, the author writes that "Bivalent cobalt is known to form .... essentially *covalent* bonds with nitrite groups, $[Co(NO_2)_4]^{=}$." No such covalent cobaltous compound is known. The author seems to make a confusion with the cobaltic compound $[Co(No_2)_6]^{\equiv}$.

On p. 139, l. 8 from the top it is stated that (NH_3) forms bonds with small covalent character. This is not correct as all cobaltammines are diamagnetic.

On p. 145, l. 8 from the top it is written that "against zero magneton value as in the case of tetrakis-ethylene thiocarbamide copper nitrate etc. ...." This is a cuprous compound and all cuprous compounds, simple or complex, are diamagnetic. So, there is no meaning in comparing the susceptibility of a cuprous compound with that of a cupric compound like $CuSO_4$, $4NH_3$ and then making conclusions about the bond type, as the author has done.

P. R.

Wireless Listeners' Compendium—by VIRENDRA KUMAR SAKSENA. Published by the author at 10, Lowther Road, Allahabad. *Pp. 96.*

This is a miscellany of explanatory notes of wireless terms and of some wireless data collected from various sources. The last page contains, what is described by the author as "Some Useful Equations". We regret to note, however, that there are quite a number of errors in these.

The average listener will perhaps find the time schedule and wavelengths of the important broadcasting stations useful.

H. R.

An Introduction to Analytical Geometry and Calculus—by T. K. RAGHAVACHARI. Published by Oxford University Press. *Pp. xx+192.*

The author starts with a short introduction dealing with the history of the development of the subjects treated in the book, which will give some valuable information to a beginner on the subject. In a small volume containing less than 200 pages the author has made an attempt to give some preliminary ideas and easy applications of two very extensive subjects, in a way quite suitable for the students of the Intermediate course.

In the first few chapters, while developing analytical geometry, the author has given proofs of various propositions with an appeal to the idea of projection, which makes it easier for a beginner to see the connecting link between pure geometry and analytical geometry. The nomenclatures occasionally used are quite new but will probably be of little use to the students. New ideas and notations should only be used when they can also be used, with advantage, even in subsequent stages.

The portion dealing with calculus starts with some simple discussions on the limits and continuity of functions. With the help of geometrical and simple analytical examples, these fundamental concepts of analysis have been introduced. The author has deduced Rolle's theorem as a corollary to the Mean-value theorem which the students will have to unlearn at a later stage, since Rolle's theorem is always considered as the fundamental theorem. In the chapters on integration a few simple cases have been discussed. The values of $\int x^n dx$ have been given in all cases except when $n = -1$ and this was necessary since the differentiation of the exponential and the logarithmic functions was omitted. This will probably put the beginners to some difficulty. It is therefore better to give some idea about the differentiation of these functions in an elementary way, though a rigorous discussion is not possible in such an elementary book.

In any case, allowing for the limited scope of the book, the treatment of the subjects dealt with are in several respects different from the usual orthodox type and will probably be much more useful to a beginner.

S. K. Chakrabarty

Manas-Samikshan (Psycho-analysis)—by S. C. Mitra. Published by Ranjan Publishing House, Calcutta. *Pp. 187. Price Rs. 2/-.*

This is a collection of essays in Bengali contributed by the author to different journals in course of the last few years. He has made an attempt to delineate the advances made in the understanding of the human mind. It deserves notice as being a step forward in bringing science to laymen. We wish that more of the distinguished scientists in our country take upon themselves similar task of 'vulgarisers' of their special branches of study. Not only interesting sketches of Freudian method of analysis of the mechanism of our mind have been included but a short history of how Freud took to this study, and an account of trends of research in this country have also been added. The possibilities of adapting educational and vocational aptitudes of young men by means of this new branch of science have also been discussed in the book. This book will give the readers a balanced idea of the complexities of our mind, which most people seem not to know and on certain aspects of which some are unfortunately found to lay wrong emphasis. This book will further serve as a stimulus for more extensive reading.

Annual Review of Biochemistry and Allied Research in India.—Vol. XI for 1940. Published by the Society of Biological Chemists, Bangalore, India. *Pp. 162 and indexes. Price Rs. 3 or 6 sh.*

As customary, this review gives us in a nutshell an account of the research work done in India and abroad by the Indian workers during the year 1940. It covers a wide range of subjects like enzymes, human nutrition, vitamins, proteins and minerals, general physiology, pharmacology, adulteration of foods, animal nutrition and dairy science, animal pathology, plant physiology, phytology (both mycology and entomology), chemistry of plant products, biochemical and other industries, chemistry of sewage and water purification and of soil fertilisation and manures. This review signifies the amount of contribution by the Indian workers in the progress of human knowledge in the field of biochemistry and its allied branches. Such annual publication is welcomed by the research workers in India as an index to the recent advances made and it shows how India is trying to keep pace with the other countries of the world in the matter of biochemical and nutritional research with emphasis on Indian problems.

B. N. G.

The Romance of Tuberculosis—by AMIYA JIBAN MOOKERJEE. Published by Thacker, Spink & Co. (1933) Ltd., Calcutta, 1939. *Pp. 196. Price not mentioned.*

The writer of this book, who has himself been a sufferer from consumption and has successfully fought against the disease, has written this book in eight fascinating chapters describing, in attractive non-technical language, the causation, symptoms, signs, diagnosis, and principles of treatment of pulmonary tuberculosis. The problem of prevention has also been touched upon. In the concluding chapter the author has given a history of his illness, his mental reactions at successive stages and the difficulties he had to contend with in getting well.

The scientific ideas expressed are generally correct, except in minor details in some places, but this need not interfere with the usefulness of the publication. The book should be in the hands of every English-reading member of the public—patients or apparently healthy people.

It is gratifying to note that a Bengali rendering of the book, also by the same author, has been published by the Bengal Tuberculosis Association.

A.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

ON THE DEVELOPMENT OF THE PERITONEAL FUNNELS IN THE KIDNEY OF *RHACOPHORUS MACULATUS* BOULENGER

THE pre-metamorphic and post-metamorphic kidneys of *Rhacophorus maculatus* Boulenger develop on lines similar to those of *Rana*.[1] To begin with, we have the formation of the early malpighian units from nephroblast vesicles which have a direct communication with the archinephric duct. These units later disappear and we then have the development of the later malpighian units. Here the communication of the units with the archinephric duct is indirect. The malpighian capsules are connected with the archinephric duct by means of the straight tubules and their outgrowths.

A consideration of the formation of peritoneal funnels shows certain deviations from those of *Rana*. The rudiments of the peritoneal funnels of the early units are developed from the thickenings of the squamous epithelium of the external walls of the malpighian capsules. The cells which are proliferated become columnar and get detached from the capsular wall. The rudiment then elongates and develops a lumen. It is pushed by the downwardly growing malpighian capsule towards the peritoneal wall, where it lies parallel to the latter. The lumen gets ciliated and opens into the coelom externally and into the blood vessel internally.

The origin of the funnel-forming rudiment is different from that of *Rana*. It arises as a condensation of blastema cells in front of the malpighian capsule and is later carried to the peritoneal wall. There is no difference in the further development of the funnel.

The formation of the rudiments of the early peritoneal funnels is comparable to that of the urodelan peritoneal funnels of *Triton*.[2] But in *Triton* the rudiment remains in connection with the malpighian capsule and establishes a connection between the coelom and the cavity of the malpighian capsule.

The main part of the development of the peritoneal funnels in connection with the later malpighian capsules is similar to that of *Rana*. But in *Rhacophorus* the blastema cells are not condensed in front of the malpighian capsule and carried to the peritoneal wall. The condensation of the blastema cells takes place near the peritoneal wall itself as the malpighian capsule approaches the peritoneal wall.

The production of the peritoneal funnels by the funnel-forming tubule is exactly similar to that described for *Rana*. In all the three types the peritoneal funnels never communicate with the cavity of the capsule but invariably establish a connection with the coelom on the one hand and the blood-vessel on the other.

Gray[2] has explained the establishment of a direct communication between the coelom and the blood circulation by the peritoneal funnels, by attributing a very important function of collecting a secretion from the coelom and passing it on to the blood circulation. In fact, Gray considers this function as a primary one and the process of excretion by the peritoneal funnels as only of secondary importance. The present author is in complete agreement with this view.

This direct communication between the blood circulation and the coelom cannot be without some physiological significance. It is impossible to see how such a connection is helpful in the process of excretion. This certainly points to an important function other than that of excretion by the peritoneal funnels. Then we are also faced with their prodigious multiplication. If they were merely excretory, the funnels developed in connection with the malpighian capsules would have been quite sufficient. The multiplication of the funnels indicates the primary nature of this collection and conduction of the secretion from the coelom.

We have the retention of the peritoneal funnels of the early units, when the entire early mesonephric

units have disappeared. Gray however has not stated whether the early peritoneal funnels are retained or not in *Rana*. When there is need for more peritoneal funnels and when there is the development of a special tubule towards their multiplication, why should already functioning early peritoneal funnels disappear?

It is noted that its larval life after the fore legs have become evident, is very short. In fact, their appearance heralds the end of its larval life. Immediately afterwards the mouth widens, tail disappears and the metamorphosis is completed. It will be remembered that it is at this stage that the funnel-forming tubule is developed and the peritoneal funnels are multiplied. This results in bringing about a rapid collection and conduction of the important secretion from the coelom.

Can it be possible then, that this secretion is in some degree responsible in shortening the larval life of the animal? If it were possible, we have to expect the disappearance of at least some of the funnels after the metamorphosis is completed and the adult stage is reached. But there is no indication of such a disappearance in the metamorphosed animal. In the adult condition it has been demonstrated in other forms that these funnels are found in a very active state and Gray[3] has pointed out recently the development of even accessory peritoneal funnels in the post-metamorphic kidney of *Rana* in addition to the already existing peritoneal funnels. Hirt[4] had also shown the existence of an extensive nerve net correlated with the presence of these funnels in the adult animal.

The development of the mesonephors of *Rhacophorus* and other Anura proceeds along such lines as to bring about a rapid collection and conduction of this important secretion from the coelom into the blood circulation. In what manner this secretion is important we are at present neither in a position to state nor is it our concern in this communication. But this much can be said. This secretion is essential to the animal both in its larval and adult life. Even in Urodela this secretion is collected from the coelom by the peritoneal funnels and conducted in an indirect manner into the blood circulation. The long larval life of Urodela does not necessitate the multiplication of the peritoneal funnels such as is seen in Anura for the collection of this secretion.

In the face of a short larval life Anura have evolved a process of multiplication of these funnels to effect a rapid collection of this secretion from the coelom. Further the efficiency of the conduction of this secretion into the blood circulation is enhanced by the establishment of a direct communication between the blood circulation and the coelom.

There is no doubt whatever that the Anuran mesonephors is evolved from a Urodelan type. The modification of the mesonephors in Anura is conditioned by different life-histories of the animals. The formation of the rudiments of the peritoneal funnels of the early mesonephric units of *Rhacophorus* are certainly to be regarded as pointing to a Urodelan ancestry.

A. RAMAKRISHNA REDDY

Government Museum,

Madras, 14-1-1942.

[1] Gray. "The Development of the Amphibian Kidney—Part I", *Quart. Jour. Micro. Sci.*, Vol. 73, 1930.
[2] Gray. "The Development of the Amphibian Kidney—Part II", *ibid.*, Vol. 75, 1933.
[3] Gray. "The Development of the Amphibian Kidney—Part III", *ibid.*, Vol. 78, 1936.
[4] Hirt, "Zür Innervation der Niere und Nebenniere des Frosches", *Zeit. f. Anat. u. Entw.*, Vol. 91, 1930.

NEUTRON-PROTON AND PROTON-PROTON SCATTERING

The general opinion about meson is that its spin value is either 0 or 1. The interaction of neutron and proton due to meson field whether represented by the scalar or the vector wave functions comes out in the form

$$-\frac{g}{r}\, e^{-\alpha r}, \text{ where } \alpha = \frac{\mu c}{h}$$

μ being the mass of the meson, and h being Planck's constant divided by 2π. The same form will hold for proton-proton interaction if after Kemmer one postulates the existence of neutral meson.

Using Born's approximation (vide eq. 6, Mott & Massey, 'Theory of Atomic Collisions', page 88) the differential cross-section for neutron-proton scattering referred to the centre of mass system can be written as

$$d\phi = \left| k' \frac{\operatorname{cosec}^2 \theta/2}{Mv^2} g \int_0^\infty \sin k'r\, e^{-\alpha r}\, dr \right|^2$$

$$= \frac{M^2 g^2}{h^4(\alpha^2 + k'^2)^2}, \text{ where } k' = \frac{Mv}{h} \sin \theta/2,$$

M = mass of proton and v its velocity.

The relation shows slight decrease of scattering intensity with increasing angle. If however we con-

sider the possibility of the interchange of the role of neutron and proton, we should get the reverse result.

The total cross-section is given by

$$\phi = \frac{4\pi M^2 g^2}{h^4 a^2 (a^2 + \nu^2)} \text{ where } \nu = \frac{Mv}{h}$$

It is seen that the total scattering cross-section slowly decreases with increasing energy as is found experimentally.

In proton-proton scattering we assume that in addition to Coulomb force there is a short range interaction force of the same nature as above. Combining Gordon's solution[1] for Coulomb force with that as found in the previous section and following the same procedure as adopted earlier by one of us[2] we can express the scattering intensity relation (referred to the laboratory system) in terms of Mott's original formula as

$$\frac{I}{I_{Mott}} = \frac{\operatorname{cosec}^4\theta + \sec^4\theta - \operatorname{cosec}^2\theta \sec^2\theta (1+\Delta) + \Delta^2}{\operatorname{cosec}^4\theta + \sec^4\theta - \operatorname{cosec}^2\theta \sec^2\theta}$$

$$\text{where } \Delta = \frac{M^2 v^2 g}{e^2 h^2}, \text{ when } a << k'$$

The agreement with experiment is good. The details will be published soon elsewhere.

D. BASU
S. K. GHOSH

Palit Laboratory of Physics,
University College of Science,
Calcutta, 7-3-1942.

[1] See Bethe and Bacher, *Rev. Mod. Phy.*, Vol. VIII, p. 131.
[2] *Phil. Mag.*, *29*, 200, 1940.

ON THE NATURE OF THE ACTIVE GROUP IN PAPAIN

The experimental basis for the conclusion that "our knowledge on the thiol nature of papain is still in an unsatisfactory state" reported by Seshagirirao and Giri[1] demands scrutiny. Two questions arise, (1) Is the nitroprusside test, they have employed, an absolute test for the presence of -SH groups? and (2) Is the thiol postulate of the nature of papain based solely on the positive nitroprusside test given by the active enzyme? The authors of the note are apparently not sure whether the method they have employed for testing the presence of sulphydryl groups in their enzyme preparations, is reliable; their conclusion regarding the thiol nature of papain is therefore untenable.

The well-known fact that native egg-albumin does not give a positive nitroprusside test does not warrant the conclusion that native egg-albumin has no thiol groups. It is clear from the work of Anson and his collaborators[2] that native egg-albumin does contain -SH groups and that the groups are probably "not linked".

Balls and Lineweaver[3] to whose work Seshagirirao and Giri have referred, suggest that only one out of about 10 -SH groups is functional in papain. The thiol nature of papain has been postulated, on the basis of a large number of observations on the influence of sulphydryl compounds, oxidising agents, maleic acid, SeO_2 and heavy metals on the activities of papain; the nitroprusside test has not been used as the sole criterion for determining the nature of papain.

The only valid conclusion that can be drawn from the results reported by Seshagirirao and Giri is that $Cu^{\cdot\cdot}$ inhibits peptonase activity on papain and that HCN annuls this heavy metal effect—a result which has been long familiar to every worker on papain.

V. S. GOVINDARAJAN

Indian Institute of Science,
Bangalore, 26-2-1942.

[1] SCIENCE AND CULTURE, *7*, 408, 1941-42.
[2] *Jour. Gen. Physiol.*, *24*, 409—see footnote, 1940-41.
[3] *Nature*, *144*, 513, 1939.

ON THE NATURE OF THE ACTIVE GROUP IN PAPAIN

In reply to the two queries raised by the author of the above note[1], namely, whether the nitroprusside test is an absolute test for the presence of thiol groups, and whether the thiol-postulate of the nature of papain is based solely on the positive nitroprusside test given by the active enzyme, we may state that the test is employed by various workers in the field for studies on papain and other enzymes[2] as a specific reaction for thiol groups. The test has been used by the workers in the same laboratory from which the author's note is communicated and the conclusions drawn on the thiol nature of papain is based on the validity of the test[3]. It is also being used in estimating sulphydryl groups of egg albumin[4], in serum and milk[5]. Sulphydryl groups are readily

estimated by using nitroprusside as an indicator of -SH in proteins. Doubt, however, has been thrown on the validity of the nitroprusside test as a consistent indicator of -SH in proteins, because crystalline papain is found to give negative results[6], although it is found to give the test after denaturation[7]. At present we are not prepared to pass any comments on this work. Further investigation is necessary. On the other hand, another crystalline proteinase recently isolated from papaya latex, which has been designated as chymopapain is found to give a strong -SH test with nitroprusside without preliminary denaturation[8]. It is clear, therefore, that depending upon the method of preparation, papain can be obtained either associated with thiols or free from thiols as tested by the nitroprusside reaction. It is probable that in the latter case thiols occur as an adsorbed impurity in the enzyme.

The study of the nature of the active group of papain has been approached by two entirely different methods. The direct method of investigation consists firstly in obtaining the enzyme preparation freed from thiols and submitting the product to qualitative and quantitative test. We adopted the following methods for removing or destroying the thiols associated with the enzyme: (i) repeated precipitation of the enzyme with acetone followed by treatment with ether, (*ii*) treatment with Cu, (*iii*) keeping at alkaline pH and (*iv*) exposure to ultraviolet light. In all these cases we obtained active preparations which do not give any tests for thiol groups. In some cases the preparations were treated with HCN at pH 5·0, for the regeneration of the activity. Regarding the influence of $Cu^{\cdot\cdot}$ the author of the note[1] has not evidently understood the exact significance of the experimental results reported in our prvious note on the subject. $Cu^{\cdot\cdot}$ was used as catalyst to destroy the -SH groups and the HCN treatment was intended to regenerate the activity by reduction. Even here the active product obtained did not give any test for thiols.

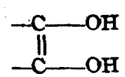
		Milk-clotting activity of Papain	Thiol groups	Dienol groups (Ascorbic acid)
1.	Influence of PH on stability	Less stable at alkaline pH and more stable at acid pH	Less stable at alkaline pH and more stable at acid pH	Less stable at alkaline pH and more stable at acid pH
2.	$Cu^{\cdot\cdot}$	Inactivates the enzyme, which can be regenerated by reduction with H_2S	Oxidises	Oxidises, the oxidised group can be reduced by H_2S
3.	Iodine	Inactivates and can be reactivated by reduction	Oxidises	Oxidises, and the oxidised group can be reduced by H_2S
4.	Ultra-violet light	Inactivates	Destroys by oxidation	Destroys by oxidation
5.	Thiol compounds (glutathione and cysteine).	Regenerates the activity by reduction	Reduces the dinulphide into thiol	Reduces the oxidised vitamin
	"	Protects the enzyme from oxidative inactivation	—	Protects the vitamin from oxidation
	"	Protects the enzyme against inactivation by ultraviolet light	—	Protects the dienol group of the vitamin against oxidation by ultraviolet light
6.	Hydrogen sulphide	Regenerates the activity by reduction	—	Reduces the oxidised group into the dienol group
7.	Ascorbic acid	Protects the enzyme against inactivation by ultraviolet light	Protects the thiols from destruction by ultraviolet light, and the thiols act as stabilisers for the enzyme	—

Another method of approach to the problem is to alter the active group of the enzyme by treatment with reagents specific to certain chemical groups, and the examination of the influence of such treatments upon the activity. We therefore tried the influence of various methods of treatment and reagents on the

gelatinase, peptonase and milk-clotting activities of papain. We have studied in a more detailed manner the nature of the active group of the milk-clotting enzyme of papain which is also shown to depend for its activity on the presence of thiols[9] and the results of this investigation will be reported briefly here. A remark regarding the conclusions drawn in such studies relating to -SH groups on the basis of observations on the influence of thiol compounds, oxidising agents, and heavy metals on enzymes is pertinent. The -SH groups behave in many respects like the dienol groups (*e.g.* in ascorbic acid). Many of the substances used in destroying or reducing the thiol and disulphide groups respectively affect the dienol groupings in similar manner. It is probable that some of the substances may destroy either by oxidation or otherwise both the thiol and the active non-thiol groups present in the enzyme. In such cases the thiols act as indicators of the oxidation and reduction of other essential groups of the enzyme which are susceptible to oxidation-reduction processes. The table given above illustrates the points referred to above.

In all cases, in which the activity of the milk-clotting enzyme treated with reagents to destroy the thiol groups, is again regenerated by treatment with HCN at pH 5·0, the preparations gave complete negative test for thiol groups. Thiols, however, serve to stabilise the active group in the enzyme. Consequently, when the thiols are destroyed by oxidation the active group of the enzyme is affected, and the enzyme readily loses activity.

It will be seen on examining the above table that a distinct parallelism exists between the inactivation and regeneration of the milk-clotting activity of papain on the one hand and the oxidation and reduction of vitamin C on the other, brought about by several reagents. These results strongly suggest that some other active group like the dienol oxidation-reduction group



is apparently necessary for the activity of the enzyme.

In this connection it may be of interest to refer to the work of Bhima Rao *et al*[10] who showed that rennin, the milk coagulating enzyme of the calf stomach contains vitamin C in combined form and does not contain sulphur. But the authors could not decide whether the vitamin existed as a part of the enzyme molecule or was associated with an impurity. Our results also establish the existence of a great difference in the behaviour of the proteolytic and milk-clotting activities of papain towards the reagents, the latter being more susceptible to oxidative influences. Further work is being carried out by us and the results will be communicated in due course, and many points referred to above will be further clarified in the paper which will be published soon.

K. V. GIRI
P. SESHAGIRIRAO

Biochemical Laboratory,
Andhra University,
Waltair, 9-3-1942.

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NUCLEAR CHANGES IN THE LINT PRIMORDIAL CELLS OF *GOSSYPIUM ARBOREUM* VAR. *TYPICUM* (Ki).

Ovules of *Gossypium arboreum* var. *typicum* (Ki) were fixed in Levitsky (5 parts of 10% Formalin and 4 parts of 1% Chromic acid) from 18 hours before flower opening to 2 days after flower opening, at two hour intervals and stained by the 'Feulgen-Fast Green technique'[1].

Fig 1 shows a binucleate cell in the epidermal layer of the ovule. There are evidences to suggest

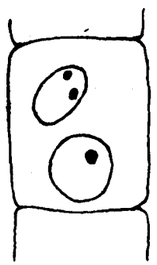

FIG 1. *G. arboreum* var. *typicum* L.S. of ovule, 3 hours before flower opening, showing a binucleate epidermal cell. X 1850

that this condition arose as a result of the suppression of the cross-wall in the previous mitosis and will be dealt with in a subsequent paper.

Fig. 2 represents two such binucleate cells near each other. The maximum number of nucleoli, so

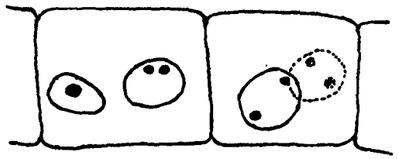

FIG. 2. L.S. of ovule showing two binucleate cells. X 1850

far noted at this stage, is only two. This might have been the result of the fusion of two of the nucleoli, from the 'four nucleolate' condition of the 'Asiatic diploids'[2], and unpublished and will be discussed in the subsequent paper.

Fig. 3 shows the fusion of the two nuclei in one of the binucleate epidermal cells. In the same figure, it is interesting to note that the adjacent cell is

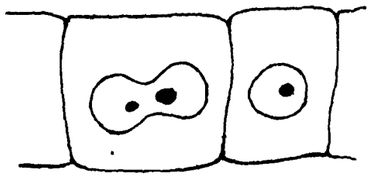

FIG. 3. Fusion of the two nuclei in one of the binucleate epidermal cells. X 1850

smaller than the one containing the 'dumb-bell' shaped fusing nuclei. Successive stages in the fusion of these nuclei have also been observed.

Fig. 4 represents a stage after the complete fusion of the two nuclei in one of the binucleate

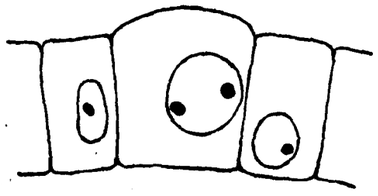

FIG. 4. L.S. of the ovule showing a lint primordial cell, with a single 'giant nucleus'. This cell has just begun to protrude. X 1850

epidermal cells. This 'fusion nucleus' is bigger than the two single nuclei in the adjacent cells. The bigger size of this cell is also maintained. From the figure it is seen, that the outer wall of this 'giant cell' has just begun to protrude. Thus it will be seen that this lint primordial cell with the big nucleus is really a tetraploid cell (4n) on the assumption that the ordinary somatic cells of the 'Asiatic cottons' are diploid (2n).

This increase in size of the nuclei of the lint primordial cells has been noticed by several investigators before, but the steps leading to it were not properly understood. It was generally assumed that these nuclei absorbed water and there by increased in size.

Fig. 5 shows a more advanced stage in the protrusion of the lint cells. Two ordinary cells having

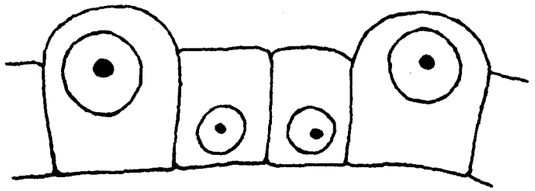

FIG. 5. A later stage in the protrusion of two lint cells. X 1850

smaller nuclei are also seen between the protruding cells.

It should be mentioned that the nuclei of the lint primordial cells, throughout the stages so far described, remain in a resting condition and are in no way different from the resting nuclei of the ordinary somatic cells. Also, the protrusion of the lint cells starts only after the fusion of the two nuclei.

A detailed account of the above phenomenon in Ki and other types of cotton will be published shortly, in the Transactions of the Bose Research Institute, Calcutta.

K. T. JACOB.

Cytogenetical Laboratory,
Bose Research Institute,
Calcutta, 7-3-1942.

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THE VARIANCE OF THE FORECASTED MEAN VALUE SUBJECTING TO TWO-WAY FLUCTUATIONS

In problems of sampling, the mean value η of a character y can be estimated with some margin of error from a sample drawn at random from a population.

But if it is difficult or not economically possible to measure the character y directly, the mean value η can be estimated with a certain order of precision with the help of a second character x. To make the whole investigation simple and concrete the background of a bivariate normal population will be assumed throughout. For estimating the mean value η of the character y it is required first to estimate the relationship between the two characters x and y from a sample drawn at random from the normal bivariate correlated population π. Once the necessary parameters of the equation of fit connecting y with x are estimated the mean value η can be determined from a second random sample of bigger size consisting of the measurements of the character x only the equation which estimates y from x being, however, taken into toto from the previous stage. The first sampling may be termed "Exploratory Stage" and the second sampling "Survey Stage".

Let n = the size of the sample in the "Exploratory Stage";

N = the size of the sample in the "Survey Stage"

and $\bar{x}' = \dfrac{x'_1 + x'_2 + \ldots + x'_N}{N}$

where $x'_1\ x'_2 \ldots x'_N$ are the values of the character x in the "Survey Stage".

Let $\bar{Y}'$ be the estimate of the mean value η made from the two stages of the sampling procedure the first stage giving the parameters of the estimating equation and the second stage enabling the mean y to be actually estimated from the mean x. Therefore this estimate $\bar{Y}'$ will be subject to error from two sources: (1) due to the sampling fluctuations (for the exploratory stage) of the estimates of the parameters which are involved in the relationship between the two characters and (2) those of the values of the character x in the "Survey Stage".

The variance of this estimate $\bar{Y}'$ of the mean value η arising from two sources has been worked out.

The (1) estimate $\bar{Y}'$ of the mean value η made from the two stages of the sampling procedure is $a + b\bar{x}'$ where a and b are the constants estimated from the "Exploratory Stage",

(2) expectation of $\bar{Y}'$ is $\alpha + \beta\xi$ where α, β and ξ are the population values of a, b and $\bar{x}'$

and (3) variance of Y' is

$$\sigma^2_y \left[\frac{1}{n} + \left\{\frac{1 + (n-4)\rho^2}{(n-3)}\right\}\left(\frac{1}{N} + \frac{1}{n}\right)\right]$$

where σ_y = variance of y in the population

and ρ = the coefficient of correlation between the two characters x and y in the population.

If $y_1', y_2', \ldots y'_N$ be the unknown values of y (in the survey stage) corresponding to values of $x_1', x_2' \ldots x'_N$

and

$$\bar{y}' = \frac{y_1' + y_2' + \ldots + y'_N}{N}$$

then the (4) discrepancy between (the actual sample mean of the character y) $\bar{y}'$ and (the estimated mean y) $\bar{Y}'$ will be

$\{\bar{y}' - (a + b\bar{x}')\}$ and (5) its expectation will be $\{\eta - (\alpha + \beta\xi)\}$

and (6) the expectation of the square of the discrepancy *i.e.*

$E\{\bar{y}' - (a + b\bar{x}')\}^2$ will be

$$\sigma^2_y \left(\frac{1}{N} + \frac{1}{n}\right)\left\{\frac{(n-2) + (n-4)\rho^2}{(n-3)}\right\}.$$

In the problems of crop-cutting experiment these expressions can be applied to obtain (3) variance of the forecasted mean yield and (6) the discrepancy between the estimated mean value $\bar{Y}'$, determined from the values of the two stages of the sampling procedure, and the corresponding unknown sample mean value $\bar{y}'$.

It may be mentioned here that the mean value η of the character y can be determined precisely from the mean value of the character x even if the degree of the relationship is weak, whereas estimates of the individual values of the character y depend on the degree of the relationship between the characters. This approach to the problem of estimating the mean value by a slight adaptation of the 'regression' procedure was made by Prof. P. C. Mahalanobis in estimating the yield of cinchona bark.

My thanks are due to him for suggesting the main lines of the above problem and to Mr S. N. Roy for helping me in some of the details.

CHAMELI BOSE

Statistical Laboratory,
Calcutta, 7-3-1942.

Mathematics and Statistics

Sample Surveys

P. C. MAHALANOBIS

MATHEMATICS, PHYSICS AND STATISTICS

PURE Mathematics has been described as all statements which can be expressed in the form

If P, then Q

with the important condition that it must be entirely immaterial what P and Q are.

All statistical statements, on the other hand, can only be made in the form:

If P, then Q will follow 9 times out of 10 or 99 times out of 100, or 999 times out of 1,000 trials, and so on.

However large the odds may be, some margin must be left for the failure of the prediction. If the statement is statistically valid then in the long run the prediction must fail to the extent of this permitted margin.

This distinction between pure mathematics and statistics is important, and represents the difference between the divergent methods of deductive and inductive logic. We may clearly see its repercussions in the history of physics. The spectacular development of classical mechanics in the seventeenth and eighteenth centuries gave an overwhelming bias to physical science in the direction of materialistic determinism. From the detailed knowledge of a system at one single instant it should be possible, according to classical physics, to predict the whole future history of the system. A complete solution, however, could be worked out only in the case of two particles: the problem of three bodies remained partly unsolved.

For studying more complicated systems consisting of many particles or phases, it gradually became necessary to introduce statistical concepts in connexion with the second law of thermodynamics in the middle of the nineteenth century. The normal (Gauss-Laplacian) curve of errors used with success, for the reduction of physical measurements, served as a model for the Maxwellian distribution of velocities in the kinetic theory of gases. Statistical mechanics was then gradually built up on probabilistic foundations by Boltzmann, Gibbs and others so that by the end of the nineteenth century statistical physics had become an integral part of science.

In the opening years of the twentieth century a more profound change took place with the advent of the quantum theory and the principle of relativity; materialistic determinism was replaced by the well-known principle of uncertainty. The whole foundation of physical science became entirely statistical in nature. The contrast between the old and the new view of things has important theoretical and practical consequences. Classical physics was founded on causal laws and mechanistic determinism. The aim was to proceed by mathematical methods from general or universal laws to particular results.

THE STATISTICAL METHOD OF SAMPLING

In statistics, on the other hand, the typical method is to proceed from the sample to the population, that is, from the particular to the general.

The sampling technique is often made inevitable by the nature of the problem. If we want to purchase a large quantity of, say, rice, or bricks or coal or electric fuses or any other commodity we usually make our choice by testing small portions or samples out of the articles offered to us. In the case of rice or bricks it is theoretically possible to examine each single grain or each single piece of brick, if we so desire and can afford to devote to the task the required time and energy. But in the case of coal or electric fuses it is not even conceptually possible to make a complete test by burning the whole consignment before we purchase it.

In practically all situations in which we have to work on a large scale, estimates have to be made almost invariably by the method of sampling. As a concrete instance of the use of the sampling method on an extensive scale, a general account of the sample census of the area under jute in Bengal is given.

Sample Survey of the Acreage under Jute in Bengal

During the 10 years, 1929-1938, the average area under jute in Bengal was roughly of the order of two and a quarter million acres, or about 3,500 square miles. A rough calculation shows that in an ordinary year more than one crore of plots sown with jute are scattered among eleven or twelve crores of plots of all kinds. One way of estimating the total area sown with jute in any particular year in Bengal would be to search out one crore or more of these individual plots under jute. This would require a large army of five or six thousand investigators and would cost something like ten or twelve lakhs of rupees.

In the method of sample survey the whole province would be divided into suitable number of zones. Within each zone a suitable number of points would be then selected strictly at random ; and at each of these points a sample-unit of a suitable size would be surveyed in detail. In this way it would be possible to determine the proportion under jute in each sample-unit, and hence the average proportion within each zone. Multiplying by the total area of each zone, it would be then possible to estimate the area under jute in each zone, and then, by subsequent tabulation, the total area under jute in each district or in the whole province. The basic idea is simple and familiar. Both precision and cost will depend not only on the size of individual sample-units but also on their total number and the manner in which they are distributed over the whole area.

The work was started on a small scale in 1937 with a complete enumeration of only 124 square miles and a sample survey with units of size 5 acres. The work was expanded in successive years till in 1941 a full scale provincial survey was carried out covering an area of nearly sixty thousand square miles.

According to this sample census the total area sown with jute in Bengal in 1941 was 15,76,000 ± 17,300 acres. The estimated probable error is thus only about 1·1 per cent. An entirely independent and objective check on the accuracy of the sample census was obtained when from a complete enumeration carried out under the Jute Regulation Scheme, the area actually sown with jute was found to be about 15,25,000 acres. A sampling survey of this nature can be carried out at a cost of only one-fifteenth of the cost of a complete enumeration.

The chief object kept in view during the exploratory stage is the construction of a basic "Cost-Variance table", from which we can find the area of sample-unit, and the density of sample-units appropriate to any assigned level of cost or any given degree of precision. This needs the simultaneous consideration of the "Variance-Function", *i.e.*, the law of variation of accuracy with change of size of sample-unit, and the 'Cost-Function' which is the corresponding law of variation of cost of operations. The forms of these laws have to be ascertained using the material accumulated during the exploratory work.

The study of the Variance Function is of great interest from the practical as well as the theoretical point of view. Where suitable material based on a complete census is available, model sampling experiments can supply valuable information. This has naturally to be supplemented by actual field experiments.

In the case of a truly binomial or Gauss-Laplacian variate, the variance decreases inversely as the size of the sample-unit. This may be called a variance function of the "normal" type. On the other hand, it is also easy to see that in a regularly patterned field the decrease in variance with increasing size of sample-units will be much slower than in the case of a random field.

As may be easily expected, fields which occur in nature often lie between these two extremes, that is, they are neither of a purely random nor of a completely patterned type. In such cases also the variance function will be determined by the type of the field. This is why a study of random and non-random fields (in the sense explained here) and associated variance functions is of great importance in connexion with the design of sample surveys.

Although designs of the type found so useful in agricultural and other experiments cannot be directly employed, we are gradually learning that in the case of sample-surveys also there are broader principles of balancing which often enable a great deal of useful information being obtained at a small cost. We are still on the fringe of the subject. The general principles of the design of sample surveys offer splendid scope for both experimental and theoretical researches, and calls for active co-operation between mathematics, statistics, and possibly also physics or engineering. In fact, from the logical as well as the utilitarian point of view, that is, in both theory and practice, sample surveys supply a common meeting ground for all these subjects.

K. R. N.

Chemistry

Certain Aspects of Pure and Applied Photo-Chemistry

M. Qureshi

After some preliminary observations on the interrelation of pure and applied sciences for the development of both, Dr Qureshi in his address discussed certain aspects of pure and applied photochemistry. He began by briefly considering the process of absorption of radiation itself by atoms and molecules, and summarised the many probabilities of atomic and molecular excitations giving rise to the well-known spectra of different classes. Various secondary processes might follow as the result of the primary activation or dissociation by light, one of which is chemical reaction, obeying the ordinary laws of kinetics, with a normal molecule. The various factors which might contribute to an apparent departure of the quantum yield of a secondary process from the law of photochemical equivalence were reviewed.

As an instance of application of the science of photochemistry, photography is the most important. It is based fundamentally on the photolysis of a silver halide to form an invisible image consisting of a colloidal solution of silver in silver halide. Vogel's discovery of sensitizing emulsions with the dye Coralin in 1872 led to the use of a large number of dyes as sensitizers and the entire range of photographic sensitiveness of emulsions has been extended by their use from 2200-5000 to 2200-13560 Å. The mechanism of formation of invisible images on the negatives is traced to the photo-dissociation of electrons, from the silver halide molecules in the ordinary negatives and from the dye molecules in the sensitized ones.

Technical applications of halogenation of organic compounds under the influence of light, such as the chlorination of methane and toluene to methyl and benzyl chlorides, of cyclohexane by sulphuryl chloride, and similar others, covered by a large number of patents, have been described.

Polymerization, a general feature of unsaturated organic compounds, is a chain reaction, and has been mostly studied as a thermal process. The influence of ultraviolet light on the polymerisation of acetylene, ethylene, vinyl halides, butadiene and isoprene has been considered sufficiently important to merit further intensive studies in this direction.

Finally, the process of carbon assimilation by living plants under the influence of sunlight has been referred to, as a photochemical process of fundamental importance. The visible products of photosynthesis are oxygen and starch. The former is emitted by the green leaf and the latter accumulates in the cell. From a consideration of the ratio of the number of molecules of carbon dioxide absorbed to the number of molecules of oxygen produced, it is concluded that the primary product of photosynthesis is a hexose. The quantum yield of this process is less than unity and indicates, on comparison with the heat absorbed in the formation of hexose, that about two-thirds of the radiant energy is wasted by the plant from the photochemical point of view. Sunlight on the surface of the earth having wavelength greater than 2900Å is not expected to promote synthesis in a single operation in absence of some other source of activation. On the the other hand, ultraviolet light of wavelength less than 2535Å is likely to decompose any formaldehyde or glucose formed. Workers differ on the question of formation of formaldehyde from carbon dioxide and water under the influence of sunlight, the results obtained by the speaker being in the negative. Catalytic reduction of carbon dioxide in the presence of heavy metal oxides has also been discussed as an interesting field of study, but the results reported till now do not seem to have received general acceptance.

J. G.

Geology

The Jurassic Rocks of Cutch—Their Bearing on some Problems of Indian Geology

RAJ NATH

DR RAJ NATH in his address while giving an account of the Jurassic Rocks of Cutch, showed that during the Jurassic period, *i.e.*, about 150 million years ago the sea had invaded Cutch and Kathiawar and extended up to Rajputana. To the north this sea was connected to the Tethys Sea which occupied the present position of the Himalayas. There also existed some form of connection between this sea and that in the south in which rocks containing some fossils similar to those of Cutch were deposited in Madagascar and in the East and South Africa. He further showed how the topmost beds of these rocks of Cutch help in determining the upper age limit of the Gondwana System which contains 98% of India's coal.

The fossils tell us the age of the rocks in which they are enclosed. This helps in building up the stratigraphy (*i.e.*, the sequence of rock formations), which is so helpful in finding out new deposits of economic importance. The earth is a great cemetery of lowly creatures who serve so wonderfully even after their death. The present civilised man has exhibited his capacities in this war which is a ruthless butchery and destruction of life and colossal waste of resources of the world. The blame for this destruction is often placed at the door of science. The scientists however discover things in the spirit of devotion for truth and selfless service and it appears there are enough resources in this world to make the entire mankind happy,—what is wanted is proper tapping of the resources in a scientific manner.

Dr Raj Nath pointed out that geology was of great cultural interest and of immense economic importance. But unfortunately it had not received as much stimulus in India as in other countries where they have recognised it as a suitable subject for study even for the school stage. Therefore, it is high time that universities and boards in-charge of education in India should take early steps to give the desired stimulus to the study of geology in this country.

To fully utilise the knowledge of geology for industrial development of India, Dr Raj Nath made the following recommendations:

(*i*) The staff of the Geological Survey which is too meagre for a vast country like India, should at least be doubled.

(*ii*) A Mineral Research Institute should be established to investigate the problem of utilisation of minerals already known in India and other allied problems.

(*iii*) A well-equipped department for the mineral investigations with the help of geo-physical methods should be placed at the disposal of the above institute.

Entomology

Certain Aspects of Morphology of Insects in Relation to Habit

D. MUKERJI

INSECTS vitally affect the interests of man, and the applications of entomological studies are of great advantage to the economic prosperity of India but unfortunately entomological studies are neglected in the Indian universities. There is, however, no sharp line of demarcation between pure and applied entomology, the progress of one branch being dependent on the development of the other. The author sounded caution against the increasing tendency of evaluating researches by the standard of immediate usefulness and brushing away those which do not savour of economic advantage.

The insects born in an age long past, have evolved in course of time, in accordance with the varying conditions of the earth, a bewildering pattern of form, structure and behaviour. They have their own way of carrying on the basic physiological functions and they are different from other groups of animals in form and structure.

Morphology is the science of forms and inquires into the structural relationship of animals. It is an observational and historical science of great importance. It should however be interpreted in terms of functions as initiated by habit or induced by the environmental conditions, so as to show the impact of forces upon the dynamics of life of insects.

How the mechanism for carrying on respiration is adjusted to suit to the conditions of life, is clearly seen in the aquatic beetles of the Dytiscid family which were evolved from a stock of land beetles. In India this family of insects is represented by several species of the genus *Cybister*. The larva or the young stage of the *Cybister* beetle lives in water but breathes atmospheric air by pushing the tip of its cylindrical tail end, out of water, like a periscope, while the rest of the body remains under water. The tip of the tail end carries a pair of breathing apertures called spiracles. Air is drawn in through these spiracles into air pipes called tracheae which by sending out branches to different tissues supply them with oxygen and carry away from them carbon dioxide. The position of the mouth at one end, and of the breathing spiracles at the opposite tail end, is of obvious advantage, for the larva can breathe and feed thereby at the same time. In addition to the terminal pair there are a number of spiracles but these are distributed on the sides of the body and are called lateral spiracles. As these remain covered by water they are of no use in inspiring air but nonetheless a few of these eliminate excess of CO_2, and emit a note to frighten the enemies of the larva. The lateral spiracles come to function as breathing organs when the larva migrates to land for passing into the quiescent stage. The author has shown how the lateral spiracles differ in structure from the terminal spiracles, and in what way the structures or organs are modified in this insect in response to an aquatic mode of life. The adaptation in the respiratory system of the social insects like the termites, and of the moisture-loving springtails or Collembola shows the importance of studying structural mechanism or its modifications in reference to habit.

While respiration is essential for the maintenance of life, reproduction is necessary for the perpetuation of the species. Reproduction in insects can be studied either from the stand point of a geneticist or from Lamarckian point of view. The mechanism of the genital organs in a male and a female of a species keeps that species sexually isolated from others, sharing the same environment, by preventing it from interbreeding or crossing with related species. Among the pulse beetles infesting stored grams and pulses, the author notes that interbreeding takes place under stress of circumstances, and a fertile hybrid generation is born, in spite of the specific differences in structure and function of the reproductive organs in two species studied by him.

The author in course of his address also pointed out the need of foundation of a bureau of entomology in India and diffusion of entomological knowledge bearing on the practice of farming and agriculture through the vehicle of the different provincial languages.

Physiology

The Need for the Expansion of Physiology and Pharmacological Research in India

B. T. KRISHNAN

IN his presidential address Prof. Krishnan stressed the necessity of devising ways and means for turning out a greater volume of research work in the domains of physiology, pharmacology, and scientific medicine in various parts of the country.

It was very unfortunate that the ancient Ayurvedic works of Sushruta and Charaka were regarded by the succeeding generations of India as of divine origin and beyond the criticism of man and there was no attempt at research and modification of the original empirical doctrines for more than 2000 years. The result has been stagnation and decadence of thought in physiological knowledge and in its application to medicine in this country, while there has been tremendous advance in the West in these fields during the past three or four centuries. If we are to progress, our present and future research must be based on the well established scientific knowledge obtainable at the present day. With all the wealth of scientific knowledge we already possess, our knowledge about living processes is still not complete.

Apart from the general problems in physiology which have an important bearing in the practice of medicine and which still require elucidation by further research, there are several special physiological and allied problems requiring urgent attention and investigation in India.

The problem of nutrition in India has not yet received the full attention that is due to it. There is a vast scope for organised research in this connection to be carried out in co-operation with the public health and agricultural departments.

With the marked growth of industries in India, the problems of industrial hygiene and medicine should engage the attention of the State and the managing bodies.

For the growth of medicine in India, there is no other subject of greater importance than pharmacological research. The scientific system of medicine, introduced in India about 250 years ago, has not yet become popular among the masses because of its costliness and unavailability in the remotest villages, where alternative systems of medicine are still flourishing.

For a systematic scientific investigation of indigenous drugs and the compilation of an Indian Pharmacopoeia which are urgent necessities, well equipped laboratories should be established at various centres where teams of workers composed of expert botanists, chemists, pharmacologists, and physicians should carry out organised research work. The funds and energy now being spent for teaching indigenous Medicine at Madras, Delhi, Jhansi, Calcutta, and other places should be diverted to establish such centres of research. In the compilation of a comprehensive Indian Pharmacopoeia, it is desirable that along with the botanical or British pharmacopoeial names, the names of the drugs in the Indian languages in colloquial use or mentioned in Ayurvedic or Unani literature are also retained. To facilitate collection of all indigenous drugs and the literature bearing on them, local indigenous drug centres should be established in each district where every indigenous practitioner of the district should report and deliver samples of the remedies he employs for diseases and a written account of all available information pertaining to the drugs. No indigenous practitioner should be allowed to dispense a remedy, the composition of which he does not reveal and a sample of which he does not deliver. The drugs and the literature so collected at each local indigenous drug centre should be transmitted by the medical officer to the nearest research centre. Periodical bulletins should be issued from the research centres regarding the efficacy of the tested drugs, their doses etc. for the benefit of the medical practitioners. If these measures are adopted, the problem of having one scientific medicine and one scientific method of treatment can certainly be solved at an early date.

Pharmaceutical and biological industry for the manufacture of all pharmacopoeial preparations, synthetic drugs, endocrine and vitamin preparations, vaccines, sera etc. should be encouraged and protected by the Government. Standardisation laboratories of the kind already established at Calcutta should be established in all provinces to control and maintain uniform standards of strength, purity, and quality of drugs.

For the supply of trained men and for the promotion of research in this field, study of pharmacology, pharmaceutics, and allied subjects should be encouraged by the Government and the universities by introducing special diplomas and degrees. A large number of research scholarships and research posts with security of tenure should be provided for, by Government research grants and private munificent endowments, and the research talent among the capable young men in this coutry should be encouraged and promoted.

Psychology and Educational Science

Measurement in Psychology

GOPESWAR PAL

OBSERVING that scientific experiments are not regarded as perfect and reliable unless the observed phenomena are quantitatively measured, Dr G. Pal in his presidential address takes stock of how far the psychologists have been able to proceed in the task of measuring mental phenomena and with what degree of success.

Two questions confront the workers in the field of quantitative psychology: Are there psychological magnitures which can be measured? And, if so, what are the units of measurement? G. T. Fechner gave us a concept of measurement of sensation. He maintained that psychical phenomenon of sensation-intensity might be regarded as the sum of a number of small sensation units exactly in the way an hour is taken to be composed of seconds. The unit chosen was the Just Noticeable Difference of Sensation (j.n.d). He assumed that these just noticeable differences at different levels of intensity of a particular sensation are all equal and hence are suitable units for measuring sensation-intensities. It must be said here that the concept of just noticeable difference of sensation as a unit did not originate with Fechner. He got the cue from Weber's experimental results.

E. H. Weber while conducting a series of experiments with lifted weights (1829-34) found that for a weight of 32 drams the average just noticeable difference for four persons who had acted as subjects in his experiments was 3 drams and for a standard of 32 ounces the difference was not 3 drams but 3 ounces. In other words, the stimulus-increase for just perceptible difference was not a constant amount but a constant portion of the weight lifted, *i.e.*, $dR/R=c$, where dR is the stimulus increase for just noticeable difference, R is the stimulus or the standard and c is a constant to be determined experimentally. Fechner with his mathematical mind discerned the rudiment of units of mental measurement in Weber's findings. Accepting Weber's equation as fundamentally correct Fechner transformed the experimental discovery of relation into a general form and interpreted it as functional relation between the physical and the psychical phenomena. Assuming that all j.n.d.'s at all levels of

intensity are equal in sensation value, Fechner concluded that when the stimulus increases, say, from 100 to 110 grams, to 121 grams and then to 133·1 grams, *i.e.*, each time by one-tenth of the standard, or in other words, in geometrical progression, the sensation increases by equal steps of one j.n.d. unit, *i.e.*, in arithmetical progression. His conclusions were expressed by the well-known formula: $S = c \log R$, where S is the sensation, R the stimulus and c a constant determined experimentally.

Fechner's conception of sensation-intensity as a multitude of small units of intensities came to be severely criticised by many later psychologists who held that every sensation was qualitatively different from every other sensation and as such could not be regarded as divisible into smaller units. They pointed out that what Fechner considered to be an intensity difference was really a qualitative difference. The present position is that the original Fechnerian concept has been given up but it has been generally agreed by the majority of the psychologists that sensation-intensities and their differences are at least magnitudes that can be graded. Careful grading of a large number of intensities as also of their differences may ultimately lead to their spacing out in such a way as almost to correspond to their true positions in the scale of intensities.

Fechner's contribution to quantitative psychology is not limited to his conception of unit sensations nor to the formulation of the Weber-Fechner Law. His monumental work on the experimental determination of the value of *threshold* still stands out as a landmark in the progress of the science of psycology. In view of Kant's declaration that psychology could never attain the rank of a true science, there were prejudices and doubts regarding the adoption of scientific methods in the study of psychology. Fechner's work and his methodology have not only broken the prejudice but have raised psychology once and for all to the dignity of a quantitative science.

Experimental determination of the 'threshold value' is an extremely difficult and complicated task. A huge amount of data has to be collected carefully and laboriously by what is known as the *Constant Method*. If the data be sufficient and the experiments are conducted under similar psychophysical conditions the variations in the judgments of the subjects obey the law of distribution of normal curve. When the observed data satisfy the law of normal distribution they are called homogeneous. As the homogeneity of data is very rare in psychophysical experiments doubts have been expressed regarding the validity of the normal distribution of the reports of judgment. Culler has shown that about 80% of the whole number of distribution followed the law. The data collected by Dr Pal in his own experiments numbering about 10,000 showed normal distribution. When the data do not follow the normal distribution law, they cannot be regarded as reliable. From the data the amount of chance errors and the values of threshold are to be calculated with the help of refined mathematical formulae.

Weber had found that dR/R was constant and Fechner supported him. The validity of Weber's relation was challenged by Aubert (1865) and Helmholtz (1866). Konig and Brodhun (1888) showed that dR/R decreased steadily as the intensity increased up to a certain point beyond which it increased. The results of Blanchard (1918) and Lowry (1931) tally somewhat with those of Konig and Brodhun. Hecht (1934) found that dR/R for just perceptible response varies with the variation of the values of R. Titchener and Fernberger thought that these discrepancies in the experimental results were due to the fact that the subjects could not maintain their attitude constant throughout the experiment. Dr Pal thinks that the inconsistency in the results is due to the fact that these were obtained from defective samples. Moreover, Weber, Fechner, Helmholtz and others varied the 'comparison stimulus' step by step by small increments until the subject could notice a change, whereas some of the other investigators used the continuous increase method,—that is, the intensity of the stimulus was increased or decreased continuously until a change was noticed. From the results of his own experiments conducted for 10 years Dr Pal comes to the conclusion that the two types of findings express measures of different capacities or of somewhat similar capacities under altogether different sets of psychophysical conditions and as such they are not directly comparable.

Recently psychologists, in keeping with the spirit of the age, have shifted their attention to fields with which human welfare is more directly concerned. Great progress has been made, of late, in the measurement of 'intelligence', 'abilities', 'personality traits', 'attitudes' and the like. Performances of definite types are graded and indices of the abilities of traits to be measured are calculated. The scores for the various performances are considered to be an indirect numerical measure of the mental processes involved in the performances.

Following the lead given by A. Binet in the matter of preparing scales of measurement of intelligence, numerous other test scales have been constructed and standardised. It is to be admitted however that most of the scales are still far from

being perfect and are not suitable for universal application. A scale suitable for the children of one nationality is not so for those of other nationalities. Besides, a scale does not indicate how much of the score of an individual is due to his innate ability and how much of it to other factors. For example, a subject's low score in an intelligence test cannot assess how much of it is due to his lack of innate ability, how much to absence of effort and interest on his part in test performances, and how much to the inhibitory influences of emotional conditions.

Summing up his views about the measurement of abilities Dr Pal says: I am not in any way minimising the overwhelming importance of the measurement of abilities. I simply desire to emphasise that mental test scores should never be accepted in the same way as the physical measurements are trusted. Certainly the best test scale measures the ability concerned but it does that within certain limits.

Dr Pal concluded his address by drawing attention of the psychologists to a serious drawback, namely, almost complete absence of co-ordination of work that is being conducted on mental testing in this country. The process of standardisation of a test requires a huge amount of labour both in collecting data and in evaluating the results. It can very seldom be adequately performed by a single individual. He appealed to the workers that instead of vying with one another in taking credit for first standardising a test, psychologists of each province should work together to construct and standardise suitable test scales. He hoped that putting our intellectual and material resources together we would be able to carry out the mental testing programme to the desired level. When that is done, the results are bound to be of great utility to the educational, vocational and industrial organizations of our society.

S. K. B.

Engineering

Engineering Education for the Engineering industry

A. H. PANDYA

THE address first deals with the history of development of engineering education in India, and deplores that until very recently importance was laid on civil engineering mainly. The first comprehensive attempt to review the subject on an all-India basis can be said to have been made by the Indian Industrial Commission whose report was published in 1918. The Commission recommended a more rapid increase in the provisions for scientific, technical, and technological training, the simplest way for the purpose being expansion of the engineering colleges (then existing) into technological institutes by the creation of new departments by the Provincial Governments and establishment of institutions of a more advanced character by the Central Government culminating gradually into imperial colleges of the very highest grade. The Calcutta University Commission in 1917-19 under the chairmanship of Sir Michael Sadler also inquired into the subject of technical education and came to similar conclusions. But when the stresses and strains of the last war were relieved, most of these recommendations were conveniently forgotten.

In 1936, the Government of India invited Messrs. Abbot and Wood to advise on certain problems of educational reorganization and particularly on problems of vocational education. They recommended diversion of a considerable percentage of the school-going students at the age of about 11 or 12 to vocational institutions to be separately established for the purpose. They also pointed out the main purposes of such schools and general principles to be followed in framing the curricula of such schools. As a result

of their report a few experimental technical schools have just been started in Bombay and Hyderabad and a Polytechnic was opened at Delhi early in 1941. Recently through the unusually large demands made by Government for technicians for war work, the subject of technical education again assumes importance and the Central Government appointed a Technical Training Enquiry Committee in 1940 under the chairmanship of Mr John Sargent, educational commissioner with the Government of India and joint secretary of the department of education, health and lands. This Committee in its report without entering into the wholesale condemnation of the present system of technical education in this country agrees with the opinion that it is too academic in content and too far divorced from firsthand contact with the needs and conditions obtaining in the country.

Dr Pandya then summarises the present tendencies in Great Britain, U. S. A., and India (Wardha Scheme) regarding aim and position of vocational education in the entire educational system of these countries, and mentions some of the recommendations of the Committee appointed by the Central Advisory Board of Education of the Government of India to examine the scheme in the light of Abbott-Wood Report on "General and Vocational Education" and of other relevant matters.

Dr Pandya suggests that aim of higher technical education is to give such a combination of humanistic, scientific, and professional training as will fit the students to take leading positions in a world in which science and engineering are of basic importance. The foundation of elementary and secondary education on which the structure of technical education rests must be strengthened before a satisfactory and efficient system of technical education can be built. Amongst other changes it is suggested that a place should be found at the secondary stage of education for training in a craft, requiring manual work and general science together with practical geometry. In the syllabus for higher engineering and technological institutions sufficient importance should be laid on gaining familiarity with the world's best thoughts in literature, economics, government, history, philosophy, and ethics—in a word, with world history in the broad sense of that term. The potentialities of research as an instrument for the education of engineers has not been fully realized in India. In Great Britain and in U. S. A. it has now been accepted, as a tenet, that research can be used very effectively in the upper years of an undergraduate course of about six years after the matriculation examination. Post-graduate classes should also be introduced where researches in engineering subjects can be carried on more intensively and effectively. The senior members of the staff should be permitted to take a certain amount of consultation practice as in medicine and law. The students should as well come in touch with industries by the introduction of the "Co-operative Courses" between the college and factories as in U.S.A. or of the "Sandwich-system" as in Great Britain. There should be closer co-operation between engineering and technological institutions and industries, leading to the benefit of both. The existing institutions should be allowed to expand both horizontally (opening up new branches) and vertically (raising the standard of teaching by affording facilities for research in pure and applied sciences). If not for every province separately, then at least, the Central Government should establish a technological institute of the highest type on a most comprehensive scale.

H. L. R.

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The Mineral Outlook in India

A review of the list of the mineral products won in India today and an appraisal of the total mineral resources of the country so far known to geologists bring home the fact that the mineral wealth of India is not, for a country of its size and population, of "enormous proportion", as is at times confidently declared from some platforms and in the public press. Except in minerals, such as iron-ore, aluminium-ore and possibly mica and titanium, the known deposits are of a decidedly limited extent and need a policy of strict conservation and planning in the interest of future national needs. This opinion receives confirmation from the experience derived from the last half-century's systematic mining and prospecting work carried out in the country. Chances of discovery of new mineral deposits of any extent and richness by the old-time methods of surface prospecting are now not many, though the new geophysical methods of locating underground mineral occurrences by electrical, magnetic and seismic instruments—methods which have hardly received any extensive systematic trials in this country—seem to offer some possibilities of bringing to light hitherto undiscovered, but in some cases suspected, deposits of petroleum, coal-measures, natural gas, underground distribution of water reservoirs, metallic loads etc.

On the other hand, the known mineral resources of India, though limited, are by no means inconsiderable and encompass a sufficient range of useful products that are necessary to make a modern civilized country more or less industrially self-contained. In the cases, especially of some non-metallic minerals, the available resources may be considered more than ample ; other minerals of this group have prospects of considerable economic expansion, several times their present insignificant production. The freest scope for expansion of India's mineral industry exists for the latter two classes of minerals which, needing comparatively small capital outlay (as compared with the huge metal-production plants), are capable of giving remunerative employment to the educated middle class and at the same time reacting favourably on the general industrial outlook of the country.

India's resources in minerals of strategic importance—minerals for munitions and defence armaments—can be regarded as adequate in some of them. India is deficient in tin, tungsten, lead, zinc, graphite and liquid fuels, but in the basic metals, iron, manganese, aluminium and chromium the country is well supplied, in the case of the former they are in large excess. Our neighbour Burma has abundant stocks of the munition-metals of which India is in defect, while her oil resources must yet be regarded as considerable. Ceylon has reserves of the world's finest graphite,—a mineral indispensable in

metallurgy, and of a magnitude sufficient to last a long period.

In the defence programme of a nation under the present-day conditions of totalitarian warfare, the metallurgical industry and its ancillary mining of minerals yielding the ferrous and alloy metals, fluxes, refractories and accessory materials are of the utmost importance. The experience of the last two years' effort in the production in India of a wide range of munitions of war, without any previous apprenticeship, is satisfactory proof of the country's adequacy in some respects, though still unequipped in a number of essentials *viz.*, specialized steels for the heavy armaments, machine tools, manufacture of aircraft, high explosives, automobile engines, big-ship construction etc.

The gravest defect of the present-day mineral industry of India is that by far the largest quantity of the produce of our manganese, mica, chromite, ilmenite, refractory and some other mines are extracted mainly for the purpose of the export trade and at a rate which will in course of but few years deplete the reserves of valuable key-metals and accessory minerals.

The bulk export of raw minerals, even where they are in large excess, without processing or refining treatment, deprives the country of the major share of the ultimate profits of the finished commodity. The old concept of India as a depot of raw materials for the workshops of foreign countries had some justification when some decades ago, both capital and talent were not easily available locally. Such is no longer the case since the changed industrial outlook brought on by the last war.

More than 20,000,000 tons of high grade manganese ore has left the country during the 30 years preceding the war, the price obtained for it being ridiculously low, the exporters having to pay the heavy cost of transport to the consuming countries. This export of manganese has been carried out not so much by genuine miners, as by traders, on much the same principle as trade in cotton, jute and wheat, regardless of the fact that metals are a rapidly wasting asset of a nation and that no geological processes or fertilisers will replenish the exhausted mines, as in the case of farm and field produce. India is thus not only so much the poorer by the loss of a metal of industrial value, but has also to pay a penalty in the shape of cost of export, leaving but little for the bare value of the ore. At the rate of export that has gone on in the past years, it is possible that at some future date, when India has begun to utilise to the full her metallurgical resources in steel manufacture, she may have to import manganese from overseas at several hundred percent premium over the price she is receiving today for her outward shipments.

In any scheme of planning for future the enforcement of following measures is called for: (1) control of the unrestricted export, in the raw state, of manganese-ores, chrome-ores, mica, ilmenite, phosphatic materials and sillimanite; and in parallel with that (2) stoppage of export of key-minerals and metallic ores without a compensatory return, or barter, of equally important minerals and metals in which this country is deficient; (3) a better adjustment of mineral tariff in the levying of export and import duties and fixing of quotas; (4) domestic treatment or part manufacture of several raw minerals before export; (5) provision of facilities for free technical advice and information on mining methods and practice, for minerals which are raised for home manufactures.

It is apparent that steps for the attainment of some of the above objects, for instance, (4) and (5) can be taken more easily and earlier than for the rest which require legislation, adjustment of foreign relations etc. The earliest action is called for the industrial utilization of those minerals with which the country is well supplied but which are either partially or entirely neglected, or but inadequately employed, in the manufacture of products which India has begun to use in increasing volume by acquiring the supplies from overseas sources. Some of the minerals, available in quantity in India, but which are scarcely put to one-tenth of their potential uses, are: various clays and earths, asbestos, barytes, mineral pigments, marble, monumental granite, refractory clays, sillimanite and kyanite, *reh* and *usar* salts for sodium and alkaline compounds, sulphur contained in the pyrites and the sulphide ores, thorium content of monazite, nitrates, phosphates, bauxite (industrial utilization besides its smelting for aluminium metal), mica, ilmenite, gypsum, magnesite and zircon. The capital and initial outlay needed for many of these mineral industries is not likely to be beyond the resources of the mercantile community. The chief impediment hitherto, however, has not been capital, but lack of knowledge

of the uses of these minerals in industry and of manufacturing technology. With the increase in the number of industrial chemists and geologists in India these mineral industries ought to acquire a far improved outlook.

In the mineral wealth of a country must be included the stores of underground water and, still more, the soils covering the surface; these form natural assets of the highest value. The vast plains of India, covering 300,000 sq. miles, over the greater part of their extent possess agricultural and underground water resources, whose full potential is not yet utilized. The water supplies in the Himalayas, fed by the perennial snowfields and glaciers, and in the Western Ghats by the periodic monsoon currents, are a profoundly important low-cost source of energy replacing fuel in the coal-less parts of the country.

RELATIVE POSITION OF INDIA WITH REGARD TO SUPPLY OF INDUSTRIAL MINERALS

I. Minerals of which our Exportable Surplus can dominate World Market :—

Iron-ore
Titanium-ore
Mica

II. Minerals of which our Exportable Surplus forms an important factor :—

Manganese-ore	Silica
Bauxite	Gypsum
Magnesite	Monumental granites
Refractory minerals	Monazite
Natural abrasives	Beryllium
Steatite	

III. Minerals in which India may be considered Self-Sustaining for present needs and those of the immediate future :—

Coal	Glass sand
Cement materials	Pyrites
Aluminium-ore	Borax
Gold	Felspars
Copper-ore	Nitrates
Chrome-ore	Phosphates
Building stones	Zircon
Marble	Arsenic
Slate	Antimony
Industrial clays	Barytes
Limestone	Precious and semiprecious stones
Mineral pigments	Vanadium
Sodium salts and alkalis	Rare earths
Alum	

IV. Minerals for which India has to depend largely or entirely on Foreign Imports :—

Silver	Mercury
Nickel	Tungsten
Petroleum	Molybdenum
Sulphur	Platinum
Lead	Graphite
Zinc	Asphalt
Tin	Potash.

In the mineral outlook of India there is one menacing prospect—the rapid depletion of the better grade coal* (metallurgical coal), the total reserves of which, according to competent authorities, are quite inadequate for future needs. They are totally insufficient to convert into metal the rich reserves of iron and manganese ores, the principal metal assets of India. It is doubtful whether they are sufficient for smelting even a third part of these ores. Small as the stock of coking coal is, it is drawn upon indiscriminately for use as ordinary fuel in railways and factories, a purpose for which second and even third grade coal is usable. The very cheapness of Indian coal at the pit-head leads to this wasteful employment of the better grade (high carbon, low ash) coal and to the adoption of crude methods of its mining. Competent authorities have also deplored the fact that few of our collieries are able to extract more than half the coal occurring in a mine by the methods in vogue, the remaining half being left in the mine to support the roof of the excavations. In the coking of coal in country-made coke-ovens (*bhattas*) much avoidable wastage of valuable byproducts takes place as no attempt is made to recover the host of industrially useful derivatives of coal,—tar, heavy lubricating oils, gas, ammonia, benzene and numerous other products, millions of gallons of which are allowed to escape into the air.

The adoption of a wise mineral policy by countries well-endowed with mineral wealth promotes international peace and good will. No country in the world, however well-supplied it be, is self-sufficient in mineral requirements, nor is any so situated that it can regard its mineral resources as purely domestic or national, as this would ignore the fundamental fact of world mineral relations. Embargos, tariffs, transport control, patent rights, dictated not by economic urgency but by political considerations, hinder international movement of minerals and have been powerful contributory factors in the world wars and the chaos in which we find ourselves today. It is wise and politic to take stock of India's resources in industrial and strategic

* This subject has been thoroughly dealt with in SCIENCE AND CULTURE. See Vol. 6, Pp. 61, 63, 1940-41 and Vol. 7, Pp. 140, 196, 1941-42.

minerals today, to enable us to form an estimate of her relative strength and weakness in these matters. With this view the above table is given; it is to be regarded as a tentative and not a rigid classification, the transference of a mineral from one category to another is possible within limits depending on a number of circumstances ; a slight overlapping of the classes, again, is unavoidable.

The exact and authoritative information on which this table is based and which in fact has enabled such a classification to be made, is derived from the valuable quinquennial reviews of the mineral production of India, published in the *Records of the Geological Survey* of India periodically since 1908.

D. N. W.

The Late Professor W. Nernst

WE are very sorry to learn through American sources the news of the passing away of Professor W. Nernst, the great physical chemist of Germany. Nernst's 'Theoretical Chemistry' was for many years a standard treatise for the students of physical chemistry all the world over. The manifold and brilliant contributions made by himself and his pupils to physics and chemistry are equally well-known. The news of his death will be regarded with profound regret wherever science is cultivated.

Prof. Nernst was born in 1864 in East Prussia and was a typical East Prussian. A man of extraordinary energy and possessed with an equally virile and active mind he had also very strong likes and dislikes. The result was, as R. A. Millikan remarks in the *Scientific Monthly*, that he had always some academic quarrel with somebody and like certain eminent scientific persons, the excitement of fighting, which was often harmless, appears to have had a stimulating effect on his intellect. Those who had the privilege of intimate acquaintance with him could however discover behind his rough exterior a kindly and benevolent soul, always ready to help his pupils not only by very helpful suggestions in their experiments but also by providing them with suitable berths in life.

As a leader of science, Nernst's place is difficult to fill up. He was attracted to physical chemistry by Wilhelm Ostwald and at an unusually early age for Germany, became a professor ordinarius in the University of Göttingen. Later he was called to occupy the chair of physical chemistry in the University of Berlin and his laboratory at Reichstagsufer was the nursery of younger physical chemists not only of Germany but of the United States of America, central and eastern countries of Europe, India and Japan. Amongst his students may be mentioned Langmuir, Lindemann (now Lord Cherwell), Sackur, Simon, Eucken, Plotnikov and many others who are now familiar names in physics and chemistry. It is remarkable that in spite of the vast amount of work which he did personally, and the vaster amount which he inspired, his laboratory was always of modest dimensions. The present writer had the good fortune of working at Nernst's laboratory during the summer season of 1921 on an experimental proof of thermal ionisation. He complained to Nernst that compared to the vast activities of the laboratory, it was rather small and wanting in suitable equipments. Nernst gave a characteristic answer, "When you shut a singing bird in a big cage, it refuses to sing." Later, he was shut in a big cage himself, when he was called to fill up the directorship of the Physikalische Chemische Reichsanstalt, on the retirement of Warburg. He did not appear to have sung much there, for after a short while he came back to the University as Ruben's successor to the chair of physics.

It will be a difficult task to give an exhaustive account of Nernst's manifold activities and it will not be attempted here. He will be best remembered by his experimental work on specific heats at low temperatures, his contributions to electro-chemistry and his 'Third Law of Thermodynamics' which he gave out in 1906 while a professor at Göttingen under the title 'Eine Neue Wärmesatz'. The full account has been given by Simon in his article in volume IX of *Ergebnisse der Exakten Naturwissenschaften*.

Looking over 36 years of Nernst's heat theorem, which is now regarded as a fundamental law of Nature, one is struck by Nernst's great powers of intuition. He rather saw than proved the truth. Let us take, for example, his idea of the chemical constant, or what amounts to the same 'The Third Law of Thermodynamics'. When the idea was first given out in 1906, it was based on very unsatisfactory experimental and theoretical grounds and his assertions of its absolute correctness did not convince many. But to establish it on surer ground, Nernst planned a wide programme of experimental works, on specific heat of gases and solids at low temperature, on vapour pressure of bodies at high and low temperatures, and studied a large number of reactions in gaseous systems. Round this central theme was worked out brilliant experimental methods, and the programme was carried out as thoroughly as any scientific work could be. It was his pupil Sackur who, by an application of the quantum theory, first found the correct value of the chemical constant for a monatomic gas. But the full significance of the law (provided anything can be called in science) came with the developments in wave-mechanics, and is associated with the names of Bose, Einstein, Fermi and Dirac.

Nernst was very proud of the Third Law, and claimed it as peculiarly his own. "The first and second laws of Thermodynamics", he once remarked, "have been built up by the labours of many men, but the third law is entirely my own".

As an example of Nernst's inspiring guidance may be mentioned the discovery of rhenium (element 75, named after Rheinland then in allied occupation), and possibly also of masurium (element 43, named after Masurian lakes in East Prussia where Hindenburg had his brilliant victory over the Russians in 1914) by the Noddacks. The work started from Nernst's attempt to find out transuranic elements. Nernst was strongly nationalistic and in the naming of the elements one can see his mind.

He had lost two grown up sons in the first World War, and his daughter was married to a banker who was found by Nazis to have Jewish blood. The consequence was that his grandchildren could not be German citizens and had to be kept in Oxford in 1936 for their education. Though he was strongly nationalistic, the present writer could not detect any trace of race prejudice in him, and he continued to take interest in the well-being of his Jewish ex-students even after the establishment of the Nazi Government.

As noted earlier, the writer of the present note reached Nernst's laboratory at Reichstagsufer in the summer of 1921 with a view to securing an experimental proof of the theory of thermal ionisation. Though the memory of the War was fresh, Nernst welcomed him cordially to the laboratory and gave him all the facilities for work. The work however could not be finished, and only a preliminary confirmation was obtained. Nernst had evidently read the application of the theory to astrophysics, but appeared not to have fully grasped its significance. He was however conscious that it was some sort of confirmation of his heat theorem in a fresh field, and when Arrhenius, who evidently had some previous academic quarrel with Nernst about the heat theorem, paid a visit to his laboratory in 1921, he did not fail to introduce the present writer to the great Scandinavian adding that a new field had been found for the application of his heat theorem. Later, the writer met Nernst at Stuttgart in 1936, when he spoke of "Die grosze astrophysikalische Arbeit". After the departure of the author, he planned a new and better method of establishing the theory of thermal ionisation experimentally and it was carried through by E. Mayer. Independent experimental confirmation of the theory of thermal ionisation was secured later by Langmuir, and in a different way by B. N. Srivastava and the present writer.

Nernst expressed his mind quite freely about men and subjects, sometimes as it would appear betraying considerable prejudice. Talking of the science of colloids, he would say, "I have never wasted my time on that *turbid* science." Einstein was a frequent visitor to Nernst's laboratory in 1921, probably to discuss properties of bodies at low temperature, which might have led later to his theories of gas-degeneration. It was a highly exhilarating sight to see the great propounder of Relativity lounging at leisure on full length in the easy chair, and scarcely uttering a word in minutes, while Nernst would be pacing to and fro, speaking all the time with great animation. Nernst spent a good deal of time in his later years in speculating on the origin of energy in stars, on the gradual 'Wärmetod des Welts', and other highly speculative topics.

A Nobel prize was awarded to Nernst in 1923.

M. N. Saha.

Cosmic Radiation*

H. J. BHABHA

Indian Institute of Science, Bangalore

(Continued from the last issue)

For quanta of the high energies of interest in cosmic radiation, the dominating process leading to their absorption is that of pair creation. While passing through the electric field of an atom, theory shows that the quantum can disappear by creating an electron and a positron, its energy being converted into the total energy of the two particles. This process is formally very closely connected with the emission of radiation by an electron described above. Indeed, the probability that in travelling a distance dt a quantum of energy k creates a positron of energy E in the range dE and an electron of energy $E_0 = k - E$ is given by formula (9) if we change the sign of E in the brackets and replace dk/kE_0^2 by dE/k^3. The distribution curves given by this formula are quite flat, and the chance that one of the particles of the pair takes the whole energy of the quantum the other being left with very little, is roughly equal to the chance that the whole energy is divided equally between the two particles.

The other processes leading to an absorption of radiation quanta, namely, the photoelectric effect and the scattering of quanta by free electrons (Compton effect), are negligible compared with the pair creation process at high energies, and indeed, the latter dominates over the former for energies above 5 m.e.v in lead and above 30 m.e.v. in light elements like aluminium. It should be remembered further that after the pair creation process the quantum ceases to exist, while in the Compton effect, a slightly less energetic quantum takes the place of the original one. Moreover, since at high energies the quantum is scattered through a small angle and loses a small fraction of its energy the Compton effect can be treated as a process in which the quantum gradually loses energy in a number of small steps, rather in analogy with the collision loss of charged particles. It is found that the resulting energy loss per unit distance is about one tenth of the collision loss of fast electrons. In the cascade process, which will be discussed immediately, it therefore decreases the number of quanta of energies below about one tenth of the critical energy, the number of quanta above this energy not being appreciably affected. It may be neglected without causing serious error.

Now consider the passage of a very high energy electron through matter. As formula (8) shows, it will lose its whole energy in a distance of at most a few units, this energy being lost mainly by emission of the order of ten quanta of energy comparable with its own. Each of these quanta will convert itself into an electron pair through the pair creation process mentioned above in travelling a distance of the order of one unit. Since at least one particle of each pair must have an energy comparable with that of the quantum emitting it, it follows that after one stage of this double process the initial electron will have given place to a considerable number of electrons, positrons and quanta of high energy. The process now just repeats itself, the number of electrons and quanta multiplying at each stage. Since, however, the mean energy of the particles falls at each step, a state of affairs is eventually reached when the average energy of the electrons and quanta is near the critical energy. At this point the radiation loss begins to become unimportant compared with the collision loss, and the whole cascade of electrons is rapidly brought to an end by the collision loss. These are the underlying physical ideas on which the cascade theory is based as originally put forward by Carlson and Oppenheimer (1937) and Bhabha and Heitler (1937).

*Being the summary of ten lectures delivered at Calcutta University during the month of December, 1940.

Fig. 3 gives a typical curve of the cascade theory. The abscissa is the distance in the characteristic units l, and the ordinate is the number of particles of energy greater than E due to a primary of energy $E_0 = 150E$. The contributions of the different stages are shown by the curves marked n=1, 2, 3, etc., the curve marked total being the sum of these. The probability of the initial electron penetrating to any given thickness is shown by the dotted curve. Fig. 3 shows

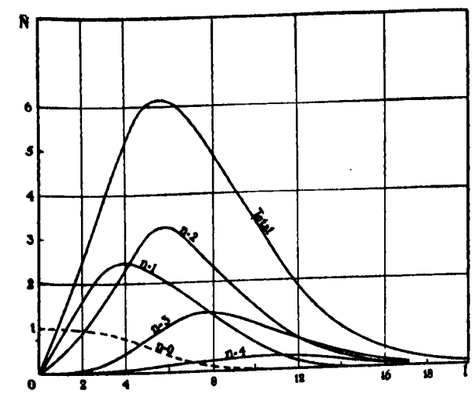

FIG. 3. The average number of particles with energies greater than E produced by one primary electron with energy E_0 has been plotted against the thickness of any material measured in the characteristic unit l, $(y = \log \frac{E_0}{E} = 5)$.

clearly that due to the cascade process electrons are found at depths far beyond the range of the original electron.

It can be shown* that the maximum number of particles of energy greater than E due to a primary electron of energy E_0 is

$$N_{max} = 0{\cdot}137 \frac{E_0}{E} \left(\log \frac{E_0}{E} - 1{\cdot}31\right)^{-\frac{1}{2}} \quad . \quad . \quad . \quad (10)$$

and this maximum is reached after a thickness t given by

$$t = 1{\cdot}01 \log \frac{E_0}{E} - 1{\cdot}57 \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Formula (10) shows that even at the maximum, the number of particles is considerably less than a tenth of what they would be if the whole energy E_0 were divided equally among electrons of energy E. This is because more than half the energy is in the form of quanta, while at the same time a part of it is already being carried by electrons of energy less than E, and a part by electrons of energy greater than E. Formula (11) shows that the maximum number of particles occurs at greater thicknesses as the primary energy E_0 increases.

The cascade theory explains the showers consisting of a large number of high-energy positively and negatively charged particles which have been observed to originate in plates of heavy material put inside a Wilson chamber. Showers consisting of a few particles were first observed by Blackett and Occhialini (1933). Experiments by later investigators have amply shown that the vast majority of showers consist of electrons and positrons and are created in accordance with the cascade theory. The large "bursts" of ionization observed in ionization chambers due to the simultaneous passage of several hundred particles are also to be interpreted in the same way. Study of the transition curves of showers, first investigated by Rossi (1933), and of bursts has shown that the maximum frequency of larger showers occurs at greater thicknesses of the absorbing substance in which the showers are produced than smaller showers, and confirms the shift of the position of the maximum predicted by formula (11) (Auger and others 1937, Böggild 1936). There are indications, however, that particles other than electrons and of much greater penetrating power are sometimes involved in showers to a small extent, and small showers consisting of two or more such penetrating particles have also been observed, which obviously cannot be explained by the cascade theory.

The cascade theory also appears to be able to explain the main features of the top half of the atmospheric absorption curves described in the previous section. The positions of the maxima of the atmospheric absorption curves are in good agreement with theory. In particular, the shift of the maximum for cascades caused by electrons of higher initial energy agrees with the fact that the maximum of the curve giving the difference between curves C and D lies at a greater depth below the top than the difference between curves B and C. There is, however, a consistent divergence between theory and experiment at depths below half the atmosphere, the experimental values for the ionization being always greater than those to be expected on the cascade theory. For example, the difference between curves C and D of figure 1 can be due to particles

*Bhabha and Chakrabarty, in course of publication.

of at most $1{\cdot}7 \times 10^{10}$ e.v., and according to the theory a cascade produced by an electron of this energy would be completely absorbed long before it reached sea level, whereas there is a noticeable difference between curves C and D at sea level. Thus, the trend of the curves in the lower atmosphere reveals that some of the particles at least have a greater penetrating power than that of electrons on the cascade theory.

The discrepancy is brought clearly into evidence by the experiments of Auger and his coworkers (1936) who measured the absorption of cosmic ray particles in lead at different altitudes. They showed that 10 cm. of lead reduced the number of cosmic ray particles to about 75%, whereas the addition of another 90 cm. of lead still allowed more than 30% of the initial number of particles through. Indeed, if the number of particles be plotted as a function of the thickness of the lead absorber, the resulting curve shows a distinct kink at about 10 cm. of lead, the slope being very steep before this kink and very small after the kink. They therefore divided the cosmic ray particles, at sea level into two groups, the soft group which is largely absorbed by 10 cm. of lead, and the hard group which penetrates more than a metre of lead. The soft group behaves in every way like electrons and positrons, and the cascade theory shows that about 15 cms. of lead would be enough to absorb the most energetic of these. To account for the vastly greater penerating power of the particles of the hard group one must attribute to the particles a mass much greater than that of the electron in order to reduce their radiation loss according to formula (3). It is however not possible to identify the particles with protons, for Wilson chamber photographs show that the ionization of particles of the penetrating group is definitely much less than that to be expected for protons of the momentum concerned, and more nearly resembles that of electrons. A detailed analysis of this and other experimental evidence leading to the conclusion that we have to do here with a new particle of mass intermediate between those of the electrons and proton is given in a paper by the present author (1938). The following experiment by Neddermeyer and Anderson (1937) however directly demonstrates the point. The cosmic ray particles entering their Wilson chamber were divided into two groups, those entering the chamber unaccompanied by another particle, and those entering the chamber accompanied by one or more particles. The energy loss of particles of both group in a lead plate put across the chamber was measured. As a result it was shown that the energy loss of particles *lying in the same energy range* was much greater for the first group than for the second, and in accordance with that to be expected theoretically for electrons. It was thus demonstrated that the second group consisted of particles which suffered much less radiation loss than electrons of the same energy, and which were excluded from being protons by their ionization. This experiment shows that a particle of mass intermediate between those of the electron and proton is concerned, which for this reason has been called a meson or mesotron. It is clear now why the above experiment effects a separation of the two types of particles, for the particles of the first group being electrons produce cascades and have a large chance of appearing accompanied by other electrons, while the particles of the second group do not produce cascades to anything like the same extent due to their very much smaller radiation loss, and hence usually appear alone.

THE MESON

Experimental determinations of the meson mass show that it lies between 130 and 200 times the electron mass. It cannot yet be claimed as established that there is only one type of meson with a unique mass, but if this assumption is made, as it usually is, then about 170 times the electron mass appears to be the best estimate of the meson mass. Denoting the meson mass by μ, the energy E and momentum p of a free meson must be connected by the equation

$$\frac{E^2}{c^2} - p^2 - \mu^2 c^2 = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

In consequence, since energy and momentum in quantum theory are connected with the operators

$$E = ih\frac{\partial}{\partial t}\,;\ p_x = -\,ih\frac{\partial}{\partial x}\,;\ \text{etc.},$$

any component ψ of the wave function of the meson must satisfy in free space the second order equation

$$\left\{\frac{\partial^2}{c^2\partial t^2} - \frac{\partial^2}{\partial x^2} - \frac{\partial^2}{\partial y^2} - \frac{\partial^2}{\partial z^2} + \chi^2\right\}\psi \quad . \quad (13)$$

where $\chi = \mu c/h$. This is true quite irrespective of the spin of the meson.

If instead of the right hand side of equation (13) being zero, we consider the meson field generated by a charge g (the word charge here is used in analogy with electromagnetic theory, but it must be remembered that the charge is *not* an electric charge and does not create an electromagnetic field) fixed at a point, then the solution of (13) is of the form

$$g\,\frac{e^{-\chi r}}{r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

where r is the distance from the fixed point. The field therefore falls away exponentially in the static case, and its range is $1/\chi$.

The rapid falling away of the solution (14) for r large compared with $1/\chi$ is a characteristic it shares in common with the forces which act between any two nuclear particles, in particular between a proton and neutron. Moreover, putting $\mu = 170m$, m being the electron mass, the range of the field (14) is of the order $2{\cdot}3 \times 10^{-13}$ cms in remarkable agreement with the experimentally found range of nuclear forces.

The property of the equation (13) in having a solution of the type (14) was made by Yukawa (1935) the basis of a theory of nuclear forces. The nuclear force between two heavy particles was assumed to arise due to the emission and reabsorption of a particle of mass μ. To agree with the observed range of nuclear forces, μ had to be chosen to be between 100 to 200m. Moreover, in order to be in agreement with the "exchange" character of nuclear forces by which a proton changes into a neutron and a neutron into a proton every time the interaction takes place, it was assumed that the nuclear field was electrically charged, or in other words that the particle giving rise to the interaction was electrically charged. Thus Yukawa's theory necessitated the postulation of positively and negatively charged particles of the mass of the order 200m, and was put forward in 1935, two years before the actual discovery of the meson in cosmic radiation. It should be noticed at once that on the above assumption in which a meson can be emitted unaccompanied by any other particle whenever a proton turns into a neutron or vice-versa, it is necessary that the meson should have a spin which is an integral multiple of h. Half integral spins are necessarily excluded by the conservation of angular momentum, since both the neutron and proton have a spin half (in units of h).

In the original work of Yukawa the meson was assumed to be a particle of spin zero. The theory has since been extended by several authors and mesons of spin 0 and 1 have been considered in detail. In particular, Kemmer (1938) has shown that in order to obtain the experimentally observed force between a proton and a neutron consisting of a combination of forces of the Heisenberg and Majorana types in agreement with those deduced from nuclear experiments by the interchange of *charged mesons only*, the meson must be assumed to have a spin 1 and be described by the vector equations given by Proca (1936). Charged mesons of spin 0, or of spin 1 described by the pseudo-vector equations lead to interactions of a type different from those required to explain nuclear data.

As long as nuclear forces are assumed to arise only through the agency of *charged* mesons, then the force between like heavy particles, as for example, two neutrons, can only arise in a higher approximation by the simultaneous exchange of two mesons between the two heavy particles, whereas the neutron-proton force arises in a lower approximation by the exchange of one meson only. On the other hand, there is very considerable evidence from experiments on nuclear scattering that the nuclear forces between all heavy particles in the same states are the same to within experimental accuracy irrespective of whether the particles are protons or neutrons. This has led to the tentative acceptance of the "charge independence hypothesis" which states that the nuclear forces between two heavy particles are exactly the same in the same states irrespective of whether the particles are charged or not. It is clear that in order to obtain a force between two like particles, say two neutrons, in the same approximation as the proton-neutron force and by the exchange of one meson only, it is necessary to postulate the existence of neutral mesons also. However, once the existence of neutral mesons is admitted, then the arguments in favour of spin 1 for the mesons disappear, for Pauli has shown that by the combined action of charged and neutral mesons of spin 0 it is possible to get the right type of nuclear interaction.

There are several physical processes, as for example, the collision of mesons with electrons and the radiation loss of mesons in the electric fields of atoms which depend very much on the spin that is attributed to the meson.* For example, the radia-

* The cross-sections for the different processes have been collected together by Pauli (1941).

tion loss of a meson of energy E is proportional to E if the meson have a spin 0 or ½ (for spin ½ the radiation loss is given formula (3), while for spin 1 it is proportional to E^2, as has been shown by Booth and Wilson (1940a) and Christy and Kusaka (1941a). Similarly, the cross-section for the production of fast electrons by collision is proportional to $\mu c^2/E$ for spin 0 or ½, while it is independent of the energy for spin 1. These differences can be used to get information about the spin of the meson from cosmic ray experiments.

It was mentioned earlier that the experiments of Auger and his co-workers show that between 25 and 30 per cent of the cosmic ray intensity at sea level consists of electrons. At depths of more than 12 metres below sea level according to Auger, and Ehmert (1937) the soft component makes up between 9 and 15% of the total intensity. Experiments have been carried out to depths of more than 100 metres of water by Ehmert. Moreover, no cascade due to an electron of any reasonable energy would penetrate to these depths. Most of the soft component at sea level, and all of it below the ground must therefore be considered as produced by the mesons. There are two ways by which mesons may do this. (1) The meson may make a very close collision with an electron, communicating a high energy to it. (2) The meson may emit a quantum of radiation in passing through the field of an atom. The energetic electron or quantum so produced then creates a shower by the cascade process. The number of large showers produced by mesons and the variation of their frequency with size therefore depend very much on the spin that is attributed to the meson. Calculations by Christy and Kusaka (1941b) show that while spin 0 or ½ is in agreement with experiments on the variation of the frequency of bursts with size, spin 1 is not. This experiment therefore appears to favour spin 0 for the meson, spin ½ being impossible if the coupling with the heavy particles mentioned above is to be maintained. The conclusion is however not definite since the calculated figures depend quadratically on the mass of the meson (as formula (3) for example shows) and if the meson was appreciably greater than 177 m, spin 1 would be in agreement with experiment.

Quite apart from practical applications, many points of fundamental theoretical importance can be made clear by studying the theory of mesons of spin 1 because the equations for a particle of spin 1 are formally very similar to the Maxwell equations, and if the meson mass be put equal to zero for a neutral meson field they go over exactly into the Maxwell equations. Just because of this similarity, a particularly clear insight can be obtained of the effect of each of the three independent particulars in which meson theory can differ from Maxwell theory. The three independent respects in which the two theories differ are:

(1) The meson has a finite rest mass μ, while light quanta have no mass. As a result longitudinally polarized meson waves may exist besides the two transversely polarized waves known in the theory of light.

(2) The meson field has an interaction with the heavy particles described by two independent constants g_1 and g_2. The former corresponds to the charge in Maxwell theory, while the latter would correspond to an explicit magnetic dipole moment. The equivalent of g_2 is zero for an electron.

(3) The meson field may be neutral as well as electrically charged, whereas a field like the Maxwell field must necessarily be neutral since quanta have no rest mass.

In order to isolate the effect of the finite rest mass of the meson consider first neutral mesons with only the g_1 interaction, putting $g_2=0$. The effect of a finite mass now manifests itself by having in the interaction energy of *longitudinally* polarized mesons with the heavy particles terms proportional to $E/\mu c^2$, E being the meson energy. The interaction therefore appears to become stronger with increasing energy. (Longitudinally polarized waves do not exist when $\mu=0$). It was however shown by Bhabha (1939) that in spite of this the scattering of longitudinally polarized mesons is actually less than that of transversely polarized mesons by a factor $(\mu c^2/E)^2$, the cross-section, if radiation reaction be neglected, being

$$\frac{8\pi}{3}\left(\frac{g_1^2}{Mc^2}\right)^2 \frac{\mu^2 c^4}{E^2}\left(1+\frac{1}{2}\frac{\mu^2 c^4}{E^2}\right) \quad . \quad (15)$$

Moreover, the quantum theory of *neutral* mesons gives a result completely agreeing with this, as shown by Booth and Wilson (1940b). The important point is therefore established that terms in the interaction which increase proportionally with the energy do *not* necessarily lead to cross-sections increasing with energy, and consequently do not justify the conclusion that they lead to Heisenberg explosions.

Next consider a neutral meson field with the g_2 interaction. The cross-section for the scattering of *transversely* polarized mesons in the quantum theory due to this explicit spin interaction is

$$\frac{64}{3}\pi\left(\frac{g'^2_2}{\mu c^2}\right)^2 \frac{p^4}{\mu^2 E^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

where $g'_2=g_2\mu c/h$, and has the dimensions of a charge. This cross-section therefore becomes very large at high energies. It can however be shown as the result of a complete classical theory that the effect of radiation reaction on the rotation of the spin is to cause the scattering to decrease at high energies (*cf.* Bhabha, 1940, *Proc. Ind. Acad. Sci. A*, *11*, 247), and to replace (16) by

$$4\pi \frac{p^4}{a^2E^2+p^6/h^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

where $a=3\mu c^2/4g'^2_2$ (Bhabha 1941). This agrees with (16) for small energies,* while for high energies it decreases as $(h/p)^2$. Its energy dependence is given in figure 4. Recently Heitler (1941) and

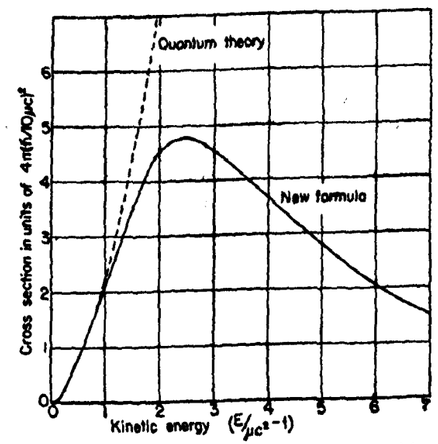

FIG. 4. The variation of cross section with energy.

Wilson (1941) have treated the effects of radiation reaction in the quantum theory and obtained a result very similar to (17). There is therefore also no justification for the view that at high energies the g_2 spin interaction would lead to very large explosions as supposed by Heisenberg. It should be noted that the rotation of the spin does not lead to the scattering of longitudinally polarized mesons since only a magneto-mesic force can act on the spin, which in the rest system behaves like a pure magnetic dipole, and longitudinal waves have no magneto-mesic force. Hence the scattering of longitudinally polarized mesons is several thousand times smaller than that of transversely polarized mesons.

Finally consider the effect of the difference (3). Putting $g_2=0$, the cross-section for the scattering of longitudinally polarized *charged* mesons is

$$4\pi\left(\frac{g_1^2}{\mu c^2}\right)^2 \frac{p^4}{\mu^2 E^2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

which, apart from increasing with the energy is larger than (15) by a factor $(M/\mu)^2$. The cause of the difference between (15) and (18) was first pointed out by Pauli* and is due to the fact that there are twice as many intermediate states by way of which the scattering can take place for neutral mesons as for charged mesons. For example, in the scattering of a neutral meson by a neutron, the meson can first be absorbed and the scattered meson then emitted, or the scattered meson first emitted and the initial meson then absorbed. In the scattering of a positive meson by a neutron on the other hand, only the transition via the first intermediate state is possible, for the neutron turns into a proton in the intermediate state, while it would have to turn into a negative proton for the transition to take place via the second intermediate state. It was first pointed out by the present author that the scattering of charged mesons is reduced to that of neutral mesons by assuming that the heavy particles can exist in states of all integral charge. Heitler (1940) has shown that on the basis of this assumption the cross-section for the scattering of a charged longitudinally polarized meson becomes

$$4\pi\left(\frac{g_1^2}{\mu c^2}\right)^2 \left\{\frac{1}{8}\left(\frac{\mu}{M}\right)^2\left(\frac{\mu c^2}{E}\right)^4+\left(\frac{\Delta M}{M}\right)^2\frac{p^4c^4}{E^4}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

* (17) is smaller than (16) at low energies by a factor 3 which is discussed in a paper by Bhabha and Madhava Rao (1941).

*This fact was communicated by Professor Pauli to the present author in a letter and its first publication was in the paper mentioned above (Bhabha 1939).

where ΔM is the mass excess of a negative proton over an ordinary proton. The assumption further definitely leads to the appearance in nature of protons of charge 2e and -e, and the magnitudes of the processes leading to the creation of these particles have been calculated and the possibilities of their experimental detection discussed (Bhabha 1940). A search by Taylor, Fraser and Dabholkar (1940) for tracks of these particles in the emulsions of photographic plates exposed to cosmic radiation at a height of 18,000 feet in the Himalayas has failed to detect these particles, due to the resolving power of the method being insufficient. Specially designed experiments with a cloud chamber are needed for this purpose.

In order to avoid the increase of the scattering by the spin given by (16), Heitler (1940) has put forward the assumption that the heavy particles can also exist in states of higher spin. However, the assumption that the heavy particles can exist in states of all integral charge by itself puts charged mesons on the same footing as neutral mesons, and allows the cross-section (17) to be applied to charged mesons also. This has been further confirmed by Bhabha and Madhava Rao (1941) who have shown that with this assumption the quantum mechanical and classical cross-sections for the scattering of mesons by the g_2 interaction agree completely in their dependence on energy, scattering angle, and directions of polarization of the incident and scattered mesons. This is not so on the usual assumption where the heavy particles only exist as protons and neutrons, and it is also not so if the heavy particles are allowed to exist in states of higher spin as postulated by Heitler. The cross-section (17) is certainly not in disagreement with existing experiments *at high energies*, though it appears to be larger than the observed cross-section at low energies. The effect of the higher spin idea would be to reduce its magnitude at low energies of the order of 3×10^8 e.v. where (17) is a maximum. Nevertheless it cannot be concluded, as Heitler (1941) has done, that it is *necessary* to allow the heavy particles to exist in states of higher spin because, first, the scattering of longitudinally polarized mesons is 20,000 times less than that of transversely polarized mesons (Bhabha 1941a) and an admixture of a considerable number of these would reduce the average cross-section which is measured in experiment. Secondly, it is not yet certain that mesons have a spin 1. For mesons of spin 0 the higher spin idea for the heavy particles is not necessary, while the assumption of allowing the heavy particles to exist in states of all integral charge has still to be made, if it is necessary to reduce the cross-section for the scattering of charged mesons of spin 0 at low energies from being of the order $(g_1^2/\mu c^2)^2$ to the order $(g_1^2/Mc^2)^2$.

A nucleus is only made up of protons and neutrons, and in the process of the radioactive emission of a β-particle (electron or positron) a neutron turns into a proton or vice-versa. In the Yukawa theory this process is made possible by assuming that a meson has an interaction with the light particles very similar, though very much smaller in magnitude, to its interaction with the heavy-particles, so that it is possible, for example, for a negative meson to disintegrate into an electron and a neutrino, energy being conserved in the process. The β-decay then takes place as a second order process in two steps. First, the heavy particle emits the meson in the intermediate state, the meson then disintegrating into an electron (or positron) and a neutrino. In order to agree with the observed life time of the radio-elements, it is necessary to assume that a free meson at rest has a life time of the order of one millionth of a second.

The meson decay plays a considerable role in cosmic ray phenomena. In media of low density like air, the distance that a meson can travel before it is stopped by collision loss is so large that there is an appreciable chance of its disintegrating while in motion. Since the resulting electron then has a high energy it produces a cascade. As a result, in media of low density like air the decay adds to the soft component which is produced by the hard component by the processes mentioned earlier, whereas in dense materials like liquids or solids, the addition due to the decay is negligible (Euler and Heisenberg 1937).

The decay of the meson also explains the so called 'density anomaly' in the absorption of the hard component. It is found that although air and water have practically the same atomic number, a given mass of air absorbs the meson component more than the same mass of water. The explanation is to be found in the fact that air being much less dense than water, the time taken to travel the same mass of air is much greater, so that there is an appreciable probability of a meson disappearing by decay on the way. Lastly Blackett (1938a) has shown that the

temperature effect of cosmic radiation can also be explained by the meson decay.

The mean life time of a stationary meson as found from cosmic ray experiments is of the same order as that to be expected on the Yukawa theory. The life time of the meson when it is in rapid motion is however much greater than this, since according to the theory of special relativity clocks in motion go slower. For mesons of the high energies which occur in cosmic radiation this change in the life time for spontaneous decay is very great (Bhabha, 1938b) being $E/\mu c^2$ times the life time of the meson when at rest. The increase in the life time of a moving meson to more than three hundred times its life time when at rest can be proved from detailed analysis of the density anomaly (Blackett 1938b), providing a most beautiful confirmation of one of the predictions of the theory of special relativity in a very extreme case.

Since the meson is unstable, it cannot come in from outside space and must be created in the atmosphere. The manner in which mesons are actually created is however not known, though there is evidence that fairly absorbable cosmic rays appear to produce showers consisting of a few penetrating particles.

To sum up, while present quantum theory appears to be able to explain all processes connected with the soft component in a quantitative way, most of the phenomena connected with the hard component appear to lie on the extreme limits of validity of the theory. A thorough investigation of these cosmic ray phenomena is our only means of obtaining a fundamental extension of our knowledge of the elementary atomic particles, and will lead to the ultimate theoretical formulation of the laws which govern the physical behaviour of nature.

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Artificial Induction of Polyploidy

with Special Reference to Colchicine

REAYAT KHAN

Department of Biology, Dacca University

(*Continued from the last issue*)

(*d*) *Treatment of buds and twigs.*—The treatment of buds on the potato tuber has already been mentioned. Young buds and growing points may be treated either with solution or paste. According to Blakeslee and others (1938) the most successful method consists in spraying the growing points with solution or better still with emulsion. But considering the poisonous nature of colchicine, this method entails some danger to the investigator. A more convenient method is to treat the growing points with lanolin paste so that the new shoots will have to grow through it. Another way of treating young vegetative or flowering shoots is to keep them immersed in colchicine solution in a tube or beaker for a desired period. Tetraploid tissue has been induced by this method in *Portulaca* by the use of a ·025% solution for one day, as well as by the use of stronger solution (Blakeslee and Avery, 1937). For shoots that are stiff and cannot easily be kept immersed, solutions in ·8% agar have proved to be more useful than the fluid solution The tip of the shoot to be treated may be covered with a vial of agar solution. A simpler method is to apply the agar solution in drops when it is still warm and fluid so as to cover the buds to be treated. The agar dries down to a thin skin which is sloughed off by the growth of the shoot (Blakeslee and Avery, 1937).

In his study of the action of colchicine on meiosis in *Allium* Levan (1939) found that, instead of tetrads, monads with the tetraploid chromosome number were formed as a result of whole inflorescences being immersed in colchicine solution.

(*e*) *Treatment of Roots.*—Navashin and Gerassimova (1940) working on *Taraxacum koksaghys* call attention to the fact that the shoots treated with colchicine and apparently tetraploid in the early stages later became diploid once again. This is attributed chiefly to insufficient penetration of the tissues. This difficulty was later obviated by immersing the roots in colchicine solution. The resulting plants were more regularly polyploid, the explanation being that the upward pentration of colchicine through the roots to the stem was very rapid and thorough. It is suggested that this method can be still more usefully employed for plants which produce adventitious buds on the root system.

(*f*) *The Injection Method.*—Bates (1939) has employed the injection method as elaborated for other purposes by the East Malling workers. "A 0·05% solution was used, a vertical slit in the stem of the plant or a severed petiole being placed in a tube of the solution. Profound morphological changes take place, and as the influence is localised, its intensity varies throughout the affected part of the plant". In the case of *Vicia faba* the flowers were swollen at the base and were all abortive except two. These gave rise to pods showing *gigas* characters with an erect habit of growth. In *Fragaria* spp. also distorted fruits were produced.

Till recently little could be done with the grasses by cholchicine treatment, the difficulty being presumably due to the protection afforded to the growing point by the leaf-sheaths and young leaves. Myers (1939), in his work on *Lolium perenne* overcame it by this method. After the plants had produced several tillers, a hypodermic needle was inserted through the outer leaf sheath near the base of a tiller and the colchicine solution was forced in until drops

appeared at the top of the inner leaf roll. Cytological examination of three of the treated plants showed a tetraploid sector.

Britten and Thompson (1941) have used the injection method to induce chromosome doubling in sterile crosses between *Triticum turgidum* and *Aegilops speltoides*. Daily injections were made with a hypodermic needle and several fully fertile offsprings with doubled chromosome number were obtained.

If the injection method does prove successful, it may be more useful than seed treatment, particularly in producing amphidiploids from species-hybrids. Frequently only a few seeds are obtained in interspecific crosses ; in such cases seed treatment which results in further mortality of seeds and seedlings, has obvious disadvantages which can easily be avoided by the injection treatment.

(*g*) *Results obtained with different groups of Plants.*—While considerable success has been achieved in the case of angiosperms, little has so far been done with regard to other groups. Among all the angiosperms experimented with so far, the *Colchicum* plant has been found to be the solitary and interesting exception*, being affected neither by the colchicine in its own cells nor by strong solutions administered artificially. In the words of Blakeslee and coworkers "It is like the snake which is immune to its own venom". Dr Conklin tried to extract anti-colchicine from the corm which would inhibit the action of colchicine on other plants but did not succeed.

Mirov and Stockwell (1939) were the first to induce polyploidy in a gymnosperm—*Pinus*. In *P. excelsa* and *P. gerardiana* tetraploidy in root cells has been induced by Sampath, Singh and Bansal (1939). More recently Jensen and Levan (1941) have experimented with a number of conifers, in some cases treating the seeds and in others injecting the vascular tissues. A detailed account in respect of *Sequoia gigantea* alone has been published so far. By soaking the seeds in ·2% colchicine solution for 2 to 5 days the author has obtained numerous seedlings of *Ephedra foliata* exhibiting deformities usually associated with tetraploids but a cytological examination has not yet been made.

Miss Satina has succeeded in doubling the chromosome number of *Marchantia polymorpha* by treating the gemmae with colchicine and has thus secured 2*n* male and female thalli of this liverwort (quoted from Blakeslee and others, 1938).

Miss Satina has also treated a representative group of fungi with saturated solutions of colchicine (4·0%) with no obvious effect (quoted from Blakeslee and others, 1938). Dr Conklin has found that some of the filamentous fungi and at least one of the bacteria thrive on colchicine and utilize it as a source of nitrogen in controlled cultures (quoted from Blakeslee and others, 1939). Preliminary tests with some algae indicate that they also may be susceptible ; at least colchicine is toxic to them and induces swollen cells (Blakeslee, 1939).

(*h*) *The Colchicum Bulbs.*—Experiments have been performed to ascertain whether the pulp from *Colchicum* bulbs or disintegrating pieces of bulbs can induce chromosome alterations particularly polyploidy. Prof. Kostoff (1939) of the Institute of Genetics, Moscow, reports that about 2 gms. of pulp from *Colchicum* bulb induced swellings in seedlings when seeds of *Triticum, Secale* and *Crepis* were germinating on the pulp, covered with filter paper in petri dishes. The seedlings that developed at a distance of 1·5 to 2·5 cm. from the pulp in the dishes showed similar symptoms. These morphologically abnormal seedlings had cells and groups of cells with altered chromosome sets (chiefly polyploid) like the seedlings treated with colchicine. Seedlings produced from seeds germinating on disintegrating pieces of *Colchicum* bulbs or near them showed the same morphological abnormalities and had polyploid cells and tissues. Morphological abnormalities and chromosome alterations were also induced when seeds were sown either in *Colchicum* plup mixed with sand or in disintegrating pieces mixed with soil and sand.

It would be interesting to know if plants growing in nature side by side with *Colchicum* get their chromosome number doubled or altered in other ways. Bates (1939) carried on observations on several sites in which *Colchicum* plants grew but failed to find anything of an abnormal nature in respect of external morphological characters in the neighbouring plants. One colony was known to be at least 20 years old and was associated with a mixed flora. The explanation given is that polyploids produced by colchicine treatment exhibit retarded growth and a delayed establishment of the root system and it is, therefore, obvious that in nature the polyploid individuals would be suppressed in

* It has, however, shown positive reaction to treatments with acenaphthene (Levan, 1940).

competition with normal seedlings or established vegetation.

B. Treatment with acenaphthene and other Chemicals

Colchicine being an expensive substance, attempts have been made to find cheaper substitutes and among the substances tried, acenaphthene has been found to be very similar in its action. Schmuck (1938), Navashin (1938) and Kostoff (1938) have shown that like colchicine it inhibits spindle formation and prevents anaphasic separation of the daughter chromosomes, leading to chromosome doubling. Its morphological effects on germinating seeds are also similar.

Since acenaphthene is only slightly soluble in water (0·003%), it cannot be applied in the same way as colchicine. Kostoff (1938) treated young inflorescences by enclosing them in a tube lined with crystals of this substance which is presumed to find its way into the cells by sublimation. Meistic irregularities were induced in *Nicotiana* by this method. The same author (1938) subsequently obtained a tetraploid lettuce by treating the germinating seed with crystals of acenaphthene and polyploid shoots from *Nicotiana* species by enclosing young shoots in tubes lined with it.

Nebel (1938) found that a saturated solution of acenaphthene had no effect on nuclear division in the staminal hairs of *Tradescantia* and that immersing the tops of young marigold plants in saturated solutions produced effects different from those of colchicine. Blakeslee (1939) states that acenaphthene was relatively ineffective in inducing 4n plants in the species with which he tested it. Dahl (1939) found that acenaphthene treatment of *Ipomoea* and *Avena* gave slightly different results from colchicine. Preliminary experiments at Cambridge have shown that oats placed after germination, in tubes lined with acenaphthene undergo changes similar to those described by Russian workers for cereals and that spindle inhibition and chromosome reduplication do in fact occur. Levan (1940) treated *Allium* bulbs by wrapping the roots in moist filter paper and putting them in petri dishes in which small amounts (about 1 gm.) of acenaphthene were placed. He also treated the bulbs of *Colchicum* which were placed in an acenaphthene atmosphere under a bell-jar. Levan's experiments show that the vapour of acenaphthene is effective in inducing polyploidy in cells and that the results obtained with acenaphthene are essentially similar to those obtained with colchicine, the main difference being that acenaphthene acts slowly. This slowness of action, as pointed out by him, is a great advantage in cytological studies and the substance may be used profitably where the material is delicate and too sensitive to the action of colchicine. It is interesting to note that while colchicine itself is ineffective on *Colchicum*, acenaphthene can bring about disturbances in mitosis and has been found to give rise to tetraploid and octoploid cells and sectors in *Colchicum autumnale*, *C. Bornmülleri*, *C. byzantinum* and *C. speciosum* (Levan, 1940).

Acenaphthene has the advantage of being cheaper and less poisonous but whether it will prove to be more useful still remains to be seen.

Chloral hydrate has long been known to induce polyploidy in cells of roots (Nemec, 1904). Sodium cacodylate has been used to induce plants with doubled chromosome number in *Portulaca* (Blakeslee, 1939). Experimenting with wheat, Schwarz (1940) found that aqueous solutions of granasan (ethyl-mercuric chloride) and "Niuifa", another mercuric seed disinfectant, induced changes similar to those produced by colchicine and acenaphthene. Traub (1941) has induced polyploidy in *Phaseolus vulgaris* and *Allium cepa* by using concentrated solutions of sulfanilamide (P-aminobenzenesulfonylamide). Several other chemicals are now known to induce polyploidy while more are being tried in search of better substitutes for colchicine but no useful purpose would be served by giving here an account of these investigations as they have not yet attained any practical significance.

Use of Bacterial Cultures

Naturally occurring tumours of plants including those caused by *Bacterium tumefaciens* are known to be formed of polyploid cells in many cases (Winge, 1927; Kostoff and Kendall, 1933). Kostoff and Kendall (1932) injected tomato plants with cultures of *B. tumefaciens* and when tumours had formed, cut off the stems 3-5 cm. above the tumours. One of the seven shoots formed directly from the tissues of the tumours was tetraploid. Another method adopted by the same workers (1934) was to decapitate diploid plants of tomato and then to inoculate the callus tissue with *B. tumefaciens*; a number of tetraploid plants were obtained in this way.

Conclusion

The discovery of the polyploidizing property of colchicine has given a tremendous impetus to research in cytogenetics. The chief value of colchicine lies in rendering the sterile hybrids fertile by a simple doubling of the chromosome number. It now makes possible many new combinations which hitherto remained only unfulfilled dreams. As Blakeslee (1939) says "We now no longer have to wait ages for the chance hybridization between species and the later rare spontaneous doubling of their chromosomes in order to secure such superior varieties". (referring to wheat, oats, timothy, tobacco and cotton etc.) "We can now make them up to order". Vavilov (1939) similarly writes that now "genetics is entering a new era of extensive application of distant hybridization".

Although only plants have hitherto been found to react successfully to colchicine, it now seems that animals also are susceptible to its action. By injecting very small amounts of greatly diluted solutions into the eggs of chickens at various stages of incubation, Dr Edna Higgins (1941) of the University of Pittsburgh "has succeeded in obtaining six healthy birds that have survived to maturity. In one group of four chickens injected after 72 hours of incubation, now seventeen months old, the combs and wattles of both males and females are twice the normal size, and the males also have two abnormally long tail-feathers apiece. Two others, out of a group injected during the thirteenth day of incubation, show less effect. Further work is now being conducted to determine whether colchicine produced the effects directly or whether it worked through the sex-glands".

Very little has so far been done in India in inducing mutations including polyploidy by chemical treatment. The difficulty of obtaining colchicine in these days is undoubtedly a factor to be considered but this must not entirely prevent us from taking up such work. It may be overcome if indigenous sources of this drug are tapped. Though at present *Colchicum autumnale* is practically the only source of colchicine, attempts are being made to extract it from other species also. Glotov (1939) reports that colchicine extracted from *Colchicum umbrosum* was nearly as effective in its action on *Ocimum canum* as that from *C. autumnale*, such differences as were noted being obviously due to impurities in the sample. Shimamura (1939) has successfully used colchicine produced in Japan to induce tetraploidy in *Allium* and beans, although owing to its impurity it is not yet recommended for use in experiments involving strict quantitative analysis. In India the genus *Colchicum* is represented by *C. luteum* found in Kashmir and if Indian chemists can extract colchicine from it, their efforts will be amply rewarded. It may be noted here that the rhizome of *Gloriosa* also contains colchicine. (Parthasarathy, 1941).*

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Physiographic Divisions of India, Burma and Ceylon

MANECK B. PITHAWALLA

University Teacher in Geography, University of Bombay

THE unification of India's varied cultures is the most crying need of the country today and the time has come when the aid of the geographical science must be sought for such an acculturation. Geography is no longer a mere description of dry facts about the earth but it is now a living and cultural science with splendid interpretive and explanatory functions. It should show the complex relationship between human endeavours through the ages and the physical environment influencing them. It is to interpret human life in the pre-historic and historic past in this light and to remodel it in the present times on a sound basis in order to secure the maximum benefit to mankind from nature. Demangeon, a disciple of Vidal de la Blache, the father of modern regional geography, prophesied that "Every region has its unique character to which contribute the features of the soil, atmosphere, plants and man. The aim of all research consists in the analysis of these features. The aim of description is to synthesise them and to show the interlocking of the phenomena which comprise regional types." (Revue Universitaire, 1918). And it has been well said by a modern geographer that "What service psychiatry renders in the realm of psychology, geography must render in the realm of history, politics, economy and sociology. It is the science of correlatedness of man and nature and must serve as a healing balm for many human ills."

THE CONCEPT OF REGION

But such a study should only be undertaken not by provinces but by 'natural' regions. In fact, the concept of *region* must be cultivated to acquire the best results. No longer should a study of geography be confined to political and man-made boundaries; but geographers should undertake it on the basis of natural physical regions, instead of slavishly adhering to the existing political frontiers. The real rhythm of life and work in a particular 'natural' region should be discovered before any plans or reforms can be made in the existing state of things in the country. Even historians would fail to establish a real unity of Indian cultures, if they are attracted only by political and administrative details and neglect the cultural aspects of the past from age to age and between one province and another. For them it is absolutely necessary to discover the unifying effects of the physical features, hydrography, climate, soil, mineral resources and other natural environment obtaining in a particular region.

For all studies, such as ecology, anthropology, industry, agriculture, etc., there must be such a stable natural or physical background to rely upon. Even in studying certain related problems of language, religion, population, water supply, communications etc., and for preparing statistics, industrial and others, there is now a great need of showing the *influence of certain homogeneous physical and more or less permanent environment on human life and of producing such homogeneous units as a background for all kinds of surveys.* Thus any province with its common physiographic characteristics must afford a good setting for the smaller field. Indian economists, agriculturists, botanists, zoologists and others should willingly accept such physical regions for their special surveys.

The director of Zoological Survey of India, recently laid stress on physiographic divisions: "Owing to the heterogeneous nature of the faunas

of the different parts, the division of this vast area into subregions is not an easy task. The affinities of the faunas of the different areas are very complicated, and probably the best course under the circumstances is to take physiographical rather than zoogeographical tracts as the basis for the considerations of the faunas of the different parts".* Similarly Indian botanists, agriculturists and others will also find these physiographic regions suitable for their work.

NO MORE "NATURAL REGIONS"

The idea of 'natural' regions should, however, be revised. The term 'natural' is vague and inaccurately and inadequately employed by geographers, but the term 'physiographic' limits the regions in a precise and specific manner. Though, therefore, natural resources based on physiography will be considered, the term 'natural' region should be dropped to avoid confusion and to achieve the best results.

VALUE OF GEOMORPHOLOGY—A BRANCH OF PHYSIOGRAPHY

Again, physiography** is a much wider science of physical geography, including the study of the earth as a whole with the atmosphere, the oceans and the land masses. For the *physiographic* regions of such a complex country as India, we shall use physiography in this broad sense and not in the restricted sense in which it is used only for geomorphology, which is a specialised branch of it, *i.e.*, a science of land forms only. The reason is that our country is of such vast subcontinental dimensions that for dividing and subdividing it into minor regions, and sections, it is necessary at times to fix some boundaries by the criteria of climate, soil fertility, crops etc. *e.g.*, the Upper, Middle and Lower Ganges Basins. At the same time for the purpose of making the main divisions, we shall chiefly rely upon morphology:

(1) The structure of the land, that is, the result of geological conditions including the kind and nature of rocks, and their initial stage before erosive agents act on them.

(2) The process of erosion, that is the destructive agents to produce their effects upon the original structure, the erosion actually depending upon the structure and the forces at work, and

(3) The stage of erosion, that is the cycle of changes taking place during the process of erosion on the original structure, *e.g.* folded rocks have the folding persistent in the landscape of a region.

Thus the most outstanding characteristics of an area to be considered as a unit are those which even a careless traveller might find in it as its topography, and which produce the greatest influence on living things.

American geographers†† have applied the above method to the whole of the U. S. A., and with the exception of a few minor areas, this scheme is also adopted by European geographers for the Continent as well. In a similar way, India can also be divided physiographically by us by taking advantage of the geological literature already published.

UTILITY OF GEOLOGICAL LITERATURE IN INDIA

There is a good deal of such geomorphological details, recorded by the Geological Survey of India, and other surveys carried out in some Indian States. These can be utilised with profit in the absence of a regular geographical survey of India. Splendid facts are being gradually revealed by Indian geologists regarding the making of India†. But the Record and Memoirs published by the Survey need a good deal of careful sifting and interpreting as to how a particular region has behaved in the history of man, and how man has reacted under the physical circumstances. Besides, geographers can undertake aerial surveying in co-operation with flying organisations and services to secure further geographical details. Land forms are the chief things to explore and in India particularly we have a vast variety and a regular museum of them. It will be a great achievement on the part of Indian geographers if they can interpret the complex relationship of these regions with human activities and responses to the environment in different regions.

* Prashad, Baini, "Zoogeography of India", SCIENCE AND CULTURE, 7, 422, 1941-42.

** "A Text Book of Geomorphology" by Philip G. Worcester, London, 1939, p. 3.

†† Fennemen, N. M., "Physiography of Western United States of America", New York, 1931 and "Physiography of Eastern United States of America", New York, 1938.

† Wadia, D. N., "The Making of India", Presidential Address, Indian Science Congress, Baroda Session, Jan. 1942.

NEED OF CO-OPERATIVE EFFORTS

In 1939, the author presented to the geography section of the Indian Science Congress, held at Lahore, a scheme of physiographic divisions of India*. Since then the problem has drawn the attention of some Indian and foreign geographers, who have helped me with constructive criticisms and suggestions. The scheme had been revised later and was presented at the Benares Session of the Congress in 1941†. It may be noted here that some Indian geographers‡ have adversely criticised my method of dividing and naming the different regions. Though their method is called geomorphological, they make no distinction between a major division and a minor section or a subsection, and neither definite physiographic character nor natural boundaries and frontiers are indicated. No distinction is also made between a mere shore facies and the major province to which it really belongs. Moreover, the factors of mineral wealth, soil and climate are altogether ignored, with the result that the "physiographic" divisions so made are some kind of 'natural' or 'geographical' regions which appear to lack scientific basis.

It is true that fixing the boundary lines can only be settled in a well-organised symposium under the auspices of a society, such as an All-India Geographical Association. It is, however, necessary to suggest a method of division and the nomenclature and to indicate the major regions, provinces and sections, which may form the basis of future work. The subsections and the matter of fixing the boundaries on the ground may be delayed, until we secure further morphological and other data from local Indian geographers.

THE SCHEME REVISED A SECOND TIME

During the last three years, therefore, efforts have been made to improving upon the original scheme of 1939 and the results are shown in the present article. I have again revised several sections and sub-sections in the light of the suggestions made by critics and of the new geomorphological data secured from research centres in India. I have redrawn the map including in it Burma, Ceylon, and other islands in the Bay of Bengal on a larger scale and have also tried to satisfy the needs of the advocates of other sciences, such as agriculturists, biologists and economists. However, there should be no mixing of the criteria of sub-division *e.g.*, rainfall, vegetation, language, culture, population etc. They will only create confusion thereby. As Prof. Frederick K. Morris of the Massachusetts Institute of Technology, has wisely expressed his opinion in a recent communication: "When the sub-division has been made on morphological grounds, you will find that all matters of climate, vegetation and human occupation will drape themselves naturally over these logical divisions."* Thus a correct appreciation of the fundamental geological and geographical factors only should determine the division of India, as Dr Baini Prashad has agreed. Once our country is thus scientifically divided and subdivided, it will be easy to utilise the regions as a basis also for preparing ethnological, racial, cultural or linguistic maps, which our geographers are so anxious to make.

THE BASIS OF DIVISION

India is most naturally divided into 3 major divisions called (1) The Extra Peninsular Mountains, (2) the Indo-Gangetic Plain, (3) the Peninsular Block. These have been already recognised by the Geological Survey of India for over 60 years. There can be no fourth major division of India possible, such as East or West Coast Division of Peneplained Lowlands. Each one of these three major divisions is then divided into 16 Provinces (Marked I, II, III etc.) according to the nature of rock, land forms, and their erosional history. These Provinces are sub-divided into 54 sections (marked A, B, C, etc.) according to the stage to which a particular land form is reached and also other physical characteristics, such as soil, climate, drainage, mineral resources etc. As a result of collecting further morphological data from local geographers and other sources, it has been possible to add some new sections to the former ones proposed by me and to subject each one to sub-division into several new minor sub-sections (marked (*a*), (*b*), (*c*), etc.) These sub-sections are not shown in the map, as they need further investigation and collaboration

* Since published under the title "The Need of Uniformity in the Physiographic Divisions of India", 1939, and subsequently revised. See *Jour. Madras Geog. Assn.*, Vol. XIV, No. 4, December 1940.

† Proc. 29th Ind. Sci. Cong., Benares, 1941, Part IV, pp. 71-75.

‡ Ahmed, Kazi, "Physiographic Divisions of India", *Ind. Geog. Jour.*, Vol. XVI, No. 3, p. 257, 1941.

* Letter to the author, dated July, 21, 1939, Cambridge, Mass.

of local geographers. Throughout the scheme, the uniformity of dividing the land physiographically has been maintained. Thus the whole country of India, including Burma and Ceylon, is now divided as under:

No. of major divisions marked 1, 2, 3	No. of Provinces marked I, II, III etc.	No. of Sections marked A, B, C, etc.	No. of Subsections marked (a), (b), (c) etc.
(1)	5	16	15
(2)	6	16	12
(3)	5	22	30
Total 3	16	54	57

BURMA

Though Burma is now politically separated from India, it is geologically and physiographically connected with the eastern flanks of the Himalayas and comes under the influence of the same monsoon currents. Consequently it has been divided in conformity with this Province in the major division No. (1) of Extra-peninsular Mountains, and its sections and sub-sections are carried further into all these Western Highlands. Burma, however, is a very complex land mass and until some further physiographical data are made available for our study, the regions proposed by me might be taken as provisional. The Andaman and Nicobar Islands really belong to a submarine chain in continuation of the Yoma Section in Burma and are, therefore, given the same sectional number.

ISLAND OF CEYLON

Ceylon, on the other hand, is an island detached from the mainland by the subsidence of the Gondwanaland only at the end of the Mesozoic period. But it has also close affinity with the gneissic terrain of South Indian region and naturally but partially linked again with it by Adam's Bridge and a very shallow strait, hardly five fathoms deep. The rocks are definitely of the Dharwar age. "The extreme degree of pressure metamorphism to which these rocks have been subjected during the orogenic revolutions of the Archaean era, is indicated by the wide prevalence and relative abundance of such small-volume minerals of condensed molecular packing as garnet, ilmenite, zircon, monazite, graphite etc." The island has a central synclinorium which is cut "into three more or less deeply eroded terraces or peneplains rising from the sea one above the other, in three tiers."* The central highland is surrounded by a ring of waterfalls, arising from the rejuvenation of the river-systems owing to block-faulting and uplifting.† Although one would like to divide Ceylon in consonance with the physiography of South India, these recent researches, coupled with the fact that the island has two powerful monsoons, resulting in a wet zone,—the S. W. portion and a comparatively dry zone,—the N. E. and E. parts, lead us to treat it as a separate entity. Mr. Wadia states further that "the highland country is distinct from the plains and lower hills country. They form two clear-cut divisions of the island on physiographic basis, but these divisions do not fit in with the dry and wet zones."‡ Taking these facts into consideration I have subdivided this extra Province into three different sections *viz.*, The Central Massif, S. W. Lowlands and N.-N.E. Dry Lowlands.

CONCLUSION

Thus, while politically the country is most unnaturally divided into presidencies, states, districts, etc., with all their natural resources cut up and their traditions and populations misplaced and mixed up in unsuitable surroundings, the proposed physiographic divisions, though numerous owing to the enormous size and nature of the country, will afford a homogeneous economic background for all regional surveys and for all human activities within the units. There will be no more maladjustment of India's varied resources to its needs and aspirations and no one-sided attempts at development. At the same time, they will afford a pattern of unity in diversities. They will also stimulate an unhampered intercourse amongst them for the mingling of their culture. It is also hoped that the physiographic boundaries indicated on the map will coincide with the cultural ones. These regions will greatly facilitate the programme of national planning in India and will conduce to the harmony and prosperity of the various peoples without losing their individuality on account of their congenial environment; and to the evolution of an all-India civilisation, which is our need today.

* Wadia, D. N., "The Making of India", *op. cit.* p. 6.

† Wadia, D. N., Proc. 29th Ind. Sci. Cong., Baroda, 1942, Pt. III, p. 122.

‡ Letter to the author, dated 13th March 1942, Colombo.

TABLE SHOWING THE PHYSIOGRAPHIC DIVISIONS OF INDIA, BURMA AND CEYLON.

DIVISION.	PROVINCE.	SECTION.	BRIEF NOTES ON PHYSIOGRAPHICAL CHARACTERISTICS ETC. AND PROJECTED SUB-SECTIONS.
1	2	3	4
(1) Extra-Peninsular Mountains. Laterally compressed. Complex series of highly contorted rocks of all kinds—an earthquake zone of unstable mountain walls, with a plutonic core, once under the Tethys Sea.	I. Western Highlands. (Western extension of the Himalayas of lower heights and folded structure of Tertiary rocks. Dry and barren parts of India).	A. Khirthar-Sulaiman Mountains.	Very dry region of barren mountains nearly 6,000 feet high and consisting of folded Tertiary rocks. The monsoons do not reach here, and there is little soil left on top. Subaerial denudation considerable, forming small plateaus. Inland drainage. Gradually passing into the Iran plateau.
		B. Kohistan Section.	Lower ranges up to 3,000 feet with slightly more rainfall, including winter showers received from western depressions. Subaerial denudation is greater with the resulting broad anticlinal valleys in which a little soil is available for grass to grow. Many hot springs due to fractures in the folds of Tertiary rocks. Typical dryland topography of limestone country. Some chances of mineral oil deposits. River valleys dry but with good potable water in their gravel underground.
	II. Greater Himalayas. (Forming the axis of the Mts. Stupendous folded mountains covered with eternal snow and having a great variety of landforms. Height above the snow-line.)	A. Northern Himalayan Section.	Snow-covered mountains with very high peaks, *e.g.*, Mt. Everest, K2, Kinchinjangha, Nanga Parvat, Nanda Devi. Highly fossiliferous sedimentary rocks from the Paleozoic to the Eocene age of complex geological structure. Older rocks are exposed due to action of powerful glaciers, etc. The leeward side merges into the Tibetan plateau. Sub-section (a) Tibetan Borderland.
		B. Southern Himalayan Section.	Windward side wetter and receiving the full force of both the monsoons. Alpine vegetation areas. Source of most of the northern rivers. Newer and highly contorted rocks outcrop in some places. The region is subjected to contortion, thrust faults and broken into deep gorges. The antecedent Indus and Sutlej river valleys lie prominently in the N.W.-S.E. direction, (a) and (b) Sub-sections.
	III. Middle Himalayas. (Mountains below the snow line: 15,000—20,000 feet high.)	A. North-West Dry Lands.	Hot and dry region, very cold winters. Marine rocks are exposed. Includes the fertile basins of the lower Kabul and Kurram rivers.
		B. Dun Section.	Longitudinal tectonic valleys lying between high ranges of mountains 15,000 to 20,000 feet high. Includes Kashmir a most beautiful Dun or structural valley, strewn over with lakes and glacial materials and cut by the Jhelum river. Mountain passes on all sides. Temperate forests on the windward side with rainfall of about 25-30 inches. Good mineral resources including coal. Other Duns covered are Dehra Dun, Kangra Dun, Chamba Dun, etc. Sub-sections (a) Indus valley, (b) Jhelum valley, (c) Chenab valley, (d) Ravi valley.
		C. Lesser Himalayas.	Limited by the average snowline 15,000 feet. Highly contorted rocks with thrust faults. Crystalline, metamorphic and Purana rocks with granite intrusions. Unlimited resources. Many Tertiary rocks formed in the Tethys sea. Good monsoon forests.
	IV. Sub-Himalayan Region. (Outer belt largely forming the foothills of the Himalayas and large longitudinal valleys.)	A. Potwar Section.	A plateau of erosion of about 1,000 feet, bounded by the Salt Range in the South and largely occupied by the Rawalpindi country cut by the Soan valley. A crumpled geosyncline. Oil fields exist in low anticlinal folds. Sub-sections (a) The Salt Range, rich in minerals including rock-salt and oil and faulted in the South, exposing a series of sedimentary rocks and (b) Attock oil wells.

TABLE SHOWING THE PHYSIOGRAPHIC DIVISIONS OF INDIA, BURMA AND CEYLON—*Continued.*

DIVISION.	PROVINCE.	SECTION.	BRIEF NOTES ON PHYSIOGRAPHICAL CHARACTERISTICS ETC. AND PROJECTED SUB-SECTIONS.
1	2	3	4
(1) Extra-Peninsular Mountains —(*Contd.*)	IV. Sub-Himalayan Region—(*Contd.*)	B. Siwalik Section.	Outer Himalayas, intervening between the Middle Himalayas and the Indo-Gangetic Plains. Low hills, 3,000 to 5,000 feet high. Tertiary fluviatile gravel deposits. Area within the Danger Zone. Sal and other sub-tropical forests. The foot-hills of the Himalayas formed of sands, gravels, boulders, etc., brought down by rivers. Rocks locally folded and overthrust. Liable to severe earthquake.
	V. Eastern Highlands. (Eastern flanks of the Himalayas consisting of a detached mass of the Deccan plateau, ranges of folded Tertiary rocks and a denuded plateau of Archaean rocks. Wetter parts of India and Burma.)	A. Shillong Plateau.	A part of the N. E. Tableland (see below) cut off from the N. E. Foreland by the Ganges-Brahmaputra. Heaviest rainfall in India, over 500 inches. Tropical forests grow. Rocks consisting of gneisses and granites.
		B. The Yomas.	Related to the Western Highlands but much wetter and damper consisting of folded Tertiary rocks. Sub-sectionsa (a) Assam hills including Naga and Patka, (b) Arakan Yoma, etc., (c) Lushāi Hills. *N.B.*—The Andaman and Nicobar islands belong to the submarine extension of the Burmese Yomas and are therefore numbered the same.
		C. Irrawadi Valley.	A broad lowland valley, a geosyncline formed from Tertiary folded rocks containing oil shales and draining the Chindwin Valley. Over 80 inches of rainfall. Sub-sections (a) Upper Irrawadi Valley, (b) Lower Irrawadi Valley, an excellent rice land. A synclinorium in relation to the Yoma anticlinarium.
		D. Shan Plateau.	A denuded plateau. Ranges of Archaean rocks separated by plains and dried-up valleys, continued into Tenasserim, Siam and Malaya Peninsula. Rich mineral deposits, such as ruby, silver, tin and lead ores.
		E. Irrawadi Delta.	Delta land of the Irrawadi. Good rainfall and rice fields.
		F. Kuladam Valley.	Lowland occupied by the Kuladam river and the elongated Burmese Coast, receiving the Bay Monsoon regularly.
		G. Salween Basin	Parts on windward side heavily forested with evergreen forests. Covers only a portion of the Salween delta, the plain of Atarain. Moulmein and the coast of Tenasserim. Sub-section (a) Tenasserim coast land.
(2) Indo-Gangetic Plain. Filled with drifted alluvium—a sagged area between the Himalayas and the Peninsular massif, now turned into a plain. A vast "hidden range" along the southern parallel of 23°N. is suspected.	I. Lower Indus Valley. (An aggraded valley below the confluence and the delta land.)	A. Western Valley Section.	Old alluvium, formed by the detritus from the mountains. Seasonal hill torrents and springs. Rich drift soil consisting of sand belts and clay belts. Floods dreaded, though rainfall scanty. Allied to the Irrawadi valley with chances of mineral oil. This section should extend into the re-entrant angle between the ranges, not belonging to British India.
		B. Eastern Valley Section.	New alluvium, crossed and recrossed by Dhoroes (old river channels). Shifting banks of the river. Largely irrigated land. Rainfall insufficient. Kalar soils, salt lakes and salt deposits.
		C. Indus Deltaic Area.	Uncultivated, swampy and sandy in parts. Changing mouths of the river. Many hydrographical changes. Rice cultivation only in parts higher up. Salt deposits are found.

TABLE SHOWING THE PHYSIOGRAPHIC DIVISIONS OF INDIA, BURMA AND CEYLON—*Continued.*

DIVISION.	PROVINCE.	SECTION.	BRIEF NOTES ON PHYSIOGRAPHICAL CHARACTERISTICS ETC. AND PROJECTED SUB-SECTIONS.
1	2	3	4
(2) Indo-Gangetic Plain —(*Contd.*)	II. Upper Indus Valley. (Bhangar land of Doabs between the Punjab Rivers and Khadar land up to their confluence.)	A. Doab Section.	Higher ground of Bhangar up to 1,000 feet. Largely cut up into Doabs by the Punjab rivers as the tributaries of the Indus. Sub-sections (*a*) Ambala streams (Chos) and sand banks, originally feeding the Gaggar.
		B. Punjab Proper.	Lowlands of Khadar formed by the detritus from the mountains in the north. Rich drift soil more clayey than the Sind soil. Wheat lands of India. Hydrographical changes in the past. Disappearance of the Sarasvati and the Gaggar. Include the plains up to the junction of the Indus with the five rivers. Largely irrigated land. Sub-section (*a*) The Gaggar plain.
	III. Desert Province (A sand-covered region forming a desert of recent growth.)	A. Pat Section.	Covered with clay or silt and with longitudinal Bhits or sandhills. Includes some old dry valleys. Dhands and salt lakes formed in the valleys. Sub-sections (*a*) Outcrops of Jurassic rocks considerably eroded by wind, and (*b*) the lower Gaggar dry valley.
		B. Thar Section.	Sea of sand-hills with their direction S.W.-N.E. as that of the monsoon winds. Rainfall slightly better and patches of grass are found.
	IV. Upper-Ganges Valley. (A synclinorium filled with alluvium forming higher sloping from about 1000 ft. Drier parts suitable for wheat. The eastern boundary can be drawn with difficulty physiographically.)	A. Indo-Gangetic Water-shed.	The region lying between the Old Jamna and the present Jamna. It has played a critical part in the history of Hindustan.
		B. The Doab Section.	Well irrigated and highly cultivated wheat land especially. Contains patches of Reh or Usar (salt) deposits. Force of monsoon is reduced here. Well irrigation. Good scope for industrial cities. Sub-sections (*a*) The Jamna-Ganges Doab. (*b*) The Gogra-Ganges Doab.
		C. Piedmont Zone.	Damper and higher wooded country. More rainfall up to 40 inches. Hill slope of gravel and coarse sand from 700 feet to 500 feet. Often covered with tall and coarse grasses near the flat plain.
		D. Trans-Jamna Tract.	The Tarai Slope of hills belonging to the Rajputana Uplands on the southern side. Good discharge from the Chambal and other streams.
	V. Middle Ganges Valley. (A plain sloping from about 500 ft. Wetter parts with rice cultivation, especially bordering on the Delta.)	A. Bhangar Section.	Bhangar part with confluences. Clayey and Kankar soil cut up by many streams. Damper than the Upper Ganges Province, but drier than the Eastern Section. Wheat crops as well as rice crops. Thickly populated and industrialised area. Rainfall up to 60 inches. Area within the earthquake zone. Several old cities are situated here.
		B. Khadar Section.	Newer alluvium. More sandy, damper rice lands. Sloping down to the basin. Sub-Section (*a*) the Duars similar to the Tarai.
	VI. Lower Ganges Valley. (An aggraded valley and the Brahmaputra-Ganges delta land.)	A. Lower Brahmaputra valley.	On the leeward side of Shillong plateau. Less rain but damp soil with alluvium overlying ancient plateau rocks. A 'ramp valley' to a great extent aggraded and liable to floods. Sub-section (*a*) Digboi oil fields.
		B. Old Ganges Delta.	The Delta has shifted gradually from west to east. Western part of old river courses. Most thickly populated parts of India. Fine silty and sandy flat. More than 60 inches of rainfall. Includes swampy parts of the old delta with former channels (Bhils) now under good rice cultivation. Mangrove swamps near the coast holding up sand and silt. Sub-section (a) Sunderbans or swampy forests, (*b*) Hooghly-Damodar valley.

TABLE SHOWING THE PHYSIOGRAPHIC DIVISIONS OF INDIA, BURMA AND CEYLON—*Continued.*

DIVISION.	PROVINCE.	SECTION.	BRIEF NOTES ON PHYSIOGRAPHICAL CHARACTERISTICS ETC. AND PROJECTED SUB-SECTIONS.
1	2	3	4
(2) Indo-Gangetic Plain —(*Contd.*)	VI. Lower Ganges Valley—(*Contd.*)	C. New Ganges Delta.	Eastern parts of the growing delta, fall of marshes enclosing islands. Old Brahmaputra flowed here. Here are jute areas. Rather unhealthy parts, which are under water during floods. Sub-sections (*a*) the Surma-Meghna valley. (*b*) Madhupur forests.
(3) The Peninsular Area. A comparatively stable block of lava and oldest Archaean rocks, forming a plateau. Relict type of mountains.	I. Rajputana Uplands. (A highly degraded mountain system.)	A. North-Western Section.	The edge of the Peninsular massif passing under the Indus plain like a sagging. The Luni river of salt water —the only watershed. A sandy waste. Arid desert topography of bad lands, pediments etc. Poorly watered. Includes Marwar, harbouring migratory people. Outcrops of Vindhya and Dharwar rocks extend up to Delhi and Agra.
		B. Marwar Peneplain.	Morphologically a peneplain, irregular and gneissic in character. Outcrops of Dharwar rocks with rich mineral deposits, *e.g.*, mica, marble, beryl, steatite, etc. Heart of Rajputana. A relic of the ancient gigantic mountains, down which even glaciers flowed in Permo-carboniferous times. Now a great synclinorium of tectonic origin. Sub-section (*a*) The Aravalli Hills, relics of a great tectonic mountain system.
		C. South-Eastern Section.	Pathar and Uparmal. A triple plateau of concentric scarps of Vindhyan sandstones in the N. E. Corner. Rich diamond deposits. Sub-sections (*a*) The Chambal valley, (*b*) Bundelkhand, (*c*) Baghelkhand.
	II. Deccan Trap Region. (A plateau of Deccan trap, basalt lava now differentially denuded into mountains and valleys. Also called Black Soil Region by agriculturists. Stair-like (trap) faces of the Ghats. Relict type topography. Marathi language boundaries coincide.)	A. Central India Tableland.	Basaltic lava rocks, forming part of the Narbada and the Tapti valley in the south and the Vindhya mountain. Flat hill-top topography. Sub-section (*a*) the Vindhyas, (*b*) the Satpuras, (*c*) the Narbada valley, (*d*) the Tapti valley.
		B. Western Ghats.	Highest parts of the denuded tableland. Good example of residual mountains. Maximum height 5,000 feet. Trap or terrace topography. Area of vulcanicity, a fissure eruption, unique in the whole country. Differential denudation. Secondary minerals available. Bearing the brunt of S. W. monsoon. Good rainfall with monsoon forests on windward side. Little disturbed by earthquakes. Flat-topped hills and intervening tableland, cut by river valleys. Sub-section (*a*) Monsoon Forest area, (*b*) Leeward area.
		C. Bombay Deccan.	Leeward side of the Ghats mainly—a true plateau. Crateriform lake of Lonar with soda deposits. Less rain and thin population. Regur or black cotton soil is the lava product. Laterite caps here and there, prominent in the Tapti valley, through which the monsoon penetrates. Sub-sections (*a*) Laterite caps, (*b*) Tapti valley.
		D. Western Peneplain.	Shows surfaces of ancient and recent peneplains with complex structural geology. Rings of Archaean, Deccan Trap, folded Jurassic, Cretaceous and Tertiary rocks, ending in vast shore facies of post-Tertiary age in Cutch and Kathiawar. Effects of marine denudation prominent. Hilly parts yet unstable. Monsoon precarious at times, causing famine. Sub-sections: (*a*) Cutch—Outcrops of older rocks surrounded by vast alluvial tracts. A shallow swamp in the monsoon season and a sandy desert in the dry season. Has suffered upheaval and subsidence due to seismic movements in the past. Probably formed part of the deltas of the Old Indus and the Hakra of Sind. (*b*) Kathiawar. A similar block separated from the N. W. plateau by a peneplain of the old Aravallis. Has a

TABLE SHOWING THE PHYSIOGRAPHIC DIVISIONS OF INDIA, BURMA AND CEYLON—*Continued.*

SECTION.	PROVINCE.	DIVISION.	BRIEF NOTES ON PHYSIOGRAPHICAL CHARACTERISTICS ETC. AND PROJECTED SUB-SECTIONS.
1	2	3	4
(3) The Peninsular Area.—*Contd.*	II. Deccan Trap Region.—(*Contd.*)	D. Western Peneplain —(*Contd.*)	coastal plain of Tertiary origin and with some good ports. (*c*) Gujarat, largely consisting of the shore facies of the Western Ghats. Good cotton soil (Regur) derived from the Deccan Trap.
		E. Konkan Coast	A faulted edge of the Deccan Trap. Bombay harbour created due to subsidence of the faulted Trap rocks. A pacific type of coast land. Sandy soil suitable for rice cultivation. Nearly 100 inches of rainfall. A plain of marine denudation with rocky spurs here and there and raised beaches or submerged swampy areas.
	III. North Eastern Tableland. (Mixed groups of denuded rocks forming the Eastern Ghats and Mahanadi-Godavari river valleys. Also called Red Soil Region. Inselberg type topography.)	A. Mahanadi Basin.	Full of Gondwana trough faults. Archaean gneisses and schists. Dharwar, Cuddapah—Vindhya and Gondwana rocks; coal and iron deposits of Bihar. Effects of the double monsoon. Rainfall 40 to 60 inches. Ends in an alluvial fan of the delta and the back-water lake Chilka, the largest in India. Luxuriant vegetation Sub-section (*a*) The Mahanadi valley, (*b*) Chota Nagpur plateau (a typical plateau of erosion).
		B. Godavari Basin.	Gondwana system of rocks with coal and iron deposits. Valley full of trough faults. Less rainfall here (30 to 40 inches). A rift valley with sand-banks cultivated. The Nagpur forest plateau with good soil and scattered villages of primitive people, (*a*) the Godavari valley, (*b*) Chatisgarh plain.
		C. Eastern Ghats.	A residual mountain not worth the name, as the rocks of Archaean origin are highly and unevenly denuded. Rainfall 60 to 80 inches due to the double monsoon. A rolling land of the Inselberg type with isolated hill ranges, ending in an extensive deltaic plain again. Sub-section (*a*) Forest Belt.
		D. Golconda Coast.	Shore facies of the Eastern Ghats, including the delta of the Mahanadi, the Godavari and the Krishna rivers. Inselberg type topography.
	IV. South Indian Region. (Most ancient block of Archaean rocks, with an Inselberg type of land form and raised-beaches. Also folded and contorted strata with a distinct orographical axis in continuation of the strike of the Ceylon land-mass. Has suffered from block faulting and uplifts with rejuvenated rivers and therefore very free from earthquakes. Also called Crystalline Soil Region.)	A. Cuddapah Section.	Rocks of the Cuddapah and Vindhya ages, a crescent of thin rocky soil affected by the retreating monsoon. Horizontal flat hills. Tank irrigation. Sub-sections: (*a*) Krishna valley and (*b*) Pennar valley, (*c*) Nallamatai Hills.
		B. Bellary Section.	Leeward side of the Ghats. A plateau of erosion. A scrubland. Rainshadow area with scanty rain. Good cotton soil. Lower levels of a gently sloping plain. Deposits of sheet laterite extensive. Sub-section (*a*) Exposures of Dharwar strips—N—S in Archaean rocks.
		C. Nilgiri Hills.	Dharwar rocks with rich mineral deposits: Mica, gold, manganese ores and granite rocks standing in relief and striking N—S. Forested owing to good rains. Mountain slopes for tea plantations. There are also terraces and water-falls. The hills are cut up by the big Palghat gap, the valley of a lost Gondwana river. Youthful topography of gorges, canyons and waterfalls after block-faulting uplifts. Sub-section (*a*) Cauvery Basin, (*b*) Coimbatore Plain.
		D. Tamil Section.	Archaean rocks of considerable denudation. Gneisses and schists. Double monsoon and good cultivation in the valleys of the rivers. Sub-sections: (*a*) Palghat gap, (*b*) Tambraparni Basin, (*c*) Palar Basin, (*d*) Cauvery Basin. The eastern boundary of this Section is to be fixed along the hills with their alluvial fans.

TABLE SHOWING THE PHYSIOGRAPHIC DIVISIONS OF INDIA, BURMA AND CEYLON—*Continued.*

SECTION.	PROVINCE.	DIVISION.	BRIEF NOTES ON PHYSIOGRAPHICAL CHARACTERISTICS ETC. AND PROJECTED SUB-SECTIONS.
1	2	3	4
(3) The Peninsular Area.—*Contd.*	IV. South Indian Region.—(*Contd.*)	E. Eastern Slopes.	Cretaceous and Older Tertiary rocks, Once submerged but later uplifted. Shore line emergence and now a plain of marine denudation, falling from 1000 feet with resulting platforms in parallel belts.
		F. Malabar Coastland.	Shore facies of Southern block, crystalline complex with belts of sandhills, lake lagoons, foot-hills and hill slopes. A few Tertiaries and marine sands visible. Alluvial area, cut up by short and rapid rivers. Heavy rainfall of the S. W. monsoon. Cocoanut trees grow. Rice land. Few natural harbours, as the coastline is unbroken.
		G. Coromandal Coastland.	Carnatic Region. Broad, coastal plain of marine denudation, falling from 1000 feet and reaching the east coast. Parallel belts from the Ghats to the delta of the Cauvery, and other river deltas. Lagoons and back waters. Marine denudation is abundant with resulting platforms. Uplifted coastland with few natural harbours. Double monsoon rains have affected the region.
	V. Island of Ceylon. (Isolated portion of the Peninsular Area.)	A. The Central Massif.	Fundamental gneisses of Ceylon striking in conformity with the gneisses of South India. The third peneplain of Wadia. Sharp fault escarpments with major waterfalls, which are rejuvenated after block uplift. Mountains some 8,000 feet high. Small volume minerals and gems. The region has undergone severe dynamo-metamorphism. Hot damp climate with evergreen forests. Tea plantations on hill slopes.
		B. S. W. Wet Lowlands.	Parts of the 1st and 2nd peneplains, but under the influence of double monsoon. Subaerial denudation considerable. Laterite formed. Sandy soil with cocoanut trees and sand dunes with lagoons and backwaters on the coastland. Some pearl banks are found.
		C. N.-N.E. Dry Lowlands.	Also forming parts of the 1st and 2nd peneplains, but drier in climate. Part of the northern plain is covered with limestone about 200 to 300 feet high. Some sandy peninsulas formed *e.g.* Jaffna. The palmyra palm flourishes here. Good fishing ground round about Trincomalee, an inlet forming the only natural harbour, on the leeward side of the Central Massif, very suitable as a naval base for India.

The Late Sir William Henry Bragg

THE scientific world loses one of its most eminent leaders in the passing away of Sir William Bragg on March 13, 1942 at the age of 79. After completing his education at Cambridge University he accepted the post of professor of physics at the University of Adelaide in Australia in 1885. When he became a professor, he had little preliminary training in conducting research, but he had apparently imbibed the spirit and though placed in the antipodes where the very atmosphere of research was lacking, he was determined not to lag behind. The epochmaking discovery of radioactivity by P. and Madam Curie and the brilliant investigations in this line by Rutherford and his collaborators soon attracted his attention and he started an investigation on the ionising process of α- and β-particles. It was Bragg who first observed that α-rays from any particular radio-active element have a definite range of travel in air and that the ionisation produced by these rays falls off abruptly at the end of their path. He also observed that the range of α-particles depends on the nature of the medium traversed. He developed the technique of ionisation chamber for detecting these particles and the accuracy of the results obtained with this technique was found to be greater than that obtained with scintillation screen. It is characteristic of Bragg that he did not publish much but whatever he has published has retained its place as standard work. By his work on radioactivity he earned the fellowship of the Royal Society in 1906. He returned to England in 1909 as professor of physics at the Leeds University.

At this time he began taking interest in investigations on X-rays. The nature of X-rays was a great mystery at the time and he wanted to prove that X-rays were electromagnetic waves by trying their reflection and refraction by means of ordinary mirrors and prisms, but no success was achieved and in spite of Barkla's investigations on the polarisation of X-rays by scattering which gave a strong support to the electromagnetic wave theory, Bragg propounded the hypothesis in 1912 that X-rays were a kind of neutral particles. But as is now well known all speculations about X-rays were swept away by the great discovery by Laue that X-rays can be diffracted by natural gratings such as crystals which consists of a space lattice of atoms. No one appears to have had a greater appreciation of the value and possibilities of this great discovery than Bragg. His son Lawrence (now Sir Lawrence Bragg) had just obtained the Tripos in natural science and had taken a special course of Crystallography. He had been interested in Pope and Barlow's idea of definite size of atoms and of crystals arising out of the tendency of constituent atoms to fill up space as economically as possible. The knowledge of crystallography on the part of the son combined with the father's skill with the ionisation chamber led to the great discovery that cleavage faces of crystals can be used for the reflection of X-rays at proper angles of incidence. The simultaneous determination of the spacings of cleavage planes of rocksalt and sylvine and of the wavelength of X-rays used by them opened up two entirely new and fruitful lines of research, namely, (*i*) a very powerful method of analysis of crystal structure, and (*ii*) a new method of determining the wavelength of X-rays. This work of the Braggs was considered to be so important that they were jointly awarded the Novel prize for physics in 1915. This discovery laid the foundations of X-ray spectroscopy, though the Braggs confined themselves to the study of crystal structure. The working of the second line was left to Moseley, Siegbahn and others. Both father and son concentrated their whole attention on the study of the structure of natural crystals, both inorganic and organic, and it is worth mentioning here that all the data published so far in these lines depend on the value of "d" for the 100 planes of NaCl first determined by them.

From Leeds, Bragg went to London in 1915 as the Quain professor of the University College. He was subsequently appointed Director of the Royal Institution and thus became successsor to the traditions of Davy, Faraday, Tyndal and Dewar and he held this position till his death. He carried on intensive studies on the structure of crystals of complicated aromatic and aliphatic compounds and his success in the case of the crystals containing complicated long chain aliphatic molecules is a marvellous achievement. Sir William Bragg jointly with his son

published the book "X-rays and Crystal structure" in 1915 and since then several editions of this work have been published. This volume has been of immense help to all the workers in this field. Another publication by Sir William Bragg entitled "An Introduction to Crystal Structures" which first came out in 1928 is also a useful treatise for beginners in research in this line. A more comprehensive treatise entitled "The Crystalline State, Vol. I" published recently by the Braggs is an extremely valuable book, and is immensely useful to students and research workers alike.

Apart from his scientific achievement, he was one of the most popular lecturers on scientific topics. His lectures drew large audiences to whom he could explain most intricate scientific topics in a highly interesting manner. His popular publications entitled "The World of Sound", "Concerning Nature of Things", "The Universe of Light" and "Old Trades and New Knowledge" will surely delight all for many years to come.

Sir William Bragg dedicated himself to the cause of science and his enthusiasm, his dogged perseverance, his great insight and above all, his genial temper made him one of the foremost men not only in the scientific world but also amongst the public. A large number of workers practically from all parts of the world were attracted by his personality to the Davy Faraday Laboratory. Sir William took personal interest in every one of them. He was keen in developing talents and encouraged every one of his students in making new discoveries. He was even young with his younger pupils ready to share with them their joys and anxieties whenever any new contribution was made. His laboratory at the Royal Institution was a veritable "Jerusalem" to crystallographers. His enthusiasm for research can be judged from the fact that only a few months before his death he took an active part in the discussion held at the Royal Society on the "Extra Spots in Laue Photographs" and contributed a few papers in this discussion explaining the observed results on the viewpoint put forward by him a few months earlier. His penetrating observations, though they could not achieve full elucidation of the subject, fully exposed the risk of hasty generalisations, and showed that even eminent scientists cannot sometimes resist the temptation of discovering "Paramore's disease". Sir William appears to have retained his intellectual powers to the full till his death.

Though Bragg himself was quite unobtrusive by nature, honours came to him as a matter of course. He was knighted in 1921, and when certain Indian students who were then working in the University College, congratulated him remarking that it was a matter of sincere pleasure that the Government had recognised the value of his great scientific discovery by conferring a knighthood on him, Bragg remarked sarcastically "My young friends, you are very much mistaken if you think that the Government has conferred this honour on me in recognition of my discovery of the reflection of X-rays. Nothing of the kind. Probably those in charge of distribution of honours have never heard of such a discovery. I have received the knighthood in recognition of some work I did in aid of war-effort". The work referred to was the perfection of an apparatus (Hydrophone) for detecting the presence of a submarine near any ship and also for finding the direction of its approach. This technique has been described by Bragg himself in his book "The World of Sound".

Among the distinctions achieved by him may be mentioned the award of the Copely Medal of the Royal Society, and the Order of Merit. He was president of the Royal Society when the second World War broke out, and Bragg complained of having had to live through two great World Wars in course of one life. He was not satisfied with the way in which Government was making use of science and scientists in aid of the War-effort, and expressed his views in his Presidential Address to the Royal Society. A summary of these views has been published in "SCIENCE AND CULTURE" (see vol. 6, p. 191, 1940-41).

Bragg's life and career are typical of an ideal scientist. He cannot compare in range of activity and penetration with some of the great figures of modern science. In fact, he concentrated on knowing "More and more about less and less". But he did retain his scientific activity to the last day of his life, and in spite of official honours, and frequent contact which he had to make with members of the Government, he never allowed himself to become a 'parlour' or a 'courtier' scientist, and expressed his mind quite freely about actions and policies of the Government in scientific matters.

Illumination with Glareless Light

STRONG illumination is not necessarily helpful for good seeing. It is common experience that a body strongly illuminated dazzles the eye and prevents seeing the detail. Even at our best condition of artificial illumination certain 'glare effect' is always present which spoils some amount of contrast in seeing the details of an object. This has been known for a long time that the contrast is greatly enhanced by viewing the object with polarised light, *i.e.*, light in which the vibrations are taking place in one particular direction.

Ordinarily such polarization is accomplished by passing the light through the crystals of quartz, tourmaline etc. These would permit the rays of light vibrating in a particular direction which depends upon the orientation of the crystals. It is therefore obvious that if another such piece is held in the polarised beam of light but with its orientation crossed, the light would be stopped. It is thus very interesting that two transparent pieces of polarisers when held with their optical orientation parallel to each other, they are transparent all right, but as one of them is rotated over the other, the transmission falls gradually until the light is stopped altogether when they are turned through a right angle (crossed position). So, the two transparent pieces together may become opaque even.

We shall now see how these properties of polarised light and polarisers have been made use of in daily life. It is clear that for wider use of polarised light, polarisers of much larger size than the naturally occurring crystals are necessary. This has recently been accomplished by special processes and large sheets of polarisers, commonly known as 'polaroids,' have been possible to manufacture.

The polaroid is now becoming an object of general interest in connection with indoor illumination. Table lamps fitted with this material give out polarised light which is glareless and comfortable.

The glareless property of polarised light has been used for a long time in microscopy. The specimen under observation is illuminated with polarised light to give distinct view of the details of its structure.

The use of polaroid sun goggles is very interesting. Each eye has two glasses of polaroids, one can be turned over the other so that different 'shade' or amount of transmission of light can be obtained by that process. If it is a very bright day, the pairs in each eye are set almost 'crossed' optically, in order to get very dark shade. But if the sun dulls off behind a patch of cloud one can immediately adjust the shade of the glass simply by turning the axis.

The motor car head-light can also take polariser to great advantage. This is a great trouble for a motorist when he meets an approaching car with its head light on. This would dazzle his eye and may lead to an accident. The difficulty is avoided by using polariser over the light, and wearing a polaroid glass or using the polariser on the motor window screen with its polarising direction just crossed relative to the head-light's. Thus, if the head lights send out light polarised in the vertical direction and the motorists use polarising glasses (on their eyes or on wind-screen) with its polarising direction horizontal, the light would not be able to trouble them.

K. Ray.

Notes and News

EUGENIC RESEARCHES IN BENGAL

EUGENIC researches and practical application of knowledge of the laws of heredity gathered from them are indispensable for the betterment of the population of any country. Very little attention has hitherto been directed to any kind of research in human genetics in this country. The greatest handicap lies in the deplorable absence of data relating to hereditary diseases and anomalies, though there is not dearth of such diseases in the country. We welcome the appearance of a bulletin entitled "Aims and Objects of Eugenic Researches in Bengal" published by the Indian Eugenics Society, Calcutta. In this paper the author Mr S. S. Sarkar has examined in detail the census figures for the year 1931 for insanes, blinds and deaf-mutes together with the data available from the annual public health reports of Bengal. The author has chalked out a comprehensive programme of eugenic research in Bengal which according to him must begin with collection of pedigrees, study of bastard population and family crosses and twin researches. Studies of social selective agencies which change the genetic composition or equilibrium of the population in the succeeding generations must also be undertaken by social anthropologists.

In a foreword, Dr B. K. Chatterji, the president of the Indian Eugenics Society has given a short history of the origin of the Society. We hope the society will initiate valuable researches in human biology and human heredity and will help to inaugurate a powerful eugenic movement in this country.

REPORT OF THE ZOOLOGICAL SURVEY OF INDIA

THE triennial report of the Zoological Survey of India for the period 1938-1941 records little material change in the activities of the department since the report for the period 1935-1938 was written. For want of funds the field activities have been greatly restricted nor has it been possible to extend the research activities of the Department. Friendly collaboration with research institutions and educational bodies has however steadily increased and the Department has been frequently consulted by other scientific departments and scientific institutions and the general public in connection with zoological, biological and allied problems. The Department also undertook biological investigations at Pulta in connection with the water-supply of Calcutta, and studied the role of indigenous species of fish as larvivorous forms in connection with anti-malaria measures in the Jharia mining settlement. Other important problems tackled by the Department were (*i*) the identification of animals of economic importance from the medical or sanitary point of view, (*ii*) the preparation of a scheme for the investigation and development of the Chilka Lake fisheries, and (*iii*) identification of human and animal remains excavated by the Archaeological Survey at various prehistoric sites in different parts of India.

The cadre of gazetted officers for the Zoological Survey of India as sanctioned in 1922 and modified in 1933 has never been filled up to its full strength. The director has to perform heavy duties as he has to carry on efficiently the work of administration of the department and, in addition, to supervise and carry out scientific research and to attend to the heavy duties in connection with the Indian Museum. During the period under review none of the officers was able to spend more than a month in the year in the field owing to insufficient grants. This can hardly be regarded as satisfactory for a department like the Zoological Survey of India. For the scientific work of the Zoological Survey of India which alone can serve as the guardian of the country's animal food resources and look after their proper development, conservation and exploitation, necessary funds should be provided, and the Department should be enabled to undertake extensive field work which besides adding to our scientific knowledge is sure to prove of great economic value to the country. The record of work carried out in the laboratories of the Zoological Survey of India is fairly satisfactory, a

large number of papers mainly on the material of the Survey sent to foreign specialists were also published in the Departmental publications. Fourteen parts of the "Records of the Indian Museum" and two of the "Memoirs of the Indian Museum" have been published during the period under review. In view of the increased activities of the Department and the reduction of staff effected in 1931-32, we think the Government of India should take up the question of increasing the annual grants for the Department in order to ensure more efficient working of the Department and for improving the public galleries of the Indian Museum.

C. R. REDDY SIXTIETH BIRTHDAY COMMEMORATION VOLUME

THE Andhra University has done well in publishing in a collected form the articles that were presented to Dr C. R. Reddy, the well-known scholar and educationist and vice-chancellor of the Andhra University, on the occasion of his sixtieth birthday, by the scientists of India. The volume contains a number of highly specialised contributions from the pen of eminent scientists in the country as also a number of articles dealing with the problem of development of scientific research and industries in India. The first article is contributed by Sir C. V. Raman and N. S. Nagendranath and contains an exposition of the theory of two types of X-ray reflection in crystals. In an article entitled "The war and its repercussions on the chemical industries of India", Dr J. C. Ghosh has given an outline of some of the problems that face the chemical manufacturers in India at the present moment. Dr H. K. Sen has discussed the role of scientific research in relation to industrial development and stressed the necessity of wise planning of scientific and technical research in India. The volume contains 21 articles covering a wide range of subjects and provides useful and interesting reading.

PROGRESS OF METEOROLOGY IN U. S. A.

ON the occasion of completing the 50th year of the U. S. Weather Bureau, F. W. Reichelderfen, chief of the Bureau, has published a short historical summary of the development of weather forecasting service in U. S. A. On November 1, 1871 the first systematized meteorological reports taken in the United States were read from the instruments at 24 stations and telegraphic transmission was made to Washington and other cities and ports. The field network of observing and reporting stations under the Weather Bureau's supervision has grown to 800. Forecasting centres number 14 including those in Alaska and Hawaiian Islands. Special services like the hurricane warning service, the aviation weather service, the fire weather service, the river flood service, the fruit frost service etc., have been established and forecasts and warnings are conveyed to the public through the facilities of 600 radio stations, automatic telephone announcements and storm warning displays. The organisation includes 5,000 unpaid observers in addition to a somewhat larger number for furnishing the specialized observations required in the special services. In the last 50 years the number of climatological observing points has been increased to over 5,000. Theoretical researches of Weather Bureau meteorologists in U. S. A. have contributed continuously to the knowledge and value of the science of meteorology as would be evident from the contributions of lasting value published in the long series of the monthly Weather Reviews. Recent developments in meteorology are in a large measure due to invention and refinement of methods for observing the conditions of upper levels of the atmosphere. More than twenty years ago the Weather Bureau began gathering upper air records by means of occasional balloon flights. During the early 30's this method was replaced by airplane observations made with instruments carried aloft at specified times and places. More recently the radiosonde has displaced the airplane as a means for gathering upper air data. In the United States today there are 50 radiosonde stations taking observations twice a day. The upper air data have supplemented and clarified many of the working principles of the air-mass and frontal system of weather analysis and forecasting and seem to offer good promise of a reliable extension of the time period of forecasts.

DATING OF ARCHAEOLOGICAL EVENTS FROM STUDY OF POLLEN GRAINS

NATURAL vegetation of any locality depend upon the climatic conditions and during the big climatic changes since the last retreat of the ice the natural vegetation belts have all moved north with the improvement of the climatic conditions, reached latitudes higher than those of today and have again moved somewhat southwards. As for example, in Southern Britain the last 15 or 20,000 years have seen the country covered in turn with tundra, birch-pine wood-land, mixed oak-forest with warmth demanding trees like the linden, and finally mixed oak-forest with less linden and more birch and some beech and horn-bean. By the recently developed system of pollen-analysis, the forest periods are made to serve as a time scale against which archaeological events

can be dated. Trees being mostly wind pollinated, their pollen is abundant and widely spread and is incorporated in all kinds of growing deposits like peat bogs or lake muds. Pollen grains can be easily identified in small samples of peat or mud by digesting the latter with alkali or other reagents. From a count of the different pollen types in a vertical series of samples, the whole forest history of the locality will reveal itself and archaeological objects can be placed in their proper forest period. Even mud clinging to scraps of pottery long left in museum shelves will yield enough pollen grains to enable a dating of this kind. The method enables all geological and climatic events of the post glacial period to be brought together with archaeological cultures into one unified scheme.

THE MASS OF THE MOON

IN the January issue of SCIENCE AND CULTURE, we gave an account of the new determination of the distance of the sun which has recently been made by Dr H. Spencer Jones, astronomer-royal of England. As a by-product of this new determination a new value of the mass of the moon has also been found. This is much more exact than the previously accepted value.

The earth does not really move round the sun in an exact ellipse, but it is the centre of gravity of the earth and the moon together that does this. The gravitational pull of the moon on the earth causes deviation of the earth on one side or the other of the ellipse. These deviations from a true elliptic path are reflected in the position of Eros as seen from the earth. Calculation made on this basis yields a value for the mass of the moon equal to 1/81·27th part of that of the earth. Allowing for the difference in size, the material of the moon is much lighter than that of the earth as a whole and proves to be of the same order as that of the surface crusts of the earth, which as is well known, is much less dense than the material forming the interior of the earth.

U. S. TECHNICAL MISSION TO INDIA

AN American Technical Mission headed by Dr Henry Grady arrived in India last month. According to a press communiqué the Government have agreed to receive this Mission in order to examine and report on the possibility of American assistance in developing as fully and as rapidly as feasible the industrial resources of India. It is necessary, however, to know the precise terms of reference of the Mission as also the procedure which it would follow so as to enable the Indian public to form some idea of its functions, its objectives and its manner of working. The Mission must not operate under a veil of secrecy so as to give rise to suspicions and misapprehensions.

Since the commencement of the war, long-term measures in regard to development of heavy and defence industries in India have been considered unnecessary by the Government of India and His Majesty's Government on the ground that assistance from the U. S. A. was expected and would obviate the need of development of such industries in India. It has been argued during the last 2½ years that unless India could produce ships or tanks within a specified period of months, it would be useless for war purposes. Shipbuilding in India was not being recognised as a war effort on the plea that it was too long-range a programme to be of effective use in war although the war itself was expected to be of long duration. On the contrary, reliance was placed on American aid in equipment despite the well-known fact that it was not to be forthcoming in the immediate future. It seems that even before the entry of America into the War and the application of Lease and Lend Scheme to India, American industrial interests were exercising an indirect influence on the war economy of India. American economic experts have visited India and the East, and there have been plans for Anglo-American economic collaboration during and after the war. Authorities in this country should see that such schemes do not result in American economic domination over India.

India would welcome any technical assistance and guidance which American Mission might give in increasing production or securing equipment for the effective prosecution of the war, but such technical assistance will be of little avail unless the Government of India have a definite policy or well-formulated plan for the establishment and development of essential and war industries. The Indian commercial community feels strongly that no advantage should be taken of the American Mission to create new non-Indian vested interests in this country, which would militate against its present or future industrial development. Indian industries which have hitherto been struggling to develop despite the lack of a vigorous industrial policy on the part of the Government and the frequent opposition of British interests will then have to face a fresh and serious obstacle. If, as a result of the Lease and Lend Act and with the aid of a technical mission, American interests are able to set up plants and exploit natural resources under American control in this country, it would be a great impediment to national economic development. The Government of India should co-operate

with the American Mission only on the basis of obtaining technical help and supply and must not surrender India's right to frame and execute her fiscal policy according to her own requirements either now or in the post-war years for securing American collaboration and should not take any action which would infringe their right to shape national economic policy in consonance with Indian interests because of any commitments of the British Government to the United States.

'GROW MORE FOOD' CAMPAIGN

THE Hon'ble Mr Nalini Ranjan Sarker recently presided over a Food Drive Conference at Delhi, which was attended by representatives of provincial and State Governments. The effect of the cessation of import of rice and wheat and the huge demand from the army has caused a strain on the present agricultural resources of India and the problem of insufficient foodstock has been accentuated by the fall in production in the country itself. Curtailment of transport facilities preventing distribution of available food supply has added to the gravity of the situation. To fight against these heavy odds the Hon'ble Mr Sarker offered a practical solution not based on any long-range policy but capable of immediate execution. Explaining his plan of accelerated agricultural production to cope with the wartime demand, the Hon'ble Mr Sarker drew what may be described as the food crop map of India giving the surplus-deficit position province by province with detailed statistical accuracy. This map revealed that apart from the partial dependence on imported rice and wheat there was hardly a province in India which was entirely self-sufficient in the matter of food crop. The only way to meet the situation, lay in a countrywide drive for increased food crop production, introducing where possible the plan of provincial self-sufficiency as an insurance against possible dislocation of transport and distribution. The cultivation of a number of commercial crop has now ceased to be remunerative propositions due to the international situation and land released from such cultivation should be utilised for the growing of food crop till, at least, the return of the remunerative value of commercial crops. An example in this direction has already been set in Bengal where considerable land has been released from jute production and employed in the production of rice yielding the most satisfactory result.

INDIAN POULTRY GAZETTE

IT is a happy news that the Indian Poultry Club established in 1910 has been recently revived and the useful publication of its quarterly journal, *Indian Poultry Gazette*, has been recommenced. The first two issues of the new series of the *Gazette* are welcome additions on our tables. The articles show a clear approach to the problems in the field. It is good that a part of the contents consists of reprints of articles of special interest to poultry farmers. The journal maintains an 'advisory bureau' where useful advice on any poultry subject is given by post and answers to certain selected queries are published in the *Gazette*. We would like to see the present efforts of the Poultry Club effectively augmented by the periodical publication of bulletins in different Indian languages for the benefit of the village breeders. The bulletins should take stock of the prevailing conditions of a particular area. Useful information about farming problems and suitable suggestions for placing the poultry husbandry on a sound economic footing require to be broadcast in their own languages to the numerous units, which are scattered all over the country. The suggested method will be very helpful for the cause which the Poultry Club champions. The old and worn-out methods of the villages need very sturdy improvement.

The editor of the *Gazette* is Mr A. J. Macdonald, officer-in-charge, Poultry Research Section, Imperial Veterinary Research Institute, Izatnagar, U. P., who is also the secretary of the Poultry Club. Mr F. Ware, animal husbandry commissioner with the Government of India is the president of the club.

TWO-MAN SUBMARINE

JAPAN'S war tactics have shocked the world and two of their martial units brought into action appear to be unrivalled in efficiency and performance. They are the one-engine aeroplane and the two-man submarine. The personnel of these units also stand out in a dare-devilish fashion. The internal combustion engine has been made the devil in the present war playing to the whims of the war lords. In our issue of August, 1940 we published a note on developments in Japanese submarine. It was reported that the Japanese had built a pocket submarine only six or seven yards long but extremely effective in torpedoing. It was further mentioned that a type of pocket submarine had been evolved which after gliding on short distance on the surface took off into the air and flew like a seaplane. It had a fish-shaped body and there were collapsible wings and propeller blades, forming into airscrew, when the machine flew in the air. The range was reported to be about 300 miles and the submarine could carry a load of four torpedoes for use under water or in the air. This machine has not yet come into limelight. It is possible that the type demonstrated before experts and press reporters was only an indication of the ingenuity in store of the Japanese naval experts. Very meagre details of the two new weapons of war are now available. Both these weapons are reported to have been used by Japan in her attack on Pearl Harbour. The one-engine aeroplane due to its light weight is capable of carrying enough fuel for a very long flight, a range which has far exceeded that of the modern fighters and bombers, and therefore very long-distance targets supposed to be immune from attacks have been caught by surprise. Two-man submarine is only 42 feet long, and when arrayed beside a standard first class Japanese submarine of 320 feet, it looks like a mosquito. Americans claim to have captured one of these machines. The whole ship is built of ¼ inch plate and divided into five compartments carrying two 18-inch torpedoes and 300 lbs. of explosives. The power is provided by electric motors and each ship has a range of 200 miles and a top speed of 24 knots. The officer-in-charge looks after steering and driving and discharges the torpedoes by remote control. The other man, a so-called rating, is a skilled engineer in charge of the intricate machinery of the submarine. These ships are supposed to be launched from a mother ship within a hundred miles of the objective, and their small outfit dealing heavy destructions has produced the most devastating surprise in the present war.

ANNOUNCEMENTS

IT is learnt that Dr P. K. Bose, lecturer in the department of chemistry, Calcutta University, has recently been appointed as deputy director of the Production of Drugs and Dressings, Government of India. Dr Bose is a very distinguished organic chemist having achieved great and wide reputation, particularly in the field of drugs and his loss to Calcutta University for the time being will, we hope no doubt, be a great gain to the department, which has been built up with great energy and consummate skill by the eminent chemist, Dr J. N. Ray, director of the Production of Drugs and Dressings.

Dr Bose has not only distinguished himself in the field of research but has been associated with several scientific societies and journals, to whose success he has made great contributions. He has been for several years honorary secretary of the Indian Chemical Society. He is an editor of the Annals of Biochemistry and Experimental Medicine and has been associated with SCIENCE AND CULTURE in the editorial board. We trust that with the experience that Dr Bose will gain in his new responsible post, he will later on prove to be one of those who, in a better and freer atmosphere, will lay the foundations of a planned drug industry in India.

PROF. MANECK B. PITHAWALLA, D.Sc., F.G.S. of Karachi has been awarded the Moos Gold Medal by the University of Bombay for the best thesis on a science subject for the year 1940-41. He was awarded the degree of doctorate of science by Bombay University for his thesis on geographical analysis of the Lower Indus Basin (Sind). Dr Pithawalla is at present engaged in his studies on the physiographic divisions of India, Burma and Ceylon.

SCIENCE IN INDUSTRY

CHARCOAL FOR MOTOR VEHICLES

OWING to the urgent need for conserving petrol, attention has recently centred in the possibility of converting a large number of the lorries and buses in India into charcoal-gas vehicles. A rough estimate of the umber of commercial lorries and buses in use in British India indicates that there are over 37,000 such vehicles functioning at the present time, and that if 50 per cent of these vehicles can be converted to run on charcoal gas, a total of some 18,000 tons of charcoal per month will be required.

In a leaflet issued by the Forest Research Institute five common species of Indian wood are mentioned as making good charcoal. Many other Indian species are expected to be equally suitable. In this leaflet specifications for producer-gas charcoal are given and other information likely to be of use to charcoal manufacturers and the forest department, has been included for ready reference. The harder and closer-textured the wood is, the better the charcoal for producer gas, provided its ash content is low. Making of the charcoal should be done preferably in metal or brick kilns, but ordinary mud-covered kilns can be used if proper supervision is given.

Organisation, especially in the spheres of supply, distribution and proper grading are the important features of charcoal production and we hope the Forest Institute will take the initiative at a place where the available facilities are expected not to impede the war efforts at hand. The necessity however of a substitute fuel for the automobile engines is gradually becoming very pressing and should weigh equally with other projects.

In the United Kingdom it has been found that producer gas vehicles can be efficiently run with soft-coke as fuel. Indian soft coke has not been tested for this purpose. A research in this direction is called for, and Bihar and parts of Bengal can expect to use soft coke in producer gas plants.

WATER FOR SUGAR CANE

ACCURATE measurement of the quantity of water required for different varieties of cane under different treatments is engaging the attention of the Sugar Cane Research Station at Padegaon. The standard devices of measuring water were found unsuitable for the purpose and a differential self-recording rotary meter is now used.

It has been necessary to design suitable outlets or valves which can open and shut off water instantaneously from the feed pipe.

The arrangement made at Padegaon for giving measured quantity of water to sugarcane crop is intended for a rotation of three years. It consists of 216 plots which could be given measured quantity of water at different rates and intervals with the help of meters. Water from the distributory is first taken into a receiving tank and is then carried to a number of intermediate tanks, built in a line parallel to the plots and spaced at suitable distances. It is through these tanks that water is given to the different plots through meters. Each of these small tanks takes care of two plots. There are 108 tanks provided for the three-year scheme, with 18 tanks in each row.

WOOD FLOUR FOR DRY CELLS

IN the manufacture of dry battery cells some filling material is commonly employed in the mixture in order to provide the necessary porosity. The fillers must remain completely inert and should in no way take part in any electrical or chemical action in the cell. Infusorial earth, cork powder and wood dust are the filling materials used. Of these the first requires some treatment before use and cork powder is expensive as cork has a demand in other industries, for example, in the making of linoleum. Wood dust is a by-product of the timber industry. The right

quality of wood dust had so long been imported from Germany and the stoppage of the supply gave the stimulus to the Forest Research Institute to find out suitable varieties of Indian woods for the purpose. Treatment of woods by acid or alkali should be avoided and therefore the selected woods should possess the lowest amounts of foreign ingredients like gums, resins, tannins, colouring matter, etc., and it should be possible to extract these impurities with water alone. Two varieties have been found suitable and at the same time they are available in large quantities. These varieties are already consumed in timber industries which release large quantity of dust. Silver fir is a loftly evergreen tree growing in the outer Himalayas from Chitral to Nepal. The present use is in planks, tea boxes and packing cases. The second variety is Semul cotton tree which is common all over the country and is used for similar purposes as the silver fir.

To make wood dust inert, it is soaked in boiling water for an hour. It is filtered and the process is repeated thrice. It is dehydrated in filter press and dried in the sun and on oven till moisture content is only 5 per cent. The dust of the two varieties serve well when mixed half and half and should be ground so fine as to pass through a 100-mesh sieve.

IRRIGATION PROJECT TO RELIEVE FAMINE-STRICKEN AREAS

THE Thungabhadra Project, now under detailed investigation by the Madras Public Works Department, is intended for growing dry crops by means of irrigation in the four districts of Bellary, Anantapur, Kurnool and Cuddappah, where famine is very frequent. The soil is mainly black suitable for cotton growing.

The success of the project depends upon the satisfactory response of the soil under irrigation. As an experimental measure, a model farm of 90 acres has been built at Siruguppa, in the Bellary district. The soil of the farm is typical of the area and analysis of the top three feet shows that it consists of 60 per cent clay, 14 per cent silt, 10 per cent fine sand, 8 per cent coarse sand and 8 per cent acid soluble matter. There is facility for surface drainage of the farm and irrigation water is pumped from a near-by channel.

The experiments have been devised to study the physico-chemical reaction of the deep black soils to the application of irrigation. It is expected that some experiments will give insight into the movement of salt, base-exchange phenomena, and colloidal properties of the clay. Further studies will include field practices, manurial experiments, rotation of crops, soil management, run-off conditions, soil moisture and suitable variety of crop for the irrigated conditions.

Results already achieved at the farm tend to show that the black soils will respond very favourably to light irrigation.

SUBSTITUTES OF CORK

As a result of the war, imports of cork (bark of cork-oak) from Europe have almost ceased and experiments have been carried out at the Forest Research Institute with a view to finding out a suitable substitute. The experiments so far carried out have shown that suitable substitutes for some of the uses can be produced. For bottle stoppers, *Cryptomeria japonica* wood suitably slotted and softened by chemical treatment have been found satisfactory. A soft fine-grained wood is best suited for this work. Among the timbers so far tested, fast grown *Cryptomeria japonica* (*suji*) has proved to be the best. This timber is available in Bengal. Composite cork has been made from *Erythrina suberosa* bark and bagasse by suitable chemical treatment. Paraffin-impregnated sola pith has been successfully utilised as corks for hypodermic injection tabloid tubes. The methods of manufacturing the above are briefly described in a note recently published by the Institute.

WOOD TAR PRODUCTS

WOOD tar obtained by the destructive distillation of *Pinus* species is the source of certain medicinal products (such as *Creosotum* B.P., *Guaiacol* and its derivatives, *Pix liquida* B.P., *Oleum picis* B.P., spirit of tar and rectified oil of tar). Medicinal wood creosote (*Creosotum* B.P.) is produced both from hardwood tars, such as beech, oak, etc., as well as from tars of *Pinus* species. Wood distillation is a well established industry both in Europe and America, whereas in India, we have a solitary hardwood distillation plant at Bhadravati (Mysore State), which is run primarily for the charcoal required by the Mysore Iron and Steel Works. Consequently, all the medicinal products obtained from tar used to be imported. The present war has brought about an acute shortage of these products, hence the question of their production in the country is receiving urgent attention.

During the war of 1914, the forest department of the United Provinces started the distillation of chir pine (*Pinus longifolia*) wood in the hill forests of Kumaon and produced a tar which was considered a good substitute for the imported product and, during the period of shortage, was readily accepted by trade for tarring of ropes and other marine purposes. Highly resinous stump wood, commonly known as 'chilka' or 'torch-wood', was used for distillation. The question of reviving the chir tar industry is now engaging the attention of the Forest Department of the United Provinces and they, in collaboration with the Forest Research Institute and the Turpentine Subsidiary Industries, Ltd., Barielly are arranging for large-scale production of tar and its medicinal derivatives to meet the growing demand of the country. The manufacture of medicinal derivatives need not necessarily be a part of the parent chir tar industry, and any firm of manufacturing chemists could take it up, the required raw material being supplied by the parent industry. Backed by the demand of the Indian Medical Stores Department and of the country a full-fledged industry can certainly be run on a profitable basis, if properly organised. A leaflet giving fuller information on the above subject is available from the Forest Research Institute, Dehra Dun.

INDUSTRIAL BULLETINS

THE department of industries and commerce of the United Provinces has brought out a further list of industrial bulletins. Written by competent persons the bulletins have been published in English, Urdu and Hindi. The following are the titles of the bulletins (*i*) The Glass Industry, (*ii*) Schemes for Educated Unemployed Young men, Part II, (*iii*) Manufacture of Calcium Gluconate, (*iv*) Manufacture of Pine Wool, (*v*) Wooden toys—How to make them (in Hindi), (*vi*) Schemes for educated Unemployed Young men, Part I (in Hindi and Urdu).

Silica Gel

Its Preparation and Industrial Applications

P. B. GANGULY and R. C. RAY

Department of Chemistry, Science College, Patna

INTRODUCTION

TO roll up the entire surface of an acre into a compact mass of no greater volume than one cubic inch, may at first sight, appear an impossibility. Nevertheless this is exactly what the silica gel does. It possesses an enormous surface. According to Meyer[1] one gram of the gel has a surface of about 4·5 million square cm. Gururaja Doss and Sanjiva Rao[2] have determined the specific surface of the gel and they consider that one gm. of the gel has a surface of six million square cm. In a later paper Kiselev[3] computed the surface to be about one million square cm. per gram of the gel. Undoubtedly the surface is large and it is by virtue of this vast available surface that silica gel finds use in a large number of technical processes, which are as varied in their nature as they are important in their applications.[4]

PHYSICAL APPEARANCE OF THE GEL

Silica gel of commerce is a hard, more or less transparent granular material. The grains are usually of a size of 2-4 mm. and possess a hardness of 4·5-5. They are glassy in appearance and look like large particles of clear quartz sand. When put in water the larger pieces crumble into smaller ones with a

[1] Meyer, *Zeit. Angew. Chem.*, 37, 37, 1924.
[2] Gururaja Doss and Sanjiva Rao, *Jour. Mysore University*, 8, 40, 1935.
[3] Kiselev. *Colloid. Jour. U. S. S. R.* 2, 17, 1936.
[4] Cf. *Amer. Fertiliser.*, 55, 41, 1921.

gentle crackling noise[5] and a large sorption of water. Though the formation of silica gel and its properties as an absorbent, were the subject of investigations by van Bemmelen[6], Zsigmondy[7] and numerous other workers[8], the introduction of silica gel to technical processes originated after the investigations of Marcus[9] and the important researches of Patrick.[10] The chemical nature of the gel is the same as that of pure silica though certain commercial varieties may contain traces of alumina[11] and free sulphuric acid. Though identical in chemical composition, silica gel differs from precipitated silica in physical properties. The gel has a characteristic internal structure which imparts to it its many useful properties.

PREPARATION OF THE GEL

Silica gel is prepared from sodium silicate solutions by treatment with suitable electrolytes. Usually dilute mineral acids are used for the purpose, though the use of other electrolytes like sodium bisulphate, sodium bisulphite[12], ammonium pyroborate, ammonium sulphate[13] and sodium bicarbonate[14] has also been recommended by different authors.

The use of water soluble esters like ethyl formate and ethyl acetate for preparing silica gel has also been patented[15]. The formation of the gel is a non-reversible process and the gel is non-elastic.

The exact conditions for the production of the granular silica gel of commerce is the subject matter of numerous patents[16]. According to the formula given by Patrick, 430 c.c. of a 10 per cent. solution of sodium silicate is gradually stirred into 200 c.c. of a 10 per cent. solution of hydrochloric acid. The temperature recommended by Patrick for the formation of the gel is 10°C. Waterman[17] has recommended the use of 1250 c.c. of a 25 per cent. solution of water glass and 1650 c.c. of a 5 per cent. solution of hydrochloric acid. Thus in the proportion given by Waterman there will be an excess of alkali. Gruhl[18], on the other hand, uses water glass and acid solutions in molecular proportions. The conditions for the formation of gel have been investigated by Flemming[19] who determined the time of setting for different mixtures of acid and sodium silicate solutions. Ray and Ganguly[20] have investigated the optimum conditions for the formation of gel and have found that for each concentration of alkali silicate solution there is a limiting range of pH values in which gelation occurs. The essential details for the production of a gel may be summarised as follows:—The gel is best formed when acid and alkali silicate solutions are used in nearly molecular proportions. A solution of water glass of density between 1·2 to 1·4 is added with stirring to a 5 to 10 per cent. solution of hydrochloric acid (or equivalent sulphuric acid) till practically neutral, the mixture being maintained at 10°C. In the beginning the mixture should be in the condition of a sol but, in the course of 15-30 minutes, should set into a transparent uniform gel. The gel obtained in this way contains a large amount of water and in this condition has hardly any adsorptive capacity. The gel prepared above is next washed to free it from contained electrolytes. To shorten the otherwise lengthy washing process necessary for the removal of the last traces of alkali the use of aluminium or magnesium chloride has been recommended in the technical preparation of the gel[21]. After preliminary washing the residual alkali forms hydroxides with the aluminium or magnesium salts. For most purposes small amounts of these hydroxides are not objectionable, but when it is so desired, they can be removed by washing with sulphuric acid. The next step in the preparation of the gel is to reduce its water content. For this purpose the gel is compressed whereby the major portion of the water is drained off. In the process patented by Bayer & Co.[22] the silica hydrogel is first subjected to a pressure of 350 atmospheres, whereby a large fraction of its water content is removed. The pressed gel is then washed to remove electrolytes and dried at gradually increasing temperatures up to 200°C. Patrick had used pressure on the washed gel to remove water. In this manner the gel is obtained in the granular form in which it is supplied in commerce.

[5] Bhatnagar and Mathur, cf. *Kolloid Zeit.*, 37, 97, 1925.
[6] van Bemmelen, *Zeit, anorg, Chem.* 18, 18, 1898; *ibid*, 30, 265, 1902.
[7] Zsigmondy, *Zeit*, anorg. *Chem.*, 71, 356, 1911; *Poysik. Zeit.*, 14, 1098, 1913.
[8] Bachmann, *Zeit. anorg. Chem.*, 79, 202, 1912. Anderson, *Zeit. phys. Chem.*, 88, 191, 1914.
[9] Marcus, Br. Pat. 17873, (1911); 25220, (1912); Fr. Pat. 465569, (1913); German. Pat. 263388, 268057 (1912).
[10] Patrick. Göttingen Thesis, 1914.
[11] Ruff and Mautner, *Zeit. angew. Chem.*, 40, 428, 1927.
[12] von Bearle. German. Pat. 290530 (1916).
[13] Ernst Berl. Br. Pat. 206,267 (1937)..
[14] Hilditch. Br. Pat. 206,267 (1923).
[15] *German Pat. 665,099 (1938).*
[16] Patrick, Br. Pat. 136,543; 137,284 (1919); U. S. A. Pat. 1,297,724, 1,335,348 (1919 & 1920); 2,092,163 (1937); Canadian Pat. 200,912 (1920); 217,365 (1922).
Silica Gel. Corporation and Patrick, 1,520,305.
Fritz Stowener and I. G. Farbenind: A. G. German Pat. 574,721 (1935); 626,272 (1936).
[17] Waterman and Perquin. *Chem. Weekblad.* 22, 378, 1925; *Brennstoff. Chem.*, 6, 255, 1925.
[18] Gruhl, *Centralblatt.*, II, 1385, 1926.
[19] Flemming, *Zeit. phys, Chem.*, 41, 427, 1902.
[20] Ray and Ganguly, *Jour. Phys. Chem.* 34, 382, 1930.
[21] Holmes and Anderson, *Ind. Eng. Chem.*, 17, 258, 1925. Calvert, Dern and Alles, U. S. A. Pat. 1,502,547 (1924).
[22] Bayer and Co., French Pat. 572,959 (1924). Br. Pat. 205,081 (1923).

ACTIVATION OF THE GEL

Before use as an adsorbent silica gel requires activation. The process consists essentially in heating the gel whereby its water content is lowered. The effect of heating on silica gel has been extensively studied. When a sample of gel is heated above 700°C. it loses practically all its water and in that condition has little adsorptive capacity. According to Patrick the most favourable conditions for drying the gel consist of a preliminary heating at 120-160°C. followed by a second stage of heating at a higher temperature of 300-350°C. Watermann has shown that it is immaterial whether the gel is heated in a vacuum at 200°C. or is dehydrated by a current of dry air at 200°C. Though different temperatures have been used for activation, the results are practically the same so long as 400°C. is not exceeded. A sample of gel when examined under the X-rays by the Debye-Scheerer method showed an amorphous structure up to 400°C. but at a higher temperature a morphological transformation sets in. A proper criterion for activation is to heat the gel so that its water content lies between certain optimum limits. As has been discussed by Mautner[23], the removal of water beyond a lower limit affects the gel in two ways:—the pores collapse and coalesce whereby the capillary spaces are reduced, and the amorphous nature of the gel is transformed into the crystalline form of cristobalite. When the amount of water is between 2% and 10%, the silica gel functions best as an adsorbent. Thus Patrick[24] observed the maximum adsorption of sulphur dioxide when the silica gel contained 7% water, but the results were practically the same with gels containing 8 to 5% water. In the case of butane[25] the maximum adsorption occurred with a sample of gel containing 2% water. As a typical instance the investigations of Ray[26] on the adsorption of nitrogen peroxide by silica gel containing different amounts of water might be cited.

Water Content.	Amount of adsorption.
6·8%	47·12 gm./100 gm. gel.
5·16%	44·54 ,,
4·68%	45·30 ,,
3·27%	33·39 ,,

As is evident from the above table gels varying in water content between 7% and 4·5% gave practically identical adsorption. Below 4% water, the adsorption falls rapidly. Though in most cases a variation in the water content within certain limits is permissible, the adsorption of ammonia is an exception. Patrick and Davidheiser[27] found that the adsorption of ammonia by silica gel is considerably affected by even a small quantity of water.

STRUCTURE OF THE GEL

Silica gel has a characteristic structure. The various theories regarding the structure of silicic acid gels have been discussed by Hurd[28]. Butschli[29] first examined silicic acid gels under the microscope. He observed a honey-combed structure, the dimensions of the cavities being of the order of 1-1·5μ diameters. The earlier observations, however, were not confirmed by Zsigmondy[30]. According to Zsigmondy the structure does not consist of isolated cavities, but is composed of a network of interconnected channels of ultra-microscopic dimensions, and thus of much smaller size than 1μ. This view of the granular fine structure of silica gel is supported more or less by the ultra-microscopic studies of Bachmann[31]. The capillary structure is the basis of the theory of adsorption advanced by Patrick and McGavack[32]. The morphological conditions of the gel have been investigated by several authors. The X-ray investigations of Kyropoulos[33] by the Debye-Scheerer method have shown that the gel has an amorphous structure[34]. By a different process Braesco[35] arrived at a similar conclusion. He determined the coefficient of expansion of amorphous and crystalline silica and compared the values with that obtained with a sample prepared by heating silica gel. The results agreed with the conclusions of Kyropoulos. On ageing or on heating beyond a certain temperature the amorphous gel gradually transforms into the crystalline cristobalite form[36]. The inter-relationship between the adsorptive capacity of a gel, its water content and its morphological condition has been investigated by several authors. Briggs[37] considers that the adsorptive capacity

[23] Mautner, *Kolloid. Zeit.* 42, 273, 1927.
[24] Patrick. *Jour. Amer. Chem., Soc.*, 42, 946, 1920.
[25] Patrick and Long, *Jour. Phys. Chem.*, 29, 336, 1925.
[26] Ray, *Jour. Phys. Chem.*, 29, 74, 1925.

[27] Patrick and Davidheiser, *Jour. Amer. Chem. Soc.*, 44, 1, 1922.
[28] Hurd., *Chem. Rev.*, 22, 403, 1938.
[29] Butschli, Colloid and Capillary Chem. Freundlich., pp. 660.
[30] Zsigmondy, *Zeit. anorg. Chem.*, 71, 356, 1911.
[31] Bachmann. *Zeit. anorg. Chem.*, 73, 125, 1911; *ibid*, 79, 202, 1912.
[32] Patrick and McGavack, *loc. cit.* (ref. 24).
[33] Kyropoulos., *Zeit. anorg. Chem.*, 99, 197, 1917.
[34] *cf.* Dubrovo. *Compt. rend. Acad. Sci. U. S. S. R.*, 23, 50, 1939.
[35] Braesco *Compt. rend.*, 168, 343, 1919.
[36] Krejci and Ott., *Jour. Phys. Chem.*, 35, 2061, 1931.
[37] Briggs, *Proc. Roy. Soc.*, 100 *A*, 88, 1921.

depends on the degree of porosity on the microscopic and ultra-microscopic scale as also on the porosity of the gel on the molar scale. The relationship between the various factors bearing on adsorption is clearly illustrated by the adsorption of acetic acid investigated by Jones[38]. His values are given in the following table:—

Temperature.	Water Content.	Adsorption Gm/1 gm. gel.	Physical condition of gel.
200	6·2%	0·168	porous & amorphous
375	3·4%	0·168	porous & amorphous
680	1·0%	0·10	pores coalesce.

ADSORPTION OF WATER

The most important property of the silica gel is its capacity for adsorbing large quantities of water. Silica gel has a large preferential adsorption for water. Chaney, Ray and St. John[39] have demonstrated this preferential adsorption by shaking up a mixture of water and benzene with active carbon and silica gel respectively. The carbon adsorbs the benzene and if enough benzene be present to saturate the carbon, water may be completely rejected. Silica gel, on the other hand, will take up water and reject the benzene. The adsorption of water by silica gel was first measured by van Bemmelen[40]. More reliable measurement was carried out a few years later by Anderson. Both these experimenters used a sample of gel which was quite different from Patrick's gel. Patrick and Opdycke[41] measured the adsorption of water vapour by using a dynamic method in which the gel was in contact with air. As the presence of air retards the equilibrium process, Ray and Ganguly[42] determined the adsorption by direct weighing in vacuum. The large adsorption of water vapour is clearly demonstrated from the data based on their determination of the adsorption isotherm at 32°C. with a sample of gel containing 5·04% water.

From measurements of heats of adsorption the same authors have further shown that when silica gel is saturated with water it takes up approximately 37·5% of its weight of water by adsorption. It is interesting to note that this amount is in exact stoichiometric relation of two molecules of water

Pressure of water vapour.	Adsorption (Gms. Water/100 gms. gel.)
4·58	7·71
10·18	14·26
14·81	19·04
19·23	23·28
22·38	26·15
26·74	29·98

per mole of SiO_2. This capacity of the gel to adsorb about a third of its weight of water vapour at saturation forms the basis of a number of important technical applications.

RELATIVE ADSORBILITY OF SILICA GEL AND ACTIVE CARBON

The use of active carbon as an adsorbent is a well-established industrial process. Within the last decade, however, side by side with active carbon silica gel has found ever-increasing application as an adsorbent[43]. The efficiencies of silica gel vis-a-vis active carbon have been discussed by Rex Furness and Chaney[44]. Active carbon generally has the higher adsorptive capacity. Hoffer[45] compared the efficiencies of activated carbon and silica gel with regard to benzol adsorption and found that active carbon adsorbs about 1·9 times as much as silica. In the decolourisation of coloured kerosene active carbon is claimed to be four times as effective as silica gel. Nevertheless for some processes silica gel is preferred to carbon. Silica gel has the advantage that being hard granules, it is less easily disintegrated and consequently is more conveniently manipulated in industrial processes. Its chief advantage, however, lies in the fact that it is easily re-activated by heating. Because of its easy regeneration silica gel functions well as a circulating adsorbent and is often preferred to a static mass even of a somewhat higher adsorptive capacity. In actual process silica adsorbers are built in duplicate, so that while one unit is acting as an adsorbent, the other is undergoing re-activation, a continuous

[38] Jones, *Jour. Phys. Chem.*, 29, 326, 1925.

[39] Chaney, Ray and St. John, *Ind. Eng. Chem.*, 15, 1244, 1923.
[40] van Bemmelen, *Zeit. anorg. Chem.*, 13, 233, 1897; *ibid*, 14, 98, 1898.
[41] Patrick and Opdycke, *Jour. Phys. Chem.* 29, 601, 1925.
[42] Ray and Ganguly, *Trans. Faraday. Soc.*, 30 (II), 997, 1934.

[43] Patrick, Br. Pat. 159,508, E. C. Williams, *Jour. Soc. Chem. Ind.* 43, 97T, 1924.
[44] Rex Furness, *Jour. Soc. Chem. Ind.* 42, 850, 1923; *ibid*, 1164; N. K. Chaney, *Jour. Soc. Chem. Ind.* 42, 1141, 1923.
[45] Hoffert. *Jour. Soc. Chem. Ind.*, 44, 357T, 1925.

process being thereby maintained. For certain processes sulphur compounds which act as poisons on active carbon have no such effect on silica gel.

INDUSTRIAL USES OF SILICA GEL BASED ON ITS ADSORBING CAPACITY

Silica gel has great selectivity for water. Because of its high water adsorption the gel is used for drying air required in blast furnaces, in air conditioning plants, in the dehydration of industrial gases and in several other processes where removal of moisture is required.

The dehydration of air used in blast furnace is of great importance as the use of a properly dried blast brings about a great saving in fuel. A silica gel plant has been used for the purpose at the Wishow works of the Glasgow Iron and Steel Company[46]. About 35000 c.ft. of air intended for blast furnace are treated per minute. The silica gel dehydration produced an average saving of about 6% in the fuel consumption. Silica gel finds an important use in modern air conditioning plants. The chief factor in air conditioning processes is the moisture content of the air. By passing the current of air through adsorbers containing silica gel the humidity can be controlled and brought to any desired value. The use of silica gel in air conditioning and its advantages over other methods of dehumidification has been considered by Patterson.[47] The cost of maintenance of the silica gel equipment is comparatively low. Silica gel is now extensively used for drying compressed air and gases in leather industry, in cork and capsule manufacturing processes, in the manufacture of cables and other electrical goods and in the control of pharmaceutical operations.[48] The silica gel plant for the dehydration of natural gases at Mene, Grande Field, Venezeula is described by H. de Raay.[49] The cost of dehydration based on the price of the gel is computed as 0·34 dollar per million cubic feet of gas. An interesting use of silica gel is cited by the Silica Gel Corporation. In attempts to raise a submarine difficulties were experienced in getting air to the divers owing to the choking of air holes by the freezing of moisture from the air. The difficulty was removed by the Silica Gel Corporation[50] by means of suitably designed silica gel dehydrating units.

INDUSTRIAL USES OF SILICA GEL BASED ON ITS CAPACITY OF ADSORBING GASES AND VAPOURS

Silica gel is a powerful adsorbent not only for moisture but for many gases and vapours. It can easily remove sulphur compounds[51] which act as poisons to other adsorbents. Because of these properties the gel finds use in refrigeration plants, in oil refining and in solvent recovery processes. Commercial refrigeration is now extensively used for cold storage of food and other materials. Silica gel functions in refrigeration plants as it can adsorb large quantities of vapours of SO_2, NH_3, etc., which in the liquid form are commonly used as refrigerant, and can again evolve the gases on rise of temperature. Compared to iced refrigeration silica gel units are more compact, economical and are effective over longer periods of time. The adsorption of SO_2 and NH_3 by silica gel and its use in refrigeration has been discussed by Briggs.

The use of silica gel in refining petrol, kerosene and coke oven products has been of vital importance to the petroleum industry. The presence of more than 0·4 % of sulphur compounds or of more than 0·1 % elemental sulphur is detrimental as it leads to corrosion of different parts of automobile engines.[52,53] Silica gel removes these objectionable sulphur compounds[54] very effectively. The Medway Oil and Refining Company started the first silica gel plant for oil refining.[55] The results were very satisfactory and silica gel refining of oil became an established industrial process. In the purification of cracked gasolene and of light crude oil the sulphur removal problem is not so urgent. In these oils the removal of unsaturated hydrocarbons which soon resinify and form into gums, is much more important. Again silica gel has proved itself efficient in removing the gum-forming constituents and silica gel processes are extensively used for the refining of cracked gasolene and crude oil.

The recovery of benzol and other condensable vapours by adsorption on silica gel has been extensively studied by Williams. Silica gel has marked adsorption for the vapours of the commonly used solvents like benzene, alcohol, ether, ethyl acetate, acetone etc. During the manufacture of artificial silk, rubber goods, leather and many other substances large amounts of solvents have to be removed by

[46] Annual Report, *Soc. Chem. Ind.* 12, 21, 1927.
[47] Patterson, *Jour. Soc. Motion. Picture Engineers*, 27, 545, 1936.
[48] Robinson, *Commonwealth Eng.*, 23, 383, 1936.
[49] H. de. Raay, *Petroleum Eng.*, 10, No. 12, 45, 48, 1939.
[50] 'The Story of the Silica Gel.', p. 9 (Published by Silica Gel Corp.).

[51] Meyer, *Brennstoffchemie.*, 4, 358, 1923.
[52] Egloff and Lowry, *Amer. Chem. Soc. Convention at Chicago*, 1928.
[53] Diggs, *Ind. Eng. Chem.*, 20, 16, 1928.
[54] Waterman and Perquin, *Chem. Weekblad*, 22, 389, 1925
[55] Annual Report of Society of Chemical Industry, 9, 9 1924.

evaporation. The vapours of these solvents are very effectively recovered by adsorption by suitable silica gel plants. The efficiency of the gel used for the recovery of benzene and other vapours remains practically unimpaired on revivification.[56] Some authors consider that a carbon silica mixture containing 10 % carbon acts as a better adsorbent.[57]

MISCELLANEOUS USES OF SILICA GEL

The adsorption of nitrogen peroxide by silica gel has been investigated by Ray,[58] who showed that the gel can adsorb about 60 % of its own weight of nitrogen peroxide at ordinary temperatures. Several industrial applications have been suggested which are based on the capacity of the gel to adsorb nitrogen oxide. A process has been patented[59] in which nitrous gases are treated in a tower with air in presence of silica gel and are recovered as nitric acid of 80 to 90 % concentration by subsequently heating the saturated adsorbent. Krase[60] has recommended silica gel for separating oxides of nitrogen from other ammonia oxidation gases. A silica gel suspension for treating animal and artificial fibres is made by adding a sulfonated oil to a weak solution of sodium silicate and then adding a neutralised protein, paraffin wax, etc.[61] Fire proofing compositions are improved by adding the gel to known proofing materials. The use of silica gel as an ingredient for rubber mixtures,[62] as a base for pomades and certain pharmaceutical preparations[63] and as the starting material for a product suitable for use in microphones[64] have all been tried. In the manufacture of gas masks silica gels are not so efficient as active carbon.

USE OF SILICA GEL AS A CATALYST AND AS A SUPPORT FOR CATALYSTS

A characteristic property of the silica gel is the vast surface it possesses. Because of this property, silica gel acts as a catalyst sometimes alone but more often as a base on which a metal or a metallic oxide catalyst is deposited. Patrick[65] impregnated silica gel with oxides of tin, aluminium, tungsten, titanium, etc., and showed that such a gel could be used as a catalyst for various manufacturing processes. Used singly, silica gel was tried as a catalyst in the alkylation of aniline[66] by means of alcohols in the vapour phase, but a number of undesirable by-products resulted. Its use as a catalyst in the preparation of nitriles has also been investigated by Mitchell and Reid.[67] As a catalyst silica gel by itself is not very efficient. Silica gel is extensively used as a catalyst carrier in the oxidation of sulphur dioxide-air mixtures for the manufacture of sulphuric acid. A porous sample of the gel is sprayed with a solution of platinic chloride or potassium vanadate and a suitable reducing agent. On heating to a temperature of 250°C. metallic platinum or vanadium pentoxide is deposited in the gel, and the mass then acts as a powerful catalyst.[68] Silica gel is also an excellent carrier for palladium.[69] An advantage of great importance attaching to the catalysts deposited on silica gel is that they are unaffected by poisons.[70] The economy in the amount of platinum in platinum-silica gel catalysts is also very considerable. Besides the noble metals, silica gel is used as a carrier for many other metals and metallic oxides in catalytic processes. Nickel deposited on silica gel is efficient in hydrogenation processes. A high pressure hydrogenation of pyridine bases with nickel-silica gel catalyst has been investigated by Ushakov and Bronevskil.[71] Chromium, zinc and vanadium salts deposited on silica gel act as excellent catalysts for the oxidation of NO to NO_2. The rate of oxidation has been found to be about 600 volumes of the mixture per unit volume of the catalyst.[72] Impregnating with iron or aluminium or any oxide of that group, silica gel can act as a catalyst for many condensation reactions.[73] The polymerisation of gaseous olefines to give products of a higher boiling point suitable for use as motor fuels, has been investigated by various authors. For this purpose, silica gel impregnated with suitable proportions of zinc oxide or cadmium oxide and a compound of the metals of the third group of the periodic table, is used as the catalyst.[74] Another direction in which

[56] *cf.* Faber, Olson and Taylor, *Chem. Met. Eng.* 28, 805, 1923.
[57] Fells and Firth, *Jour. Soc. Chem. Ind.*, 46, 374, 1927; Palkin and Kolesnikov, *Jour. Applied Chem., U. S. S. R.*, 10, 1879, 1937.
[58] Ray, *loc. cit.* (ref. 26).
[59] Br. Pat. 211,845 (1925).
[60] Krase, *Chem. Met. Eng.*, 33, 674, 1926.
[61] Eugene. V. Hayes. Gratze. Br. Pat. 470,699 (1937).
[62] Kostritskaya, *Jour. Rubber. Ind. U. S. S. R.*, 11, 1165, 1936.
[63] Peronnet and Genet., *Jour. Pharm. Chem.*, 26, 490, 1937.
[64] Bell Telephone Laboratories, Inc. U. S. A., Pat. 2,151,083 (1939).

[65] Patrick, Br. Pat. 212,034 (1925); Silica Gel. Corpn. Br. Pat., 212065.
[66] Brown and Reid, *Jour. Amer. Chem. Soc.*, 46, 1836, 1924.
[67] Mitchell and Reid, *Jour. Amer. Chem. Soc.*, 53, 321, 1931.
[68] J. Malan and G. H. Malan (K. Explosive Works Ltd.), Br. Pat. 439,237 (1936).
[69] Br. Pat. 448,125 (1936).
[70] Amer. Platinum Works, Fr. Pat., 803,746 (1936).
[71] Ushakov and Bronevskil, *Jour. Gen. Chem.*, 7, 750, 1937.
[72] Kurin and Blokh, *Jour. Applied Chem., U. S. S. R.*, 11, 734, 1938.
[73] Firth and Smith, *J. C. S.*, 337, 1936.
[74] U. S. A. Pat. 2,129,649 (1938); 2,129,732 (1938).

gel-bound catalysts have been used with success is in gas analysis. Platinised silica gel gives quantitative oxidation of hydrogen and hydrocarbons.[75]

In this short article are given a few typical examples which serve to illustrate the varied uses of silica gel. Inquiry into almost any aspect of the nature of things is of absorbing interest if it is studied long enough to realize how little is known—how much there is still to learn. Silica gel is no exception to this general rule. Its theoretical problems as well as its practical applications are more numerous than what appears at the first sight. Though its use has been established now in a large number of industries, a satisfactory understanding of its structure and properties has yet to be achieved. There is no doubt that an adequate picture of its inner mechanism would be of more than passing interest. The variety and range of researches on silica gel depend partly upon the inherent structure of the material and partly upon the diversity of industrial processes in which its special characteristics have found use. One evidence of the special interest of its properties is to be found in the increasing number of publications on the subject. A quarter of a century ago all the important work did not consist of more than one hundred papers, but today much more than this number are published every year. In spite of this enormous amount of work, silica gel is receiving application in ever widening spheres, and its possibilities are still far from being exhausted. It is indeed a pity that it has not attracted much attention in our country. India abounds in vast deposits of silicate minerals from which the gel may be cheaply manufactured, and there is ample scope for its use in many Indian industries.

[75] Kobe and Barnet, *Ind. Eng. Chem.*, Annual Edn., *10*, 139, 1938.

PAPER AT WAR FRONT

To stimulate the collecting and salvaging of waste paper the British Waste Paper Recovery Association is offering £20,000 prize money to be distributed among 20 areas into which the country has been divided, £1,000 being allocated to each area. This will be divided among the local authorities in each area (city, town, urban or rural) which, between January 1 and 31 inclusive, collects most by weight of waste paper and cardboard per head of the population.

It will be easy to appreciate the above news when we know to what purposes the waste paper is put. The following notes gleaned from some of the inspiring advertisement 'effects', which have caught our attention, are interesting in this connection.

"The paper which you now hold in your hands, and every other scrap of paper that can be collected, is wanted urgently to make munitions-cartridge and shell cases, machine gun belts, radio components and many other essentials."

"One ton of paper will make 1,500 shell containers, 9,000 shell fuse components, 11,000 mine assemblies, 71,000 dust covers for aero-engines, 36,000 cut-out targets, 3,000 boxes of aero-cannon shells."

"In the trough of heavy seas six sailors in their lifeboat patiently wait for rescue. They are but a microscopic dot of the seascape, but they have a smoke-flare that can be seen for miles. Part of those smoke-flares was made from waste paper."

"Across the Libyan Desert a British ambulance comes into view. It contains two badly-hurt airmen who had to crash their plane. The sun is blazing fiercely overhead and those boys are indeed thankful for the protection of the ambulance roof. Waste paper helped to make that roof."

"Holding back the Nazi hordes before Moscow and other Russian towns are stout Russian soldiers in stout boots. Believe it or not, those boots came from England, and inside everyone was a "stiffener" made from waste paper."

During sixteen months ending in January last Great Britain saved waste paper valued at R7,000,000 and great enough in volume to fill forty cargo ships, which were thus released for the carriage of other materials.

MEDICINE & PUBLIC HEALTH

JAPANESE PHOSPHORUS BOMBS

So far as is known, the Japanese are using 250 kg. high explosive, 60 kg. incendiary and 40 lb. anti-personnel bombs against the civil population in the air raids. They are using two types of incendiary bombs, one filled with paraffin wax and the other filled with phosphorus pellets. The phosphorus type weighs about 1½ maunds and consists of a filling of a large number of pellets made of rubber or other suitable material of the size of a pigeon's egg, impregnated with phosphorus. On striking the ground, the pellets are scattered widespread, some going as far as 50 yards from the point of explosion. On explosion, the incendiary pellets ignite immediately or within a minute or two, each pellet giving a flame of 4″ to 6″ height and burning at a comparatively low temperature. The pellets burn for 5-7 minutes, giving off a grey smoke smelling slightly of burning rubber.

Phosphorus is recognisable by the dense white smoke produced and by the garlic smell. The pellets should not be touched by hand. An easy method to extinguish them is to spread wet gunny bags over the fire and then sweep up the wet gunnies into a barrel filled with water, which may then be emptied out into a pit. Any burning clothing should be immediately immersed in cold water. Any foodstuff or liquid contaminated should be thrown away.

TREATMENT OF PHOSPHORUS BURNS, POISONING AND WOUNDS

THE following note on the treatment of phosphorus burns, poisoning and wounds, collected from various sources and issued by the Safety First Association of India (*Safety News*, March, 1942, p. 103), is given below for the information of our readers:—

Burns and Scalds from Phosphorus: General Instructions: If clothing adheres to the burned surface, do not attempt to remove it, but cut clothing carefully around the burned area.

A slight burn may be dressed with sterile gauze covered with butesin picrate ointment, boric ointment, sterile vaseline (petrolatum) or 5% tannic acid. Bandage securely but not tightly.

A more severe burn should be dressed with sterile gauze covered with butesin picrate, boric ointment or sterile vaseline (petrolatum). The physician can then redress the burn after determining its degree and extent. Do not open blisters without instructions from a physician.

Wash immediately with large quantities of water, then with a 5% solution of sodium bicarbonate. Burns should be treated with 1% copper sulphate solution. Dress with butesin picrate ointment, boric ointment or sterile vaseline as directed above.

(Butesin picrate is a product of Abbot Laboratories, U. S. A. Boric ointment or sterile vaseline are standard preparations available in the market.)

Phosphorus Poison (swallowed):

1. Induce vomiting by administering the universal antidote:—2 parts pulverised charcoal, 1 part magnesium oxide, 1 part tannic acid. Dose:—One heaping teaspoonful in a small glass of water.
2. Administer 2 grams copper sulphate in 100 c.c. water.
3. Administer large quantities of water and 5 to 10 c.c. of oxidised turpentine (turpentine which has had long exposure to air). Do not give milk or white of egg.
4. Administer 15 gms. of magnesium sulphate in 100 c.c. water.

Wounds:—Wounds caused by yellow phosphorus must be given immediate treatment. When a particle of phosphorus comes into contact with the skin, it gives cause to a very severe wound and unless the wound is treated immediately, yellow phosphorus may get into the blood stream. The fatal dose is

only 0·1 gram when taken internally, but if the phosphorus enters the blood stream, a much smaller dose may be fatal.

Phosphorus wounds should be treated with an oxidising agent such as permanganate of potash or hydrogen peroxide.

If the wound is not a deep one and if immediate treatment can be given, a strong liquid of permanganate of potash should be used, the wound being repeatedly washed.

In case of deeper wounds or delayed treatment, it is recommended that a 33% strong hydrogen peroxide solution be used. Only after a complete removal of all the yellow phosphorus, and a thorough cleaning up of the wound, can the usual treatment for burns be given.

AVIATION AND SPREAD OF INFECTION

THE rapid progress in the field of aviation has not only increased the risk of wounds and death by violence among the civil population but also the risk of importation of infectious diseases and diseases transmitted by mosquitoes and other insects. Yellow fever, which is transmitted by a species of mosquito, is a case in point. The incubation period of the disease is only 2-6 days and the infected individual remains infective to mosquitoes for 4-7 days. Steps have now been taken not only to disinfect aeroplanes by spraying with a watery solution of pyrethrum but also by immunizing persons against the infection.

Apart from this, aviation has been found to be a useful means of reaching medical aid promptly to injured or diseased persons in outlying areas.

A lot of research work is also being conducted with regard to the effect of aviation on the human organism. We wish workers in India had taken up the subject for research, now that an Indian Air Force is developing.

QUININE AND THE PRESENT WAR

THE *British Medical Journal* of the 31st January, 1942 has deservedly drawn attention to the seriousness of quinine shortage owing to the occupation of Java by the enemies. The war has shown how international industrial groups discouraged the production of quinine in India and other countries to the detriment of malaria prevention. In the past, malaria had caused more deaths than war injuries in several campaigns in tropical and subtropical regions and had seriously interfered with the efficiency of the fighting units.

The cultivation of cinchona trees need certain climatic coditions. The present cinchona plantations in India do not supply even a fraction of our quinine requirements. India has adequate suitable soil for the cultivation of cinchona. Even if the plantations are extended now, it will take several years for the slow growing plants to yield the required quantity of quinine. Can we think of any tentative arrangements for the protection of the population from malaria during the intervening period?

One possibility is to find out synthetic antimalarial drugs, like atebrin and some of the sulphonamide derivatives. Some American workers (Coggeshall, L. T., Maier, J., and Best, C. A., *Jour. Amer. Med. Assocn.*, *117*, 1077, 1941) have found that sodium $p.p^1$-diaminodiphenyl-sulphone-N, N_1-didextrose sulphonate (promin) have a curative effect on patients infected with either benign or tertian malaria. Sulphadiazine has also been seen to produce a demonstrable effect. It must be remembered that the synthetic drugs are more toxic than cinchona alkaloids.

Whether these synthetic drugs will be as cheap as quinine, it is not known. Totaquina, which consists of 15% quinine and 70% crystallizable alkaloids, obtained either from *Cinchona succirubra, Cinchona robusta* or *Cinchona ledgeriana,* might be given a trial, or small quantities of quinine may be combined with some of the synthetic derivatives, thus conserving the stock of cinchona derivatives which may be made available until the plantations reach maturity. It must be remembered, however, that quinine is not a true causal prophylactic and that it does not prevent infection but that it undoubtedly reduces the number of clinical attacks in a given period and that it has the advantage of extremely low toxicity. It has been suggested that efforts might also be made to recover the alkaloids from the urine of persons taking quinine by the mouth.

We suggest that when cinchona plantations are developing, attempts should be made at university centres to manufacture suitable synthetic drugs of low toxicity.

Soya Bean in Infant Feeding

[*From the Section of Physiological Hygiene*
All-India Institute of Hygiene and Public Health, Calcutta.]

METABOLISM OF INFANTS

The metabolism of an infant rapidly increases in the first eighteen months after which it steadily drops down during the rest of its life. The infant is further characterised by its great anabolic activity remaining in positive nitrogen balance. These facts indicate strikingly the greater importance of nutrition in the infant, than in an adult. Nature has however provided a single food for the infant ideally suited for its purposes. The human breast milk if available in sufficient quantities to infants, the problem of its nutrition is completely solved. If however this food is deficient in amount or absent, the devising of substitutes is so difficult a problem that "in many countries of the world the alternative to breast feeding is usually the early demise of the infant".

INDIAN CONDITIONS

During an investigation into the milk yields of South Indian women it was noticed that all the twenty individuals examined were producing such small quantities as to be very inadequate to the daily requirements of an infant. This might perhaps partially explain the high infant mortality rates in India and one of the methods of reducing this should be to provide suitable substitutes to breast milk.

The rapid advances in pediatrics during the present century has succeeded in making use of cow's milk suitably modified in rearing up satisfactorily infants even in the complete absence of breast milk. This achievement however has very little significance to India where the total milk production (Wright 1937) is so small as to preclude our dependence on this source for the infants. The situation is about the same in other Asiatic countries as China as well as in large tracts of Africa. Thanks to the lead given by our present Viceroy, we hope to see a future with the milk problem solved. In the interim period it is necessary to explore other possible sources of infant food.

Soya bean milk is one such though it is by no means a new thing. For centuries it has been used extensively in China and Japan where milk and its products are so scarce and expensive that their use is limited. The use of soya bean milk could not have lasted that long if it had not been found to be satisfactory by generations of the Chinese and the Japanese. Their experience is of practical value for India with similar economic standards and a similar situation with regard to availability of milk and milk products. Based on this line of argument the writer of this note made certain investigations on the value of soya bean milk on Indian infants over five years ago. The success of the experiment, though not comparable with that of whole milk, showed the practical value of the exceedingly cheap soya bean milk for Indian conditions.

CLINICAL EXPERIENCE WITH SOYA BEAN MILK

Careful observations on the value of soya bean milk for infants are available from about the beginning of this century. Ruhrah (1909) administered the milk therapeutically to infants in cases of diarrhoea and digestive disturbances, marasmic infants, and for subnormal children with satisfactory results. Sinclair (1916) reported that out of 74 cases of diarrhoea 44 did well on feeds of soya bean milk. Tso (1928) and his colleagues made several clinical reports on the use of soya bean milk prepared according to age-long Chinese methods. On the basis of considerable metabolic studies they made several additions such as sugar, calcium lactate, sodium chloride, cod liver oil and cabbage soup to improve its nutritive value. Such milks became very popular among public health workers in and around Peking. Hill and Stewert (1929) utilized the pressed cake (residue after extraction of oil) to make a milk with supplements of barley flour, olive oil, sodium chloride, and calcium carbonate, and demonstrated that about forty infants thrived well on this. Rittinger and his associates Dembo and Torrey in a series of reports from 1932 gave the results of feeding hundreds of infants with very satisfactory results authenticated by X-ray

pictures, biochemical investigations and blood counts. They however ensured sufficiency of minerals and vitamins by appropriate additions to the milk. Reid (1935) with a view to improving the preparation with "first class protein" added egg yolk. He even spray-dried the milk to a powder and it is theoretically superior to simple soya bean milk. The cost of this however is near about that of cow's milk and as such is of little practical value and constitutes only a laboratory preparation which has not been adapted by pediatricians.

Lanzing and Van Veen (1937) produced a very cheap preparation with additions of sugar, cocoanut oil, salt and boiled papaya juice. The composition and vitamin content are said to correspond approximately to cow's milk. They found that by stages infants could be made to tolerate this preparation well. Horvath (1938) mentions that the famous opulently cared for and vigorously fed Dionne quintuplets were given a soya bean acidophilus milk. Guy and Yeh (1938) continued the investigations of soya bean milk already being used by the Pieping Health Station and out of an urgent need to supply some of their infants an artificial food cheaper than cow's milk. They, like others, made appropriate additions and standardised the methods of preparation.

The most recent report is that of the eminent pediatrician Helen Mackay (1940), a member of the staff of Medical Research Council, England. Her investigations on soya bean milk extended from 1935 to 1938 and were contrasted with two control groups. The results were entirely satisfactory and the paper is entitled very appropriately "A cheap and efficient substitute for breast milk". The preparation she employed was a proprietary preparation called Yolac which is a mixture of equal parts of full cream dried milk and soya flour. The present writer's experience also from 1935-1938 was on groups of unselected infants attending a child welfare centre. For theoretical considerations to be mentioned later, a new preparation of soya bean and groundnut was used and was exceedingly palatable and well tolerated by even tender infants. The gain in weight on this preparation was of course inferior to a control group on cow's milk but then we are here contrasting two preparations one of which is about ten times costlier than the other.

METHODS OF MAKING SOYA BEAN MILK

Raw bean flour:—Ordinary finely ground flour of raw soya beans or pressed cake (residue after extraction of oil) can be stirred up with about 8 times their weight of water and boiled to give a fairly stable suspension resembling milk. The taste of this however is slightly bitter and not very pleasant.

"Wet Grinding":—A slight variation of this is what is known as "wet grinding". The beans are soaked overnight and in the morning ground in a stone mill to give a creamy paste diluted to appropriate consistency and filtered. The milk is boiled before use.

Roasted bean flour:—The bitter taste is more or less completely removed if the beans are roasted before being ground into flour.

Steam Processed Flour:—In America by a process known as Berczeller process a commercial flour called "Soyolk" is available with a high fat content and keeping qualities devoid of the unpleasant strong taste of the bean. The details of the process are: the clean beans are subjected to the action of steam for 10 to 15 minutes, dried and cracked to remove the husks along with the germs. The flour made out of this is further subjected to steam which removes certain volatile material responsible for the bitter taste. The flour is a fine cream coloured powder with very little taste and is easily made into a milk with boiling water.

Soya bean flour with dried milk:—Helen Mackay's prescription called "Yolac" is just this Soyolk with equal quantity of full cream dried milk powder. These preparations are exceedingly handy and a milk feed is easily prepared by stirring with hot water.

Ground soya bean milk:—The groundnut soya bean milk preparation was based on the consideration of the fact that a milk constituted of soya bean alone showed a lower value of fat content than cow's or human milk. The cheap groundnut is richer in fat than soya bean. Further the roasted groundnut is exceedingly pleasant to the taste and nutty in flavour and needs no persuasion for Indians to use it. Two parts of soya bean and one part groundnut are roasted over a hot pan till they assume a light golden yellow hue and give a fine aroma. They are then soaked in water for about half an hour, the outer skin of the soya bean and the red skin of groundnut rubbed off and finally the beans are ground to a fine paste in an ordinary grinding stone commonly found in most Indian houses. The mash is then taken up in a churner or any suitable vessel and churned with about six to seven times the original weight of the grains taken. The product is then strained through a cloth with gentle squeezing. The milk after boiling is ready for consumption. A pinch of salt or sugar might be added according to taste.

TABLE SHOWING COMPOSITION IN PERCENTAGE OF VARIOUS KINDS OF MILK

Constituents	Human milk	Cow's milk	"Wet ground" Soya bean milk	Guy & Yeh's roast Soya bean milk with additions	Lanzing & Van Veen's Soya milk with additions	Helen Mackay's 'Yolac'	Groundnut Soya bean milk
Protein	2·0	3·4	3·7	4·2	3·5	4·0	3·5
Fat	3·7	3·7	1·7	1·4	2·3	3·2	3·2
Carbohydrates	6·4	4·9	1·4	10·2	6·0	3·4	3·4
Ash	0·3	0·7	...	...	0·5	0·6	0·2
Calcium	0·40	0·12	0·02	0·08	0·13	0·06	0·05
Phosphorus	0·10	0·09	0·04	0·06	...	0·05	0·09
Iron mgm.	0·2	0·08	...	...	...	9·7	2·4
Vit. in Gama	62·00	55·00	...	...	17·00	...	...
Vit. B, in Gama ...	...	70	...	...	60·00	...	...
Vit. C mgm.	5·0	2·0	...	...	2·5	...	...
Calories	69·00	69·00	37	72	60·00	58·00	58·00

COMPOSITION OF SOYA BEAN MILK

The table given presents the figures of analysis of soya bean milks prepared in 5 different ways. For comparison the analysis of cow's and human milk are also given. In preparing soya bean milks attempts are usually made to simulate the cow's milk. However it would be more rational to simulate the human milk.

One of the defects of ordinary soya bean milk is the low content of fat and carbohydrates. It will be noticed that the groundnut soya bean milk has not this defect. The carbohydrate of this modified preparation is however in the form of a polysaccharide starch and as such unsuitable to tender infants who do not produce enough amylase for digestion. Home made malted cereals may in those cases be added and is not likely to increase the cost.

Another defect of soya bean milk is its low mineral content particularly with respect to calcium. In many prescriptions calcium salts are added in appropriate quantities.

There is however one mineral in soya bean milk which is of great nutritional value. Iron is present in nearly ten times that even in human milk. So rich indeed is this element that soya bean milk is said to be a popular remedy for anaemia in China (Adolf and Kao, 1932). Helen Mackay confirmed this by reporting that Yolac was better than even Hemolac, her famous milk preparation containing iron to prevent anaemias in infants.

With regard to vitamins Van Veen *et al* have made the only analysis and they showed that by appropriate additions at no great cost the values for A, B, and C were as much as in fresh milks.

CONCLUSION

The nutrition of an infant is of greater importance to its life than it is to an adult. Nature has provided it with an ideal food for this. However this milk is in many cases not available in sufficient quantity or even completely lacking. Cow's milk with suitable modifications are efficient substitutes but conditions in India at present are not suitable for us to depend on this source. Soya bean milk used for centuries in China offers a practical solution to this problem. Clinical experience reported over forty years from America, China, India and England substantiates this hope.

It may be appropriate to quote from a recent publication of the Food Research Division of the United States Department of Agriculture. "The most expensive food constituents are minerals, vitamins, proteins and fats. Soya bean flour is rich in all these food constituents and yet relatively cheap."

Lastly to quote from Helen Mackay, 1940: "It is hoped that the investigations here described may encourage the large-scale use in infant feeding of a

mixture of milk with this cheap foodstuff in those parts of the world where a sufficiency of milk alone is beyond the means of the people."

"It is suggested that owing to its relative cheapness it merits extended trial in countries where for economic reasons, a satisfactory substitute for breast milk has hitherto been unobtainable."

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GERMANY'S CONQUEST OF INDUSTRIES

From the piecemeal information provided by German interests about the formation of "Francolor" the 200-million-franc combine for the French dyestuffs industry, it is difficult to form a credible picture of what has actually happened. The transaction, however, is of special interest, not only because of the great values involved, but because it is typical of German industrial acquisitions in other European countries. The essential fact is that I. G. Farbenindustrie has acquired a 51 per cent interest in the entire French dyestuffs industry without any payment in cash or material apart from the transfer of an unspecified number of its own shares to the four French firms who had to give up their dyestuffs factories. Kuhlmann, Nord, St. Denis and St. Clair-du-Rhone are not permitted to manufacture dyestuffs in their remaining plant and Francolor will not compete with the German producers in foreign markets, while I. G. Farbenindustrie has generously agreed not to supply France or French colonies with dyestuffs made by Francolor. The German company will also hand over to the new French company processes "the profitability of which in France is assured". The payments made to the French firms which had to hand over their dyestuffs factories have been calculated not on the basis of what the plant is worth, but "from the volume of business under consideration of German-French market differences". As the French dyestuffs makers only handed over their factories and I. G. Farbenindustrie did not pay anything to the firm for its 51 per cent. participation, Francolor has started business by incurring a large debt to pay for the stocks taken over. The above is quoted from the *The Chemical Age*.

In the midst of 'offensives' these deals are being arranged away from the fronts with an eye to the future. The restrictions on British export trade by the department of overseas trade have now become a subject of serious comments by the trade journals and the following comment typifies the present sentiment.

"The start of a foreign office or indeed of any new office demands a great deal of spade work, and it will be found that our enemies are not neglecting this aspect of post-war economy. A resident manager, say, during the next six months might well be in a position to start work very actively by the time the war ends." It has been stressed that work should proceed in close co-operation with local entrepreneurs. A change in British methods of business is being now sought.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

SEPARATION OF LIQUIDS FROM BINARY LIQUID MIXTURES BY THE METHOD OF THERMAL DIFFUSION

In recent times important results have been obtained by Clusius and Dickel[1] and by Korshing and Wirtz[2] on the separation of liquids in (*i*) binary liquid mixtures (*i.e.*, mixtures of two different substances in liquid form miscible in all proportions, *e.g.*, benzene and chlorobenzene), and of isotopes, in (*ii*) liquid isotopic mixtures, *i.e.*, mixtures of two isotopic substances both in the liquid state, by the application of the phenomenon of thermal diffusion. In one of their experiments with acetone-water mixture they found that the proportion of water which has a molecular weight much smaller than that of acetone was increased at the 'heavy' end, *i.e.*, at the bottom of their diffusion column. They explained this by saying that the water in the liquid state is polymerised so that, although the molecular weight of water is less than that of acetone, the weight of the polymeric molecule attains a value greater than that of acetone. The explanation is of an *ad hoc* nature and more experiments are needed to establish Clusius and Dickel's hypothesis. For this purpose a metallic thermal diffusion apparatus was constructed at this laboratory. It consists of two concentric metal tubes, each 1 metre in length and separated from each other by an annular space of width 0·02 cm. The experimental liquid mixture is enclosed in this space. The inner brass tube is heated by hot oil while the outer copper tube is cooled by circulation of cold water in a jacket surrounding it. Experiments on the separation of a few liquid mixtures have been carried out with this apparatus and the results that have been obtained are given in the following table.

Expt. No.	Liquid Mixture	Mol. Wt.	Density	Initial composition	Temp. Diff.	Time of Expt.	Final composition at the 'Heavy' end
1	Benzene (C_6H_6) + Chlorobenzene (C_6H_5Cl)	78 112·5	0·878 1·107	49·3% + 50·7%	50°C	20 hrs.	34·9% + 65·1%
2	*n*-Heptane (C_7H_{16}) + *n*-Butyl Alcohol (C_4H_9OH)	100·1 74·1	0·684 0·808	52·8% + 47·2%	80°C	24 hrs.	30·5% + 69·5%
3	Pyridine (C_5H_5N) + Nitrobenzene ($C_6H_5NO_2$)	79 123	0·982 1·207	51·7% + 48·3%	85°C	24 hrs.	25·9% + 74·1%

It is seen from the table that the concentration of the component in the mixture having larger density invariably increases at the bottom of the column. In the case of the mixture of *n*-butyl alcohol and *n*-heptane, although the molecular weight of the former is smaller than that of the latter, the alcohol with the larger density goes to the 'heavy' end. One

may be tempted to explain this fact in the way as was done by Clusius and Dickel for the acetone-water mixture. But, from the results of investigations on the dielectric constants and molecular polarisations of liquids as carried out by Smyth and Stoops[3], it can be concluded that the almost constant contribution of butyl alcohol in solution in heptane to the total polarisation at a mean temperature of 40°C and over the concentration range of 0·4 and upwards indicates that the butyl alcohol is unassociated. That is to say, the butyl alcohol molecules under such conditions are not polymerised. Moreover, their results on the measurement of the permanent electric moment of butyl alcohol in the same solution agree with the value of this moment for butyl alcohol in the vapour state[4]. One might argue further that the molecules of butyl alcohol in the vapour state are associated ; but this is very unlikely as can be seen from the results of Miles[5] on the measurement of the dielectric constant and electric moment of some alcohol vapours. Here the Debye Law,

$$3\,\frac{(\epsilon-1)}{(\epsilon+2)}\,vT = aT + b$$

connecting the dielectric constant ϵ and temperature T is found to be satisfied for a definite pressure.

So it is concluded that in the mixtures studied in the present investigation, butyl alcohol molecules are single and they have come down the 'heavy' end in spite of their smaller molecular weight compared to that of heptane. This fact probably indicates that it is the *density and not the molecular weight* which determines the increase in concentration of a liquid at the bottom of the column. The results obtained in the case of (*i*) acetone-water and (*ii*) water-heavy water mixtures can also be explained in the same way and there is no need of invoking the phenomenon of polymerisation. To explain the last case, it is not necessary to assume that D_2O is more polymerised than H_2O in the liquid state. Thus it might be concluded that the phenomenon of thermal diffusion in liquids works not on the motion of individual molecules but on that of elements of volume, *i.e.*, large groups of molecules which determine the increase of concentration of any component at a particular end of the separating column.

Investigations of this nature are likely to throw light on the physical nature of the liquid state.

This investigation was undertaken at the suggestion of Prof. M. N. Saha, F.R.S. My grateful thanks are due to him and also to Dr S. C. Sirkar, D.Sc., for many helpful discussions on the problem.

K. C. NIYOGI

Palit Laboratory of Physics,
University College of Science,
Calcutta, 1-4-1942.

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A NOTE ON PARTIALLY BALANCED INCOMPLETE BLOCK DESIGNS

One of us (K. R. Nair), in collaboration with R. C. Bose[1], developed a system of incomplete block designs, for experiments involving v varieties or treatments arranged in randomized blocks of k plots ($v>k$). These designs possessed the following properties :—

"(*i*) Every variety is replicated r times.

(*ii*) With respect to every given variety, the remaining ones fall into groups of $n_1, n_2, \ldots n_m$ each, such that every variety of the i-th group occurs exactly λ_i times, with the given variety, the numbers λ_i and n_i being independent of the variety with which we start. Without loss of generality we will assume $\lambda_i > \lambda_{i+1}$. The numbers $\lambda_1, \lambda_2, \ldots \lambda_m$ are all *unequal* and may include 0, but $n_1, n_2, \ldots n_m$ must all be non-zero and may be equal or unequal. *Two varieties occurring together* λ_i *times, may be called i-th associates.* Each belongs of course to the i-th group with respect to the other.

(*iii*) Given any two varieties which are i-th associates, the number of varieties common to the j-th associates of one, and the k-th associates of the other, is independent of the pair of i-th associates with which we start. This number is denoted by p^i_{jk}. Clearly $p^i_{jk} = p^i_{kj}$."

It can easily be shown that,

$$\left.\begin{array}{l} \sum_1^m n_i = v-1\,; \quad \sum_1^m n_i\lambda_i = r(k-1)\,; \\ \sum_{k=1}^m p^i_{jk} = n_j - 1 \text{ or } n_j \text{ according as } i=j \text{ or } i\neq j \\ \text{and} \quad n_i\,p^i_{jk} = n_j\,p^j_{ik} = n_k\,p^k_{ij}\,. \end{array}\right\} \quad \ldots (1)$$

The object of this note is to point out that, by a change in the definition of the partially balanced designs, Yates' quasi-factorial designs in blocks of p) plots ($k<m-1$) could also be brought under the same category. The change consists in waiving the condition that $\lambda_1, \lambda_2, \ldots \lambda_m$ should all be unequal, so much so there will be more classes of associates than there are different λ's, or, in other words, the various classes of associates cannot all be differentiated by means of the λ_i-criterion.

In designs where the λ_i-criterion fails to describe the various classes of associates, geometrical or other properties of the design could be brought to our aid for differentiating them. Thus the three-dimensional quasi-factorial design for p^3 varieties in blocks of p plots has 3 classes of associates, with

$$\left.\begin{array}{lll} n_1 = 3(p-1), & n_2 = 3(p-1)^2, & n_3 = (p-1)^3 \\ \lambda_1 = 1, & \lambda_2 = 0, & \lambda_3 = 0 \end{array}\right\} \quad (2)$$

The three classes of associates can easily be differentiated in the following manner :—

They found that Yates' quasi-factorial designs for p^m varieties in blocks of p^k plots, when k is $m-1$, and his balanced incomplete block designs, were special cases of the Partially Balanced Designs.

Let the p^3 varieties be each indexed by means of letters and suffixes like $(a_i\ b_i\ c_i)$, each suffix taking values from 1 to p. The first class of associates of $a_i\ b_i\ c_i)$ will be the varieties of the form $(a_i\ b_i\ c_j)$ $(a_i\ b_m\ c_i)$ and $(a_h\ b_i\ c_n)$; the second class will be (varieties of the form $(a_i\ b_m\ c_j)$, $(a_i\ b_i\ c_n)$ and $(a_h b_m c_n$ and the third class will include all varieties of the form $(a_i\ b_m\ c_n)$.

It can be shown that the general class of quasi-factorial designs discussed by us in a previous note[2], and hence also the balanced confounded designs for factorial experiments, belong to the modified system of partially balanced incomplete block designs. Thus a $p\times q$ experiment ($p\neq q$) in blocks of k plots, will be a partially balanced design with *three* associate-classes even if $\lambda_2=\lambda_3$. Similarly for a $p\times q\times s$ experiment in blocks of k plots, and so on.

It is interesting to note that in confounded designs for symmetrical factorial experiments, where only two or more replications are used, resulting in partial but unequal loss of information on different sets of degrees of freedom of the interactions confounded, the conditions of partially balanced designs appear to be fulfilled. For instance, in a 3^3 experiment in blocks of 3 plots preserving main effects, we can have a design with 3 replications, where $n_1=6$, $n_2=8$, $n_3=12$; and $\lambda_1=1$, $\lambda_2=0$, $\lambda_3=0$.

An important point which may therefore be noted is that by this discovery of the general properties of all incomplete block designs, the process of statistical analysis and tests of significance of comparisons between pairs of treatment effects could be based on certain standard sets of formulae, whether the experiments are factorial or not. Detailed working methods for analysis of confounded designs etc., will be given in a paper to be published in *Sankhyā*.

K. RAGHAVAN NAIR
C. RADHAKRISHNA RAO

Statistical Laboratory,
Calcutta, 2-4-1942.

[1] R. C. Bose and K. R. Nair, *Sankhyā*, IV (3), 337, 1939.
[2] K. R. Nair and C. R. Rao, SCIENCE AND CULTURE, 7, 457, 1941-42.

CLEANING OF OIL-PAINTING ON WOOD

In February, 1941, the curator of Asutosh Museum of Indian Art, Calcutta University, gave for cleaning the writer two wooden manuscript-covers supposed to belong to the early nineteenth century. Both sides of each manuscript-cover were as black as ink. The wood, on enquiry, was found to be Sal (*Sorea robusta*). It was collected from the district of Chittagong.

The specimens were treated with potatoes, onions, methylated spirit and spirit turpentine in a particular order. On the first day cut surface of a big potato was rubbed with a circular motion against the outer sides of both the specimens. On the second day the same process was repeated with onion. After the application of both the potato and onion black dusts were removed with dry cotton. On the third day after repetition of the second day's process writing appeared on certain portions and gradually colours were seen. On the fourth day, the same process was repeated and on the outer side of one of the covers Dasavatar scenes became clearly visible, while on the outer side of the other plank the portraits of Jagannath, Balaram, Subhadra, and of others were visible. Then on the fifth day a cotton swab damped in methylated spirit was applied on a part of the outer cover immediately followed by another cotton swab damped in spirit of turpentine. Care was taken so that the time between these two applications did not go beyond one second. This process was continued for ten minutes daily and repeated successively for seven days. After that good result was obtained.

On the inner side of both the specimens the colour that was observed was also black, but on rubbing potato and onion with a circular motion one after another on the same day and on applying methylated spirit later on, yellow colour appeared. There was no painting on this side but on each specimen three lotuses were found engraved in a line.

The dimensions of the specimens are as follows: length—46·1 cm., breadth—12·0 cm. and thickness 1·8 cm.

On the Dasavatar part, it was found after cleaning that the base line is red with the following colours in the figures—yellowish, blue (deep), green (medium).

On the Jagannath, Balaram, Subhadra etc., part—the base line is red and the following tints are found in the figures—yellowish, yellow (deep), blue (deep), green (medium), white (slightly yellowish).

The names of the deities are written in black soot. The engraved lotuses of both the specimens are medium yellow in colour.

After cleaning, a very thin coat of liquid paraffin was applied on each side of the specimens and they have been kept under observation since the 12th August last. The specimens are in good condition till the date of writing.

The writer is grateful to Messrs. T. C. Bagchi and S. C. Bardoloi, senior students of the department of anthropology, Calcutta University for their kind assistance in the laboratory.

MINENDRANATH BASU

Museum Method Laboratory,
Department of Anthropology,
Calcutta University,
Calcutta, 6-3-1942.

ANALYSIS OF EXPERIMENTS BY SPLITTING THE TREATMENT SUM OF SQUARES

In a previous paper[1] it was pointed out how in any experiment the treatments can be grouped together into a number of groups, and the sum of squares for treatments can be split up into those between and within groups. The conclusion as to the significance of the groups is usually drawn on the basis of the residual error. But it is possible that the error for group comparison is different from that for comparison within groups. In such a case it is necessary to split up the residual sum of squares into two portions, one appropriate for the comparison of group differences and the other for comparison within groups. This splitting can be done in all experiments, symmetrical or non-symmetrical, as follows.

Split the whole experiment into as many hypothetical experiments as there are groups, the treatments involved in them being those of the respective groups. The error appropriate for comparing the sum of squares for treatments within groups is the pooled estimate of the residual error for the different hypothetical experiments. The error for comparing the sum of squares for groups is that based on the difference between the residual sum of squares for the whole experiment and the sum of the residual sum of square of the different hypothetical experiments.

P. V. KRISHNA IYER

Imperial Agricultural Research Institute,
New Delhi, 18-3-1942.

[1] *Ind. Jour. Ag. Sc.*, *10*, 686-690.

EARTHEN RINGS FROM BENARES

Certain undecorated earthen rings excavated at Mohenjo-daro have been described by Marshall[1] as "pottery bracelets, which were presumably worn by the poorer classes". In a footnote he says: "It is still uncertain whether the more roughly made specimens are not jar-stands".

Exactly similar undecorated rings of burnt earth, and *made entirely by hand*, are sold in the bazars of Benares, Lucknow, Delhi, Agra and Lahore, where they are used as stands for round-bottomed earthen jars. The rings bought from a potter in Luxa, Benares, are of various sizes ranging from 19·95 cm. to 4·4 cm. in diameter. The thickness varies from 2·3 cm. to 1 cm. All of them are burnt red except the smallest one, which is sent to the market only after being dried in the sun. This last type serves as a stand for round-bottomed earthen lamps commonly used throughout northern India.

The commonest size sold in Benares bazar has a diameter of about 9 or 10 cm.

It is suggested that the earthen rings of Mohenjo-daro were also stands for round-bottomed earthen vessels. Two specimens from Harappa preserved in the University Museum of Anthropology are of the size most commonly sold in Benares; their outer diameters being 9·5 cm. and 7·8 cm.

TARUN CHANDRA BAGCHI

Department of Anthropology,
Calcutta University,
Calcutta, 12-3-1942.

[1] Marshall, 'Mohenjo-daro and the Indus Civilization', Vol. 2, pp. 530-31.

HISTOLOGICAL DISTRIBUTION OF ALKALOIDS IN THE HIMALAYAN *BERBERIS*

The microscopical structures of the tissues of the roots, stems and leaves of most of the known *Berberis*, *B. aristata* DC, *B. insignis* Hook f., *B. lycium* Royle, *B. nepalensis* Spreng., *B. umbellata* Wall., *B. vulgaris* Linn., *B. Wallichiana* DC, and *B. Wallichiana* DC. var. *latifolia*, growing in the Himalayas[1] are studied with a view to understanding the biological significance of the alkaloids present in them. It is observed that in the roots, young and old, main and fibrous, alkaloids are most abundant in a ring of parenchymatous tissues around the vascular bundles and the sclerenchymatous pericycle and the hard bast of the phloem. In the stems, alkaloids are deposited in the medullary rays and in the outermost region of the xylem. In the leaves, the sclerenchymatous hypodermis and the pericycle, the xylem of the vascular bundles in the mid-rib and the veins passing through the mesophyll show the presence of alkaloids. In all cases, the phloem in the roots, the stems and the leaves, is free from alkaloids.

An examination of the distribution of the alkaloids throughout the various tissues reveal the fact that the Himalayan *Berberis* species possess a deep seated phellogen and as such a large cortical area and that the alkaloids occur in the cortical tissues. The alkaloids are also distributed in tissues which are known chiefly to perform mechanical functions, *e.g.*, the sclerenchyma. The alkaloids are stored mainly in dead and other cells which take no part in metabolic activities and so they are not drawn at all in metabolic changes. It has been found that the accumulation of alkaloids takes place in specified tissues from year to year. A biochemical study of the variation and function of alkaloids in *B. nepalensis* and some other Himalayan *Berberis* species has been made with respect to the seasonal variations of the total alkaloid contents, the effect of manuring the plants with different chemical fertilisers and of omission of essential elements thus starving the plants. The results obtained in some cases show a connection between the utilisation of protein in the growth of the plants and the synthesis and storage of alkaloids.

The histological distribution of alkaloids, therefore, leads to the deduction that the alkaloids in the Himalayan *Berberis* are merely stored as waste products, a view put forward by Pictet[2], and held up by several authors like Annett[3], Cromwell[4] and Chaze[5]. In *Berberis*, deposits of alkaloids have been detected in the outermost cells of the bark and in the dead tissues of the plant, where the accumulation of the alkaloids is harmless to its metabolic activities.

A detailed account of this paper will be shortly published elsewhere.

R. CHATTERJEE

St. Joseph's College,
North Point,
Darjeeling, 25-3-1942.

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PHYSICAL ANTHROPOLOGY OF THE BHUIYAS OF MAYURBHANJ*

In November, 1940 the writers examined the blood of thirty-two adult male Bhuiyas of Protappur, a village in Mayurbhanj. All the samples were examined carefully with fresh standard serum. Somatometric measurements, pulse, respiration, temperature and blood pressures were also recorded.

The Bhuiyas are a Hinduised tribe living in Mayurbhanj State. From somatometric and somatoscopic points of view, short, dolichocephalic, mesorrhine, wavy hair and dark-brown complexions are the characteristics of these Bhuiyas.

The percentage of blood groups is shown in table I.

TABLE I

O	A	B	AB
12·5%	31·25%	37·5%	18·75%

The mean values of pulse, respiration, temperature and blood pressures are given in table II.

TABLE II

Pulse	Respiration	Temperature	Blood pressures Systolic	Blood pressures Diastolic
79·5	20·1	97·4	125	86

Details regarding the nature of the compound and its physiological significance, etc., will shortly be published elsewhere. From the results of clinical observation on several human diabetic patients, it can be said definitely that it has a very great influence, by oral administration, in relieving symptoms of glycosuria with restoration of former strength and energy within a fortnight or so (daily dose not exceeding 20 mgs.), which cannot be achieved so easily by insulin or its other active preparations. It has also been found to bring about relief in other ailments accompanied with diabetes (i.e., pyorrhoea, eye troubles, joint pains, susceptibility to cold, etc.) within a very short period.

The name 'anti-diabetin' has provisionally been suggested for this new compound.

Further investigations are in progress.

My best thanks are due to Prof. J. K. Chowdhury and Prof. S. N. Bose for their keen interest in this work.

RABINDRA NATH BASU
MINENDRA NATH BASU

Department of Anthropology,
Calcutta University,
Calcutta, 27-3-1942.

* The data were collected by the writers who accompanied the Under-Graduate Anthropological excursion party, Calcutta University, in November, 1940.

ON A NEW ANTIDIABETIC COMPOUND

It has recently been recorded[1] "that in almost all civilised countries, the incidence of diabetes has been known to rise gradually, but steadily to a fearful degree, and yet no method has been known at least to keep its incidence under control, if not to completely eradicate it". The famous discovery of insulin from islets of Langerhans[2] in the year 1922, has no doubt created a new era in the treatment of this disease, but the result, as is known, is a very temporary one.

It has been possible by the author to find a new chemical compound from some indigenous drug source of India, a deficiency of which type of compound—it is suggested—causes great disturbance in carbohydrate metabolism in the system and brings about in the long run symptoms of hyperglycemia and glycosuria accompanied with other ailments.

Physiological Section,
Chemical Laboratory,
Dacca University,
Dacca, 20-3-1942.

M. C. NATH

[1] Merchant, *The Antiseptic*, 37, 441, 1940.
[2] Banting and Best, *Am. Jour., Physiol*, 59, 479, 1922.

IDENTIFICATION OF FOSSIL WOOD FROM THE LALMAI RANGE IN COMILLA, BENGAL

While working on a fossil wood from the Mainamati Hills, Tipperah, Bengal[1], the author came across the critical remarks by Chowdhury[2,3], on the doubtful identification of the "Fossil wood of the Dipterocarpoxylon type from the Lalmai Range, in Comilla, Bengal" by Sen[4]. Recently the original slides on the basis of which Sen described his specimen were handed over to the writer by Dr M. Chatterjee, professor of geology, Presidency College, Calcutta for re-investigation.

The original slides were prepared as early as 1929 by Prof. B. Sahni. The preservation of the fossil is not satisfactory but the microscopic examination reveals such structures, which are sufficient for the systematic identification of the fossil.

FIG. 1. Transverse section showing secondary growth, distribution of tylosed vessels and parenchyma cells. x40.

From the following anatomical description of the specimen, it will be apparent that the fossil was not correctly identified.

(*i*) Growth Ring—Indistinct to Distinct. (*ii*) Vessels—Medium to large sized, irregularly scattered throughout the wood, usually circular in shape, mostly in groups of 2-4 ; isolated ones fairly large, heavily tylosed. (*iii*) Parenchyma—(*a*) Paratracheal —1 several seriate ; (*b*) Paratracheal-zonate—2-7 seriate (mostly 2-4) ; (*c*) Metatracheal—rare ; (*d*) Diffuse—not observed. (*iv*) Rays—(*a*) Simple—1-3 seriate (mostly 1) ; (*b*) Fusiform—2-4 seriate (mostly 3) with gum ducts surrounded by a layer of epithelial cells. (*v*) Gum Ducts—Horizontal present, vertical not observed.

FIG. 2. Tangential section showing tylosed vessels, uniseriate rays and Fusiform rays with gum duct. x40.

The above description agrees with the general description of the genus *Gluta*, family Anacardiaceae[5]. Chowdhury, while describing his Dipterocarpoxylon garoense[3] discussed at length the importance of the presence of vertical gum ducts in his fossil. In his opinion this is one of the most important diagnostic feature of Dipterocarpacae. Sen's specimen does not show the presence of vertical gum ducts[7] and Tracheids around ducts. His specimen however shows the presence of horizontal gum ducts in fusiform rays. This presence of the horizontal gum ducts coupled with the absence of the vertical ones makes the identification of the fossil easier. According to Chowdhury[2], Brown[6] and Pearson and Brown[5] only three genera of the Anacardiaceae have horizontal gum ducts, one of which is *Gluta*.

FIG. 3. Tangential section showing a Fusiform ray with gum duct. x200.

The microscopic descriptions given by Sen needs some critical examination. They are as follows:—

(1) He says "Vessels are isolated and evenly distributed throughout the wood." This is somewhat misleading, some vessels are isolated no doubt but they are also found in radial pairs and they are irregularly and not "evenly" distributed throughout the wood.

(2) Regarding the medullary rays he says "The medullary rays are generally one cell wide, 6-15 height." He failed to notice the two types of rays and the horizontal gum ducts in fusiform rays, which are distinctly visible under the high powers.

(3) About the Parenchyma he observes, "Wood parenchyma is very abundant and occurs in tangential bands". This description is most inadequate for the identification of wood, as the distribution of

parenchyma varies very much among the different genera and species of wood.

Above all Sen followed Holden[7] in describing his fossil. Chowdhury says, "Since Holden's specimen was not correctly identified it appears to be justified to conclude that Sen's specimen is not a true Dipterocarpoxylon"[3]. He also observes that "Besides the question of pitting, the other anatomical structure of the fossil seems to be similar to that of Gluta"[2].

A comparison of Sen's specimen with that of D. garoense and G. assamicum as described by Chowdhury[2,3] and Glutoxylon sp.[6] from the Mainamati hills in Tipperah, as described by the author, confirms Chowdhury's doubts as to the correct identification by Sen. The specimen is a Glutoxylon sp. and not Dipterocarpoxylon as identified by Sen. Full details of the paper will be published later on elsewhere.

Thanks are due to Dr M. Chatterjee, professor of geology, Presidency College, Calcutta, for the slides ; to Prof. Agharkar, for his kind permission to work in his laboratory and to Mr A. K. Ghosh for his guidance and helpful criticism.

ANIL MUKHERJEE

Botanical Laboratory,
Calcutta University,
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SCIENCE AND CULTURE

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The Sericultural Industry in India

MODERN WORLD is rapidly passing into what may perhaps be called the age of substitutes. As a result of the exigencies of war artificial rubber, leather, petrol, plastics and a host of other artificial materials are being produced in increasingly larger quantities, and in many cases the artificial products are proving more useful in various respects than the corresponding natural materials. Artificial silk began to make headway quite early among such substances, and the degree to which it has supplanted fabrics of both natural silk and cotton is quite considerable. Nylon is a new synthetic fibre, which, it is claimed, will prove superior to natural silk in most properties. Stories of these developments have been told from time to time in the columns of SCIENCE AND CULTURE.

Such artificial products will increasingly form a permanent feature of national economy in all progressive countries. Although particular politico-economic circumstances might have favoured the rapid development of several of these products, it should be clearly realised that scientific spirit and indefatigable scientific search for new knowledge are at the bottom of these outstanding developments of synthetic chemistry in this new age. These developments, particularly during the present century, have upset and are sure to upset to a considerable degree the economy of the nineteenth century. Agricultural practices and cottage industries of centuries are bound to receive concussions from what science is projecting on the human community. The correct attitude to the new situation, however, is not a denial of science, but an adjustment of old conditions to the new discoveries and inventions, so that the age of poverty may be substituted by an age of plenty, such as can be ensured by science in a well-ordered society.

Important natural products of India like silk, jute and shellac will, without doubt, in future years meet with increasing competition from substitutes. The reaction should not be to give up the natural products but to strive to develop them along better lines. Science has made it possible for better and better substitutes to be provided. Science can likewise make it possible for the natural products to be produced under far better and more economic lines than have hitherto been practised. Primitive conditions of production which belong to an age free from competition should deservedly disappear in favour of scientific methods. The Indian Lac Research Institute under the guidance of Dr H. K. Sen has shown how shellac can more than hold its own in spite of competition. Similar developments should help to improve products like jute and silk. It is noticeable how in Japan, in spite of the large production of artificial silk (rayon) her considerable production of natural silk has remained unimpaired. As a matter of fact, science should pay equal attention to natural and synthetic products, because experience has

shown that they can in co-operation give a more satisfying life to man than has hitherto been possible.

Sericultural industry of India is an industry of a natural product, to which we would invite special attention especially in view of the fact that India is the only country in the British empire producing silk. Natural silk has proved to be indispensable for parachutes, thus clearly indicating that no substitute has yet been discovered possessing the essential properties of the natural product. It is therefore imperative that this industry should be tackled scientifically throughout all its stages from mulberry, silkworm and reeling down to the distribution and marketing stages. It is well known that our silk industry is doing none too well. The All-India Sericultural Conference held in Bangalore on the 14th December, 1939, went into this question in considerable detail and made several valuable suggestions. This is a very opportune time for giving greater publicity to the problem of the silk industry as war requirements, particularly for parachutes, are far in excess of what India produces at present, and provide a welcome stimulus to the industry. It would be desirable to utilise this opportunity to establish the industry on a firm foundation, as has been done in Japan.

The necessities and problems of sericulture are:

(1) good races of silkworms producing cocoons with a large silk content,

(2) good mulberry producing sufficient leaf with a high nutritive value on which the worms can be fed,

(3) presence of a large body of peasantry who can undertake mulberry cultivation and rearing of silkworms as a subsidiary occupation to agriculture,

(4) adequate arrangements for the production and supply of disease-free seed (silkworm eggs) to silkworm rearers. (Otherwise rearing frequently fails on accout of the prevalence of hereditary pebrine disease; this can be controlled only by the elimination of diseased eggs through microscopic examination. For this reason, in Japan, egg production is under the direct control of Government and production by other agencies is prohibited by law. In Italy and France too egg-producers are licensed, and their work controlled by competent authorities),

(5) good machinery and methods for reeling out raw silk from the cocoons,

(6) standardisation of the raw silk,

(7) large reeling factories producing standardised raw silk in sufficiently large quantities so that a product of uniform quality may be available in sufficient quantity to meet the demand,

(8) agency to test and certify that the lots of raw silk supplied are of the standard stipulated for. A Government Raw Silk Conditioning House is also necessary for conditioning weight and testing quality, and giving certificates of conditioned weight and quality. There are two such houses in Japan, two in China, one in France and two in Italy. Even importing coutries, *viz.* U. S. A. and England maintain conditioning houses to test whether the raw silk supplied is of the standard stipulated for,

(9) the preceding items are essential for the development of sericulture comprising cocoon production and raw silk production. While cocoon production is in the hands of peasants reeling is done in factories, but the two agents are entirely interdependent. Presence of reeling factoris stimulates cocoon production. While cocoons provide the raw material for reeling, they do not flourish unless there is a reeling industry to purchase cocoons,

(10) the product of reeling is raw silk which must have a large outlet in order that reeling may be conducted on an extensive scale. The only two outlets for raw silk are (*a*) export to countries where rearing of cocoons is not possible but where there is a large demand for raw silk for use in silk weaving, and (*b*) manufacture of silk fabrics which also must have an export market in order that manufacture may be carried on on a large scale. About 1935 Japan exported about 70 per cent of her raw silk and also about 1024 lakh yen worth of silk tissues. Both raw silk and silk tissues require to be standardised and exports must be supported by certificates of standard. There must therefore be conditioning houses both for raw silk and silk fabrics. Japan maintains two conditioning houses for the export of raw silk, seven such houses for raw silk used in silk weaving cetres in Japan itself, and twelve silk cloth conditioning houses in different silk-weaving districts.

The essential problems and requirements of the silk industry, and the necessity of simultaneous development of its three stages, *viz.*, cocoon production, reeling and weaving will now be evident. The Bengal Department of Sericulture up to 1936 had been looking after only egg-production. Out of the three stages again the existence of an efficient reeling organisation must be strongly stressed.

Sericulture on some scale exists mainly in three areas in India at present, *viz.* Kashmir, Mysore and Bengal. In Madras also there is a sericultural *taluk*; this however really forms a part of the Mysore plateau —its problems are exactly like those of Mysore and it rears the same Mysore race of worm. On account of the climatic conditions and other causes the problems of Kashmir are different from those of the other two areas. Kashmir rears univoltine (one-brooded) races of silkworms and uses leaves of mulberry trees which are the State property. The State maintains large reeling factories and the Sericulture Department of the State is organised to carry out reeling and for this purpose produces disease-free eggs, distributes eggs to the rearers who are allowed free use of mulberry leaves, and collect and pay for the cocoons at a stipulated rate. Leaves of tree mulberry in Kashmir as silkworm food are superior to those of bush mulberry used in Bengal and Mysore. Also univoltine worms are much superior to the multivoltine ones of Bengal and Mysore. In Mysore the major portion of bush mulberry is pruned only once a year and leaves plucked and fed to the worms. In Bengal the system followed is pruning down the bushes several times in the year and whole twigs with leaves are supplied to the worms. The Bengal system is the worst as leaves do not develop and mature properly before they are fed to the worms. As a consequence the old existing multivoltine worms of Bengal, Nistari and Chhotopolu, produce the worst cocoons. Poor food is also responsible for lack of proper resistance of the worms to diseases.

Research therefore is necessary on the following lines in the multivoltine rearing areas. Details of present work in this connection are taken from the proceedings of the All-India Sericulture Conference already referred to.

Research for improvement of mulberry, which is responsible for about sixty per cent of the total cost of the cocoon production, is exceedingly important. In Mysore various foreign mulberries are under trial. Bush grown from seeds is said to be better than that from cuttings (which is the common practice) and cuttings from seedling plants are said to result in a better type of bush than cuttings from bush raised from cuttings. Groundnut cake, and a mixture of groundnut cake and sulphate of ammonia are claimed to be very satisfactory manures for mulberry. Growing of tree mulberry is being encouraged by the grant of a State bonus so that the cost of leaf may be reduced.

In Bengal a method of growing what is termed "high bush" from grafts has recently been evolved and is being introduced. These high bushes do not suffer from drought like the ordinary bush, yield a superior quality of leaves with high nutritive value which is said to have proved its utility in enabling worms to resist diseases, while the yield of leaves compares very favourably with that of ordinary bushes. The method of growing bush direct from seeds previously unknown has also been introduced. A scheme for getting trees grown from grafts on payment of a bonus is reported to have been given effect to lately. As mulberry has not been scientifically worked out in India, Bengal has undertaken this work. The investigation is being carried out by a special research botanist and a building and land, for the scheme have been donated by a private gentleman, Mr Haridas Majumdar, at Narayanpur beyond the Dum Dum Aerodrome. In this research station 118 types of mulberry have so far been collected, and are being grown for study with the object of finding out the best types suitable for Bengal conditions.

For improvement of races of worms and consequently of cocoons the Mysore Department has evolved a method of producing first-cross eggs by crossing the female of the indigenous Mysore worm with a foreign univoltine one turned multivoltine locally. For each rearing the first-cross egg has to

be produced and supplied to the rearers. The first-cross cocoons are superior to those of the indigenous multivoltine race. Foreign univoltine worms are however now difficult to obtain. Japan prohibited their export, and the war has stopped supply entirely.

In Bengal two fixed hybrid multivoltine races of worms, named Nistid and Nismo, produced in Burma as a result of crossing between Italian univoltine and local multivoltine worms and introduced into Bengal about 1936 are said to be giving much better results than the old Nistari and Chhotopolu. With a view to further improving worms, a biological research officer has been engaged and the Calcutta University has given land for growing mulberry and laboratory accommodation for this officer in the University College of Science at Ballygunge, Calcutta. He is said to be working for the fixation of two new hybrid races named Itan and Ichot, the results of crosses between the Italian and the local Nistari and Chhotopolu.

Mysore is carrying out researches on the refrigeration of eggs to regulate hatching, wherever necessary according to climatic conditions.

For the study of silk worm diseases and control methods, Bengal has engaged a protozoologist who has also been accommodated in the zoological department of the University College of Science at Ballygunge. The Bengal Department has also employed an agri-biochemist, who is now accommodated at the Bose Research Institute, Calcutta, and is engaged on chemical problems connected with mulberry, soil and food, and diseases of worms. He has already discovered the existence of a connection between the deficiency of phosphates in soils with a diseased condition of mulberry called *tukra* which causes crumpling and loss of leaves. The Bengal Government has a scheme of centralising the research officers in a proposed Sericultural Research and Training Institute which will also be entrusted with the duty of training staff teachers and other workers for the Sericultural Department.

For improvement of reeling the Mysore Government started a filature several years ago, and has now subsidised a large private filature. In Bengal the Peddie Silk Reeling Institute has been started at Malda and the new machinery and methods evolved here are being adopted by reelers. Private capitalists have come forward and are starting large filatures with improved machinery.

Bengal has started the first Raw Silk Conditioning House in India at Howrah and this is helping in improving the quality of raw silk with a view to its standardisation.

For improvement of silk weaving the Mysore Government started a weaving factory several years ago. In Bengal the old small Silk Weaving and Dyeing Institute at Berhampore is being reorganised into the Bengal Silk Technological Institute, with a scheme of organising the silk weavers of the province and arranging for the production of standardised fabrics.

For organising production and the supply of disease-free silk worm seed (eggs) to rearers, Mysore is developing aided grainages with Government bonus, and Madras is following the same method. Bengal however seems to have been backward in this respect in that it had arranged only for the production and supply not of examined eggs but of seed cocoons produced from examined eggs. Such seed cocoons are said to be not as good as examined eggs, but the rearers being used to seed cocoons the Department had to carry out some propaganda. Demand for examined eggs has now arisen and a scheme of starting aided grainages for production and supply of examined eggs is under consideration.

Mysore has started a spun silk mill with government aid thus providing a market for the waste products of sericulture.

All the above steps that have been or are being taken are in the right direction. The various bodies concerned in the initiation of researches including the Imperial Council of Agricultural Research have to be congratulated for what has been done so far. It is, however, necessary that the sericultural industries in Bengal, Mysore and Kashmir, should be viewed as a whole, for the experience of one may well be of advantage to the others and co-operation would undoubtedly give strength to the industry as a whole. Inauguration of the All-India Sericultural Conference has materially helped in this connection, but a permanent body to effect this co-ordination and a permanent All-India Sericultural Research Institute are urgently required for the healthy development along proper lines of the silk industry in the country.

Variable Stars

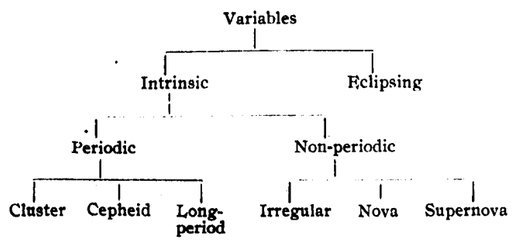
H. K. SEN

Department of Mathematics, Allahabad University

"STRANGE objects, which persist in showing a type of spectrum entirely out of keeping with their luminosity, may ultimately teach us more than a host which radiate according to rule", remarked Sir Arthur Eddington (1922) on the white dwarf companion of Sirius. It is well known that most of the stars radiate "according to rule". Geological evidence shows that the sun has been radiating more or less at its present rate for millions of years, for any appreciable variation in the solar constant would have wiped out all terrestrial life. But there are stars whose light shows a periodic fluctuation in brightness. Russell (1938) estimates that probably at least five per cent. of all stars is slightly variable. It is these which form the most fascinating subject of study for the astronomer. In the following pages we shall attempt to set forth what have been learnt and how much more we have to learn from them.

CLASSIFICATION

The following classification gives the different kinds of variable stars:



The eclipsing variables are binary systems in which one component periodically shuts out light from the other. The light-curve is a flat line most of the time, broken by a sharp fall at the time of eclipse. Essentially different from these are the stars whose light varies due to some intrinsic cause. Quite a number of these show well-defined periods of variation. Their spectra show the Doppler effect, which is interpreted as the velocity-curve of the pulsation of the surface of the star. The velocity-curve is a mirror image of the light-curve, which shows a sharp rise to maximum followed by a comparatively slow decline with indications of a hump in the curve.

The irregular variables form a nondescript class which shows no clearly defined period. The novae are very faint stars which suddenly flare up to transitory brilliance. The supernova is the nova on a super scale.

DISCOVERY AND CATALOGUING

We do not know if the ancient and medieval astronomers studied variable stars, for we have no records save a few references to novae. The need of a star catalogue is believed to have occurred to Hipparchus (*c.* 130 B.C.) by the sudden appearance of a nova. About twenty long-period variables are now known which can be seen at their maximum brightness with the naked eye. So far as we know, only one of these, *viz.*, Mira (the wonderful) was discovered before the invention of the telescope (by Fabricius in 1596). The variations of the others might have been noticed, but records of the observations were not made, or at least have not been preserved. Systematic investigation of the brightness of the star dates with Argelander (1799-1875). Till the close of the nineteenth century, variable stars were found either during a general examination of the sky or while framing catalogues of stars. The photographic plate and the spectroscope, however, have now given to the astronomer a very efficient and systematic method of detecting variables. Work has been rapid in the present century, to which contribution by amateur bodies, *e.g.*, the American Association of Variable Star Observers, has been great.

PERIODIC VARIABLES

Below we give a list of the chief types of the Periodic Variables with some relevant data.

Name	*Period*	*Number known*	*Light Range*
Cluster	0·56 days	620	2·5
Cepheid	5·6 ,,	287	2·1
Long-period	280 ,,	2144	63

The Cluster Variables are those found in the globular clusters. It should be noted that there are three clearly defined ranges of period, *viz.*, short, medium and long. Why there should not be any intermediate ranges between them remains a mystery. The periodicity is not so well-marked in the long-period variables as in the Cepheids. The range of variation is also much greater in the former. In the present article we shall confine ourselves to the Cepheid Variables. We hope to discuss the other Variables in a subsequent article.

THE CEPHEID VARIABLE

The Cepheid Variables are super-giants, that is, very highly luminous stars of large mass and very low density. In fact, as Merrill (1938) has observed, "variability is a disease of bloated stars". The central condensation rapidly diminishes with advancing spectral type, and the δ Cephei F-5 stars are approximately homogeneous (Kopal, 1938). The spectral type advances towards M on the Hertzsprung-Russell diagram, that is it becomes redder, with increasing period. There is a definite relation between period and absolute luminosity called the period-luminosity relation ; this is the most important property of the Cepheid Variables, which has made them the "yard-sticks" of the Universe. Generally, the larger the period, the greater the luminosity but the matter is not so simple ; it is best to work with a curve (called the period-luminosity curve) which is drawn for Cepheids of known periods and known absolute luminosities. From this the absolute luminosity of any other Cepheid in any part of the sky can be read off, if its period be known. From the observed apparent luminosity of the Cepheid, its distance can then be calculated. The method was discovered by Miss Leavitt of Harvard and applied by her to find the distances of Cepheids in the Magellanic Clouds which are so far off (about 80,000 light years) that the trigonometric method of finding distances by measuring the parallax utterly fails for them. Shapley extended the method to find the distances of remote globular clusters ; while Hubble capped it all by finding out the distances of Cepheids in the extra-galactic nebulae beyond our own and thereby finding out the distances of the nebulae themselves. The power of the method will be appreciated from the fact that light takes 870,000 years to reach us from the Andromeda Nebula, which is one of the nearest amongst the multitudes of spiral nebulae which exist in this vast Universe. The light which reaches us now from the nebulae started its course when we were non-existent, and we cannot be very much sure that the nebula still is where we see it now, or, in fact, if it exists at all, at the present moment.

The Cepheids exhibit another remarkable relationship—the period varies inversely as the square root of the density. This flatly contradicts, according to Eddington (1918), the Helmholtz-Kelvin Gravitational Contraction Hypothesis of the Source of Stellar Energy. On this hypothesis, Eddington has calculated that δ Cephei should change its period by 40 seconds annually, whereas the observed annual change is only 0·05 second. According to Eddington's estimate, δ Cephei would take about 10^7 years to pass from type G to type F, which agrees with the modern view of the time scale.

THEORIES OF CEPHEID VARIATION

Several theories have been advanced to explain Cepheid variability, but only one has held the field so far. Most old theories assumed the variables to be solid or liquid bodies. These we will not consider, as it is more or less established that the Cepheids obey the perfect gas law. The eclipse theory which ruled for a long time pictured the variable star as a binary system in which one component periodically eclipsed the light from the other. Two fatal objections to this theory are that (*i*) the orbit calculated from the velocity-curves is too small for the theory to be physically possible ; in fact, the secondary would dip into the primary at periastron ; and that (*ii*) the afore-mentioned period-density relation, *viz.*, that the period varies inversely as the square root of the density, makes it highly improbable that the period of the secondary should depend on the density of the primary.

No rotational theory of Cepheid variation is possible, according to Eddington (1926), as the spectral lines would then be extremely diffuse, owing to a differential velocity in the line of sight between different portions of the stellar disc. Jeans (1929*a*) ascribes the variation to the rotation and oscillations of a pear-shaped body about to undergo fission. The fission theory, or, for that matter, any theory based on the orientation of the star's axis, does not seem to be acceptable, as astronomers are of the opinion that the variable has approximate spherical symmetry, that is, it would look the same at all times and at all angles (Merrill, 1938*a*).

THE PULSATION THEORY

The most natural way is to ascribe the variation to the periodic pulsations of the star under the combined action of the elastic and gravitational forces. Ritter (1880) was the first to consider the pulsations of a gas sphere with a view to applying to variable stars. Plummer (1923) first raised objections against the eclipse theory on the ground that deviations from the elliptic orbit were found of a kind impossible to ascribe to gravitational perturbation by a third body. Shapley (1914) placed the arguments against the eclipse theory on a sound basis and advocated in its place the pulsation theory. Eddington (1926*a*) has given detailed mathematical treatment of the fundamental mode of small radial and adiabatic pulsations of his standard model, and obtained the period-density relation and a theoretical estimate of the period of δ Cephei which is approximately half of the observed period. Edgar (1933) has calculated the period of the first overtone, and Schwartzschild (1941) has calculated very recently, that of the first four.

UNSOLVED PROBLEMS

The pulsation theory, though it has survived the other theories, has not yet proved its worth completely. According to Eddington (1941), there are still three outstanding problems to be solved :

(1) Maintenance of Cepheid Pulsation.

There is a small dissipation of energy due to periodic flow of heat, and Eddington (1926*b*) has calculated the time of decay of the pulsation to be of the order of 8000 years. This demands some agency to maintain the pulsation.

(2) The quarter period retardation of phase.

It has been found from observation that the maximum light from the star comes not when it is in the stage of greatest compression, but about a quarter period later when it has its maximum velocity of approach towards the observer.

(3) The period-luminosity law.

Eddington (1941) is of the opinion that the three problems are interconnected and explains them together by assuming a critical hydrogen layer near the surface of the star, which is ionised and de-ionised in the course of the pulsation. Gamow (1939), on the other hand, attributes the cause of Cepheid variation to the nuclear transformation of light elements, such as lithium, boron and beryllium.

OBJECTIONS TO THE PULSATION THEORY

Objection of another sort has been raised by Shinjo and Jeans (1929*c*) according to whom the velocity-curves, in the pulsation theory, ought to contain higher modes of incommensurable period, which have not, however, been observed for the Cepheids. Eddington (1926*c*) answers on the basis of Woltjer's calculations, that the overtones are stronger near the surface where the dissipation is greater, so that their absence is accounted for. Sterne (1937), however, is of the opinion that the overtones ought to be observable in certain stars. He (1940) and Schwartzschild (1941*a*) have recently observed them in some short-period variables.

The most cogent objection against the pulsation theory has been advanced in a very recent and interesting investigation due to Prof. A. C. Banerji (*Proc. Nat. Inst. Sc. India*, in the press). Eddington (1926*a*) has considered only small oscillations and neglected the square of the amplitude. This, on his own admission, is not feasible, as the amplitude may amount to one-twelfths of the star's radius. Banerji has shown the radial oscillations to be unstable when the second order terms are taken account of, and, on this basis, has given an entirely new and very plausible theory of the much vexed problem of the origin of the solar system.

BANERJI'S CEPHEID THEORY OF THE ORIGIN OF THE SOLAR SYSTEM

The Sun is supposed to be originally part of a Cepheid variable of about nine times the Sun's mass, oscillating with small amplitude. The near-by passage

of a star of about the mass of the Cepheid increases the amplitude of the Cepheid's oscillations. The passage of the second star need not be grazing or very near, but only sufficiently near to produce appreciable tidal protuberances in the Cepheid. Banerji has shown that under these conditions dynamical instability is caused in the Cepheid's oscillations, resulting in ejection of matter of the Sun's mass from it. The planets are supposed to be formed out of the part of the ribbon attached to the Sun's mass and the rest of the development is as in the earlier theories. It has been shown that the visiting star has sufficient angular momentum to impart the necessary amount to the planets. It has also been shown that the solar ystem will have to take about two-fifths of the energy of the parent Cepheid to escape from the latter. Thus Banerji's theory solves in a most natural way the two outstanding difficulties of the previous theories, *viz.*, of energy and angular momentum. A specially remarkable feature of the theory is that it makes a lesser number of assumptions than any other existing theory. The parent Cepheid, in this theory, will also have a planetary system of its own, and the probability of there being other planetary systems than our own is definitely increased.

DENSITY CONDENSATION IN CEPHEID VARIABLES

Banerji's investigations throw an important light on the density condensation in Cepheid variables. Following his method, the author has shown (*Proc. Nat. Acad. Sc. Allahabad*, in the press), instability of radial oscillations for various laws of density proceeding in direct and inverse powers of the radial distance. It has been surmised that stable oscillations are only possible for the homogeneous star, and the calculated period of oscillation of δ Cephei, assuming it to be homogeneous, has been found to accord closely with observation. According to Chandrasekhar (1936) and Kopal (1938), the Cepheids are of very little central condensation. In fact, as Kopal observes, "The Cephei F-5 stars seem to approach the limit of homogeneity." Eddington has also stressed that the Cepheid must be much less centrally condensed than the standard model.

BINARY STARS, THE SOLAR SYSTEM AND THE SPIRAL CONFIGURATIONS

The author has further found that the only star capable of uniform radial oscillations is the homogeneous sphere or the homogeneous slightly oblate spheriod. The theory has been advanced that a slowly rotating almost spherical homogeneous star gains in angular velocity with radiation of energy. At a stage the spheroid gains sufficient oblateness for its homogeneity to be disturbed and the oscillations to be unstable. As the star has hardly any central condensation, it breaks up by fission, according to Jeans (1926), into two comparable masses. This would give birth to the double star system. A passing star would, on the other hand, help in the formation of the planetary system, as envisaged by Banerji. Finally, if the parent star be of great central condensation, *e.g.*, of the type of Roche's model, it would undergo an equatorial break-up, matter streaming out from the two ends of a diameter, forming the arms of a spiral configuration. The theory, as herein set forth, is a merger of the Fission Theory of Cepheid variation of Jeans and of the Pulsation Theory of Shapley and Eddington. The spectroscopic binaries would form the connecting link between the Cepheid variables and the double stars. It is interesting to note that Jeans (1926*b*) finds observational support for this suggestion, and Kopal (1936) finds freshly formed binaries to be homogeneous or almost so. The central condensation in binaries, according to Kopal, is due to ageing.

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Modern Conception of Valency

PRIYADARANJAN RÂY

Khaira Professor of Chemistry, Calcutta University

ATTRACTIVE forces, operating between atoms, molecules or even larger material units and leading to their aggregation, are, on ultimate analysis, found to be electrical in nature ; for, as is well known, the primary material particle—the chemist's atom—is essentially made up of elementary electrical components. These forces can, however, be classified and correlated as described below.

A. (*i*) Forces resulting from Coloumb or electrostatic attraction between oppositely charged ions, which are characterised by having well-defined electronic structure with spherically symmetrical charge distribution. These forces are, threfore, exerted uniformly in all directions around the ions. The atoms of metallic elements, *e.g.*, Na, Ca, etc., tend to lose their outermost electrons to form stable cations, and the atoms of non-metallic elements, namely, Cl, Br, O, etc., are, on the other hand, prone to take up additional electrons with ease to form stable anions. These ions thus closely simulate the structure of noble gases like neon, argon or krypton. This type of attractive force, say in a compound, represented by the usual chemical formula NaCl, is regarded by the chemists as an electrostatic valence force and the name *electrovalency* is given to it. The loss or gain of one electron by an atom represents one unit of this electrovalency. Between two such oppositely charged ions of a compound chemists are accustomed to assign a valence bond to which the name *ionic*, *polar* or *heteropolar* bond is given. Each such bond is supposed to saturate one unit of valency on each ion.

It might be pointed out in this connection that there is also a repulsive force operating between the ions and that like the Coloumb attraction this increases, rather more rapidly, as the electronic shells of the two ions approaching each other begin to interpenetrate. But for this, the two ions would have coalesced and lost their individual identity. The normal state of an ionic compound represents, therefore, an equilibrium condition when these two opposing forces balance each other. This confers on the ions their characteristic radii and sizes.

As the ions exert their force uniformly in all directions, they tend to co-ordinate, or attract around them, as nearest neighbours as many ions of the opposite charge as possible. This results in a close-packed, highly co-ordinated structure for the crystalline ionic compounds ; namely, cubic, octahedral and hexagonal configurations. The structure in any particular case is mainly determined by geometrical consideration based on the ionic radii and by the principle of electrical neutrality. This latter demands that the number of ions of each kind in a structure shall be equal and hence the co-ordination or the arrangement of each ion around the other must be the same. Thus, for instance, in a crystal of sodium chloride each sodium ion is surrounded by six chlorine ions at the corner of a regular octahedron and *vice versa*. In fact, there exists no discrete NaCl molecule in the crystal ; the whole crystal may be regarded as one giant molecule (Riesemolekule). In this condition the unit positive charge on each sodium ion exerts its attractive force uniformly upon six surrounding chlorine ions and *vice versa*. As a consequence the strength of the electrostatic valence force or bond strength between any two neighbouring Na^+ and Cl^- ions is only ⅙ in magnitude of our usual unit of valency. This again is not a constant characteristic of sodium or chlorine ion. It varies with the size of the oppositely charged neighbour. In caesium chloride crystal, for example, each chlorine ion is surrounded by eight caesium, and eight chlorine are packed around each caesium ion as neighbours, disposed symmetrically at the corners of a cube. The magnitude of the electrostatic valence bond between each caesium and chlorine becomes only ⅛ of the usual unit.

Thus we find that in the case of crystalline ionic compounds our usual integral conception of valence bonds entirely breaks down. But this does not affect the valency of sodium or chlorine, which maintain their usual value of one, as valency is identified with the number of unit charges on the ion. We have no definite evidence of the existence of individual NaCl molecule, except possibly in the gaseous state.

(*ii*) Forces resulting from electrostatic attraction between a central ion and the surrounding molecules or groups with permanent dipole moments. Molecules like NH_3 and H_2O, in which the centres of positive and negative charges do not coincide due to their unsymmetrical structure, possess permanent electrical dipoles. These are, therefore, easily attracted by the charge of a central ion leading to the formation of complexes like $[Ni(NH_3)_4]^{++}$, $[Ni(H_2O)_6]^{++}$, $[Cu(NH_3)_4]^{++}$, etc. This type of valence force is usually termed an ion-dipole valency or *co-ordination valency,* which in the case of many hydrates and ammoniates is only a special kind of electrovalency.

This ion-dipole valency may also result from the electrostatic attraction between a central ion and the induced dipole of a polarizable molecule.

Electrostatic interaction between two or more molecules with permanent dipole character, leading to the phenomenon of association or other abnormalities in solution, also comes under this category.

Two molecules or atoms, which are individually neutral and symmetrical with zero dipole moment, can nevertheless develop dipole character by induction in consequence of the interaction between their electrical field. A helium atom, for instance, possibly always possesses an actual dipole moment, as the centre of the negative charge of the two planetary electrons seldom coincides with the positive nuclear charge. This can, however, be never detected in an applied electric field on account of the extraordinarily high rate of motion of the electrons around the nucleus compared with the orientation of the dipole in the field. Such a measurement could give simply the average moment which will evidently be zero, as the actual dipole is oriented as often in one direction as in the opposite. But at any instant this helium atom with its temporary moment can induce a dipole moment in a neighbouring atom, which leads to an attraction between them. The attractive force, which is thus developed between two apparently neutral molecules, manifests itself in the form of van der Waal's attraction and accounts for the liquefaction and solidification of inert gases like He, Ne, Ar, etc. This force is, of course, always associated with all the other interatomic forces and the latter are, therefore, superimposed upon it. From the consideration of valency problem we may ignore it altogether as of little consequence owing to its comparatively very small magnitude.

B. In molecules of non-metallic elements, such as H_2, O_2, N_2, Cl_2, etc., and in organic molecules we come across an entirely different type of attractive or valence force, to which the name *covalency* is given. This type of valence force generally acts in definite directions in space giving rise to a triangular, pyramidal, tetrahedral, octahedral or planer square configurations of the molecule. Definite bonds or linkages between atoms are, therefore, assumed here, to which the name *covalent, homopolar* or *nonpolar bond* is given as suggested by Langmuir. Following Lewis we generally interpret this type of valence force as due to the sharing of a pair of electrons per bond by the two combining atoms. This gives rise to a stable electronic configuration around each of the bonded atoms, resembling those of the inert gases.

Lewis's conception was placed by Heitler and London on a sound theoretical basis by the application of one of the fundamental principles of quantum mechanics—the principle of resonance—to the problem of chemical valency of the non-polar type. When two atoms with an unbalanced electron in each, such as two hydrogen atoms, approach each other, the energy of their interaction may manifest itself in an attraction between them if the spins of the electrons be antiparallel or oppositely directed. It is said that two such atomic systems, under these conditions, are in resonance. The effect may be viewed as an oscillatory interchange of two electrons between the two atoms in such a way that neither of the electrons can be regarded as associated with any particular atom, but they appear to belong to both. This gives us roughly a picture of the formation of molecule from atoms. With parallel spins, on the other hand, a repulsion occurs.

The above representation of the electron-pair bond on the quantum mechanical basis is in perfect agreement with Pauli Exclusion Principle. This principle of great significance and universal validity was discovered by Pauli in 1925. It states that *"No two electrons in any atomic or molecular system can coincide in all four quantum numbers."* This important rule has provided us with a key to the understanding of the Periodic System and the properties of chemical elements.

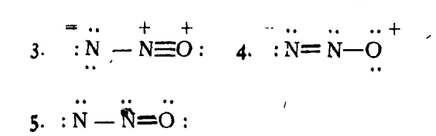
According to the principle of resonance, therefore, if a system is represented by two structures, which are equally stable, the normal state of the system will be represented by neither of them alone but by a combination to which both will equally contribute. For a system of two normal hydrogen atoms two ideal and equally stable structures can be constructed, as shown below, by the interchange of two electrons designated as 'a' and 'b' between the two nuclei represented by H_A and H_B.

The normal state of the hydrogen molecule, on the basis of the principle of resonance, will, therefore, be represented by a combination of the above two structures, which means an equal sharing of the two electrons by the two nuclei. This is how an electron-pair bond is formed. The energy of its formation is derived from the resonance energy corresponding to the interchange of two electrons between the two nuclei.

What is said above for a simple molecule like H_2, holds equally good for more complicated cases. Usually, for a large number of chemical compounds a definite valence bond structure can be easily assigned in keeping with their properties. But instances are not rare, when a molecule may be represented by two or more equally possible and stable structures, none of which alone accounts unambiguously for the properties of the substance. The molecule, on the basis of quantum mechanical principles, can, therefore, be described as resonating among these various possible valence-bond structures, its actual state being represented by a combination of them all.

Resonance* may occur between structures of covalent and electrovalent types, or it may involve structures, as is more often the case, differing only in the distribution of bonds, covalent or electrovalent, or both. It may be emphasised in this connection that one of the most fundamental rules regarding resonance is that it can occur only among structures with the same number of unpaired electrons. A few instances will make these points clear.

Nitrous oxide, whose molecule is known to be linear with the oxygen atom at one end, may be represented by a number of different structures:



Of these, the number 3, 4 and 5 may be discarded, as the juxtaposition of positive charges in 3 and the smaller number of covalent bonds in 4 and 5 make them less stable than 1 and 2. A choice between the latter two is, however, difficult as they are closely similar in nature having the same number of covalent bonds, a similar charge distribution and the same number of unpaired electrons (*i.e.*, zero). All the necessary conditions for resonance are here fulfilled, and the properties of the molecule actually correspond to a normal state involving resonance between the structures 1 and 2. The molecule has a low dipole moment, which can only be accounted for as due to the partial neutralisation of the opposed moments of the two structures. The interatomic distances and the force constants of the molecule also support this view. Hence the normal structure of the nitrous oxide molecule is derived from a combination of the structures 1 and 2. But it should not, therefore, be assumed that the structure of the molecule can be represented by a single, well-defined, unambiguous pattern intermediate between 1 and 2. That will be in conflict with the very concept of resonance. In effect, the properties of a molecule in resonance are not intermediate between those of the resonating structures, but corresponds to a state more stable than the stablest of all possible structures among which it resonates by an amount of energy known as resonance energy. Hence a resonating molecule like N_2O possesses, so to say, an electronic structure to which a single valence-bond diagram cannot be assigned. It manifests properties expected for an average of

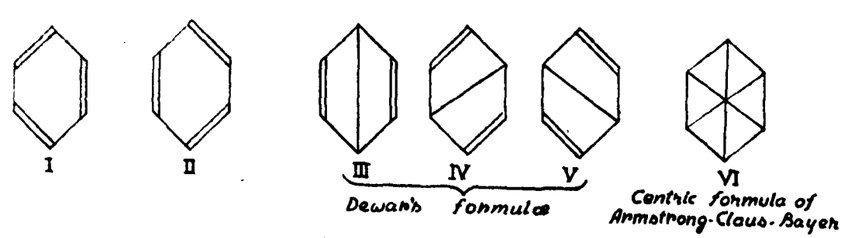
* The conception of resonance as presented in this article is based mainly on the exposition given by Pauling in a series of papers on the "Nature of the Chemical Bond", published in the Journal of American Chemical Society, 1931-33, and in his book of the same name published in 1939-40.

the two structures, somewhat modified by the stabilizing influence of resonance. This distinguishes resonance from *tautomerism*, which implies a mixture of two or more types of molecules in dynamic equilibrium, each having its characteristic properties and structure unchanged. If nitrous oxide gas would have been a tautomeric mixture of two types of molecules having structures 1 and 2, its dipole moment would have been quite high, being the mean of the values for the two types which would individually orient themselves in an applied electric field. But as the molecule resonates between structures 1 and 2 with an extraordinarily high frequency, the two types will not have time enough for proper individual orientation in the electric field without suffering interconversion. The moments of the two structures being opposite thus cancel each other. The difference between tautomerism and resonance is, therefore, based on a difference in the transformation rate of the structures involved and on the additional resonance energy stabilizing the resonating molecule.

A discussion of the configuration of benzene will make our ideas about resonance clearer. Of the various structures suggested for this molecule at one time or other by different chemists, that due to Kekule is universally accepted. By numerous physical and chemical evidences benzene has been proved to possess a perfectly symmetrical, hexagonal, coplanar configuration. Kekule formula for benzene can, however, be represented by two equally valid and stable configurations I and II.

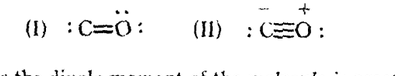
i.e., its stability and behaviour as a comparatively saturated compound in spite of having three double-bonds in the molecule. As the two equivalent Kekule structures cannot appreciably differ in their energy content and stability, it may be concluded at once that the normal state of the benzene molecule is stabilized by resonance between them. This eliminates the unsaturated or reactive character in benzene, making all the bonds equivalent and thus giving rise to what are known as aromatic properties. As all the bonds are equivalent and share a double-bond character, it follows that the benzene ring should be regular, hexagonal and coplanar.

The presence of resonance in a molecule is suggested not only by theoretical considerations but is actually indicated and supported by many experimental evidences; *e.g.*, chemical properties, interatomic distances, dipole moments, resonance energies, etc. The heat of formation of a resonating molecule is always greater than that calculated from the bond energies, given by thermochemical data, of the molecule represented by any single valence-bond structure. The difference between the actual and calculated values gives the resonance energy of the molecule. In a similar way the interatomic distances in a resonating molecule differ from the accepted constant values for the atoms concerned, connected by a covalent bond of any given type (single, double or triple). Thus the C—C interatomic distance for a single bond has a value of 1·54 A.U., that for a double

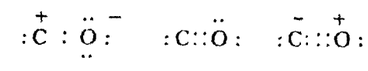


The configurations III to VI obviously correspond to a state of much lower stability because of the weaker bonds between diagonal and distant atoms. Their contribution to the actual state of the benzene molecule may, therefore, be neglected. A single Kekule structure, I or II, on the other hand, cannot satisfactorily account for the properties of benzene, bond is 1·33 A.U. The observed value, however, in the case of benzene is 1·39 ± 0·01 A.U., showing that all the bonds are of equivalent character. This value, on the other hand, is not intermediate between those for a single and a double bond but is closer to that of the latter, due to extra stabilisation by the resonance energy.

Another interesting instance of resonance is furnished by carbon monoxide molecule. Two structures I and II had been suggested for the molecule, and evidences for and against each were advanced. But as neither of them alone can satisfactorily account for all the properties of the molecule, a resonance between them readily suggests itself.

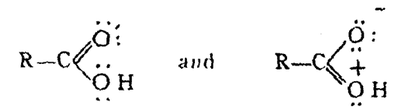


But as the dipole moment of the molecule is practically negligible, the molecule should rather be regarded as resonating among the three structures:

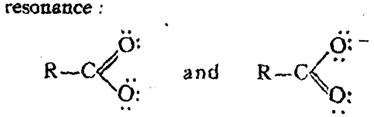


Structures (I) and (III), with oppositely directed moments contributing equally, render the moment of the actual state of the molecule vanishingly small.

The properties of carboxylic acids are best understood on the conception of resonance between the structures:



The two structures are not quite equivalent as in the case of benzene, still the energy-difference is not so large as to inhibit resonance altogether. In the form of their corresponding ions, however, the two structures become perfectly equivalent with complete resonance:



This is in close agreement with observed facts, as the presence of a double bond (C=O) in these compounds could not be demonstrated by any physical method. Suggestion of prototropy or migration of the hydrogen ion, as advanced by some, would make the molecule only tautomeric, which is not actually the case.

We are now in a position to state the most important and fundamental rules regarding resonance.

(*i*) Resonance can occur only among structures, which are equivalent or very nearly equivalent with little difference in energy content or stability.

(*ii*) It can occur only among structures with the same number of unpaired electrons.

(*iii*) The positions of the various atoms in the structures, among which resonance can occur, must remain the same.

(*iv*) The difference between the structures, among which resonance occurs, lies only in the distribution of valence bonds or electrons.

There is a definite distinction between tautomerism and resonance. In tautomerism the substance exists in two definitely different molecular structures in dynamic equilibrium. In fact tautomers are isomers which are readily interconvertible; *i.e.*, isomers inseparable from one another in the pure state in spite of their individual existence. In resonance the frequency of this interconversion is, on the other hand, extraordinarily high, almost thousandfold greater than the frequency of nuclear vibration. As a result, none of the various possible structures of a resonating molecule may be regarded as having an individual existence of their own. A stable equilibrium configuration derived from the combination of all represents the apparent or normal structure of a resonating molecule.

C. There are certain substances in which the forces holding together the constituent atoms are neither of the Coloumb type, nor due to exchange or sharing of electrons in resonance leading to a covalent bond. The name *metallic bond* is given to this type of valence force. All metals, intermetallic compounds and substances with metallic properties (such as high value of thermal and elctrical conductivity, metallic lustre, ductility, malleability, etc.) are formed as a result of the operation of this type of valence force. The most striking characteristic of the metallic bond consists in the mobility of the bonding electrons.

Between two atoms of a metal, both of similar or equal electropositive character, there can neither be a transference of valence electrons of one to the other to form oppositely charged ions, nor can there be a mutual sharing of valence electrons to give rise to a covalent bond. Because neither of these arrangements could give a stable electronic configuration of inert gases around them. As a result, the valence electrons

leave their parent atoms and simply vibrate in pairs around the metallic cores or positive ions of the lattice. This is in agreement with the modern quantum mechanical theory of metals as developed by Sommerfeld, Bloch and others, according to which a metal may be considered as an assemblage of positive ions immersed in a sea of free electrons. The attraction between the positive ions and the electrons gives the coherence of the structure and its stability results from a balancing repulsive force, the origin of which is traced to Pauli Exclusion Principle. The valence electrons in a piece of metal, *e.g.*, a single crystal, are quantized and arranged in a nearly continuous set of close-spaced energy levels, being held in common by all the positive ions in the crystal, which, therefore, behaves as a gigantic molecule. Here also, as in the case of single atoms and molecules, the Exclusion Principle regulates the distribution of electrons ; and this prevents the structure from collapsing due to strong attraction between the positive ions and the electrons. The presence of these mobile electrons in metals provides an explanation of their characteristic properties.

The attraction between the positive ions and the mobile electrons or, as it is often called, the electron gas is neither limited in direction or number. It may be regarded as spherically or symmetrically distributed, acting on as many neighbours as may be packed around each ion. In metals and metallic compounds we, therefore, meet with a close-packed, highly co-ordinated (with co-ordination number 12 or 8) structure. The metallic bond, therefore, resembles the ionic bond but differs from the latter in that it is exerted between two atoms of similar or identical electrical character. The principle of electrical neutrality, which determines the relative number of atoms of each kind in an ionic compound and gives rise to a simple molecular composition, is inoperative in metallic systems, whose structure in consequence is determined solely by geometrical considerations. The laws of constant and multiple proportions, which regulate the formation of ionic compounds through the demands of electrical neutrality, practically break down in the case of alloys and intermetallic compounds, whose composition is often neither simple nor constant.

The metallic bond resembles the covalent bond in that the electrons are arranged in pairs in a series of closely spaced energy levels surrounding the positive ions, due to the operation of Pauli Principle. It differs, however, from the latter having no restriction on the bond direction and the numerical composition.

Hence, the metallic bond may be regarded as an intermediate stage between the ionic and covalent bonds, sharing some characteristics of both.

Besides metals and intermetallic compounds, there is a large number of substances whose properties are best accounted for on the assumption of metallic bonds. Borides, carbides, nitrides, silicides of metals and metalloids, as well as many compounds of transitional metals with non-metals or metalloids, such as pyrites (FeS_2), arsenical pyrites ($FeAsS$), copper sulphide (Cu_2S), cobalt arsenide (Co_3As_4), etc., belong to this group.

We thus find that the chemical bond may be classified into three main types: (1) Ionic, (2) Atomic or Covalent, (3) Metallic. Besides these three ideally extreme types there may, of course, be a number of transitional stages into details of which we need not enter for the present. For instance, an electrostatic co-ordinate bond between a central ion and a dipole molecule, or between a central ion and another ion, under certain conditions may pass into a covalent bond (co-ordinate covalency), giving rise to what are known as Penetration Complexes.

The Birjhia—Asurs

Economic Life of an Aboriginal Tribe of Chota Nagpur

S. B. DAS GUPTA

THE Birjhia-Asurs form a section of the population (generally known as Asurs) in the Chota Nagpur and Surguja area. They are differently named at different places. In the Kasmar Pargana they are known as Asur-Birjhia, in Barwe and Chechari as Agaria-Birjhia or simply as Agaria or Birjhia, while in the Surguja State they are called Kol-Birjhia. But whatever the difference in the prefix of their name they belong to one single tribe. There is a further division of the tribe with respect to their attitude towards the use of vermilion at the time of marriage and at other times for the beautification of the body.

FIG. 1. A GROUP OF ASURS IN FRONT OF THEIR HUTS.

With the Sinduraha the use of vermilion is deemed essential at the time of marriage while the Telhas detest the use of vermilion.

In the economic sphere the Birjhias are one of the poorest classes of the Chota Nagpur and the neighbouring area, if not of the whole of India. In spite of hard labour and frugal habits, the people cannot store enough food for the whole year. Many families go without food sometimes for two or three days at a stretch ; and most of them remain ill-fed for a large part of the year.

Agriculture is the chief food-producing activity of the people. But the environmental conditions have compelled them to look after other economic pursuits, such as hunting and collection of wild vegetable products for sustenance. Thus we find the Birjhias occupied in different kinds of works at different seasons in their endeavour to replenish their meagre food-supply.

HUNTING

Hunting forms an important economic pursuit for a considerable part of the year. The period between the months of January and May may be said to be the hunting season *par excellence*. The people generally hunt in parties and in the months of *Baisakh* (April-May) and *Jaistha* (May-June) sometimes several villages go together.

Success in hunting is ascribed to the magico-religious activities of the village priests—the Baiga and the Deohari. Consequently the latter have a special claim over the flesh of animals bagged.

Deer, boars, wild goats, hares and porcupines are among the chief game animals while wild fowls, partridges and green pigeons form the chief game birds. They do not run after the Lengurs (Semnopethicus) like the Birhors.

Bows and arrows and axes are the chief weapons of chase. But apart from these, the Asurs improvise various kinds of traps to capture birds and animals. Of these the dead-fall traps are very common. These are set up to capture all sorts of creatures from the small rats and squirrels to wild boars, goats and even wolves.

FISHING

Fishing plays no important part in the Birjhia economic life. Situated as they are in the hills and jungles the Birjhias seldom have occasions to encounter big water courses. Hence the few methods of fishing known to the people are those that can be conveniently employed in small hill streams and narrow courses. Poisoning is the most important of

FIG. 2. AN ASUR DWELLING ON THE TOP OF A HILL.

these methods and the people use five different kinds of materials including fruits and barks of wild trees for the purpose. Automatic basket traps and fish hooks are also used. In rare cases nets (*Pilni Jal*) may also be found.

The poisons used in fishing are obtained from (*i*) Maona fruits in winter, (*ii*) Biri fruits in summer, (*iii*) Gorair roots, (*iv*) Arair barks, and (*v*) juice of Sidhu plants at other times. The fruits, roots and barks referred to above are first crushed and then they are scattered over the water. The water is then thoroughly stirred. After some time the fishes float up half-dead and are easily caught. The Sidhu juice is used when fishing in bigger streams, specially when these are swollen with rain water.

FOOD FROM PLANTS

For a very considerable part of the year the main, if not the only, food of the Birjhias are wild roots, tubers, flowers and leaves that are collected from the forest at different seasons of the year. The roots and tubers, such as Yam, Githi, Nakoa and Kulu are dug out from the forests where they grow wild, in the months of *Paus* and *Magh* (December-February). Of these the last three, namely the Githi, Nakoa and Kulu are eaten with great difficulty. The Kulu is very poisonous and has to be boiled with water four or five times, discarding the water each time, before it can be eaten with salt. Githi is very bitter and Nakoa is irritating. In spite of this the Birjhias manage to eat these foods so as to be able to save as much as possible of his food store for the future. From the month of *Chaitra* (March-April) to near the end of *Jaistha* (May-June) Mahua flowers are collected by the people which form an important food. These flowers are preserved after drying in the sun. In the rainy season when they have almost nothing to eat but have to labour in the field the Mahua flowers are beaten in a mortar with water into a paste known as Latha. Three or four ounces of the Latha and a pot of water are enough for a meal. Another ntural produce collected in this period are the Koenar leaves. These are eaten when still tender. The leaves are boiled with water and are eaten as principal food by simply adding salt, or as accessory with rice.

Ordinarily the womenfolk collect these vegetable products, but there is no prohibition for the men if they want to do this work. The men sometimes help their women in digging out the roots and tubers with the dibble. All these provide food for the Birjhias for at least two months in the year.

DOMESTIC ANIMALS

The Birjhia-Asurs keep pigs, poultry, cattle, goats and dogs. Pigs and poultry serve as sacrifices to the various deities as also as food on special occasions such as marriage or when guests are to be entertained. The cattle are used mainly to draw ploughs where plough cultivation has been adopted. Goats are also treated in the same way as pigs with this difference that they are not so frequently required for sacrifices to the deities. The dog is an important and an invariable companion in every hunting expedition.

CULTIVATION

The lands of the Birjhias are mainly of two kinds: the Beonra lands on the slopes of hills where shifting cultivation is practised and the ploughable lands. The Beonra lands are not fixed but have to be

changed every year. The ploughable lands are however various in nature. Attached to every individual household there is a plot of land enclosed within fence known as Bari lands. The slightly elevated but plain fields situated away from water-courses are called Tand. Those that are lower than the preceding ones and enjoy a better water supply are called Keta. While the fields that enjoy a perennial water supply, usually the beds of streamlets, are called Teona. Almost every family possesses one or more small plots of the above types of land.

The fertility of the lands ploughed by the Birjhias is very poor. Consequently taxes exacted from them are also much less than what other people have to pay for the better type of lands they enjoy. The taxes are directly paid to the landlord or to his representative by the individua's themselves and not through any co-villager. There is no fixed rate of taxes for the Beonra lands where this type of tillage is still permitted. About ten per cent of the total Arahar crops of the individual is the usual tax levied and is recovered in kind. The people say that they used to be treated more generously in earlier days when they were required to supply the landlord with only a handful of Birni grass (from which broom is made) and about two pounds of *Bansful* (bamboo buds) as taxes.

The Birjhias follow two kinds of cultivation. The members of a village together clear a large patch of hill-slope by cutting the trees and the undergrowth and burning them after they are dried in the sun. At the advent of rains with the simple implements, such as the dibble (Ramba) and the scratcher (Gorgani) they sow Arahar, Marua, different types of beans, cucumbers, gourds and several other less important crops. The Arahar seeds are dropped into the small holes made with the dibble; while the Marua seeds are scattered over the field after which the field is thoroughly scratched with the Gorgani. This type of cultivation is known as Beonra cultivation in this area. Along with it they also cultivate a few plots at the foot of hills with the plough. At the present day the latter type of agriculture is the chief food-producing activity of the Birjhias while the former is quickly going to disuse.

The people like Beonra cultivation very much. But as the government and the landlords have almost totally prohibited the cutting of trees and the undergrowth on the spur of hills they have been gradually forced to give up this method. Some of the landlords however still allow this mode of cultivation within their estates.

The plot of Beonra land cultivated one year almost looses its fertility next year, when only Marua and Gudli can be grown; a new Beonra land has to be prepared that year as before. In this way the Beonra cultivators have to move from place to place with their dwellings along with their new Beonra

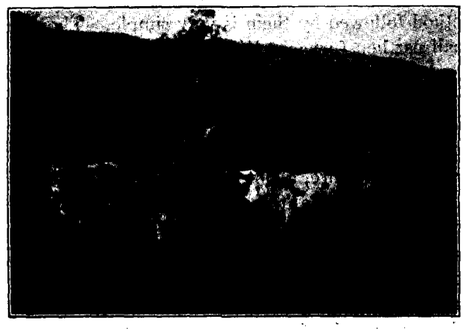


FIG. 3. TWO ASUR BOYS PLOUGHING AT THE FOOT OF A HILL.

lands. After five or six years trees again grow sufficiently high in the abondoned Beonra fields when they are cut down again and the plot is again brought under cultivation for another year.

Plough cultivation seems to have been adopted from the agricultural people, such as the Oraons, who live in their neighbourhood. But the process of adaptation seems to be rather slow; many people neither possess cattle nor plough and sometimes lack both. The reason for this perhaps lies in the fact that ploughable fields are rarely available to the average Birjhia. The Birjhias were dwellers on the hills where they practised shifting cultivation. But when forests were closed to them and they turned to the low lands they found that the fields were already occupied by other peoples such as the Oraons, or the price sought was so high that the poor Birjhia could not afford to pay that. They tried to plough the plain lands at high altitudes; but the output from the unfriendly soil was very meagre.

Most of the religious ceremonies of the Birjhia are connected with cultivation. Sowing and harvesting of crops and such other activities associated with

cultivation offer opportunities for individual and communal festivities.

IRON SMELTING AND BASKETRY

Besides the above occupations the average Birjhia also engages himself in some other avocations, such as iron-smelting and basketry. Iron smelting in fact is a very old industry of the Asurs traditionally associated with the very creation of the tribe itself. The method followed by them is very simple. They build small earthen furnaces (*Kuthi*) about three feet high, circular in horizontal section and slightly tapering from bottom upwards. The diameter of the base is about two feet and that at the top eighteen to nineteen inches. Through the middle of this structure runs a vertical aperture, about six inches in diameter, from top to bottom slightly widening towards the base. This is the hearth proper. This is first filled with charcoal and as the charcoal is burnt down it is fed from top with fresh quantities of charcoal mixed with small pieces of iron ore. A continuous blast of air is blown into the furnace, throughout the operation, with the help of a pair of bellows (*chapua*), adjusted near the opening of the hearth at the bottom of the

FIG. 4. SMELTING IRON IN THEIR PRIMITIVE FURNACE. AIR IS BLOWN INTO THE FURNACE BY THE PERSON WORKING BY FOOT A PAIR OF BELLOWS. ON THE TOP OF THE FURNACE ARE KEPT CHARCOAL AND ORES MIXED TOGETHER. THESE ARE DROPPED INTO THE FURNACE IN SMALL QUANTITIES FROM TIME TO TIME. THE WOMAN IS BREAKING THE LUMP OF ORES INTO SMALL PIECES.

furnace. The bellows are worked by foot. The opening of the furnace at the bottom is kept closed with dusts and ashes. After the operation is continued for some time a small hole is made in the dust and ashes at the opening with a poker, and the molten slag runs out through this hole. The slag hardens as soon as it comes outside and is removed with the pincers.

It has been found that after about five hours a furnace may yield about eight pounds of iron on an average. Of course this depends mainly upon the kind of ore used. At the end of the operation the white-hot block of iron is taken out of the furnace with the pincers and beaten with a hammer on a stone to remove the adhering slag. The reddish metal thus obtained is used for making ploughshares ; but when tools and implements are made, the metal is further subjected to a smelting process in a smithy. As the mass becomes white hot small quantities of dusts from the ground are thrown on it to "cleanse" it as the Asur explains it. The dusts and the impurities of the metal probably form a slag which is separated in the liquid state. The metal loses its reddish colour by this process.

Three kinds of ores are generally used by the people—(1) Tumba, (2) Gati, and (3) Polo. These on analysis have given the following results :

Tumba :—	SiO_2	5·69%
	Fe_2O_3	80·99%
	Al_2O_3	1·21%
	TiO_2	0·32%
	MnO	0·12%
	MgO	1·12%
	P_2O_5	0·48%
	Loss on ignition ...	9·76%
		99·69%

Gati :—This iron ore contains a higher percentage of SiO_2.

Polo :—	Fe_2O_3	67·68%
	SiO_2	12·12%

These occupations are not, however, of much economic importance at present, but the entire tribe seems to be divided into two groups on the basis of the two industrial occupations—iron smelting and basketry. There are many families which are traditionally iron smelters but not basket makers ; and there are others who are basket makers from old days but never iron smelters. But this difference of occupation has not been able to create any distinction as

among the Hindu castes. There is no restriction whatsoever on inter-marriage and commensality between the members of the two groups. Both the groups have been Beonra cultivators and look back to their happy days of Beonra cultivation very fondly.

Trading does not occupy any place of importance in the economic life of the people. They generally sell storing- and carrying- baskets made of bamboo, rain hats made from leaves, winnowing baskets, ploughshares made from iron smelted by themselves and sometimes bees-wax and deer-horns. They purchase salt, tobacco and such other articles with the money received for their works. Paddy, mustard seeds or Arahar pulses from the Beonra are sometimes sold when taxes are to be paid. There are also some people who, travelling from village to village, sharpen the ploughshares of the agriculturists and earn a living by this means.

DIVISION OF LABOUR

Ploughing in the field and sowing are masculine affairs while the women lend helping hands at harvesting the crop and threshing the grains. In the Beonra the women take part in planting, sowing and reaping but not in cutting and firing the trees.

Hunting is a male occupation out and out ; but women take part in fishing. Collection of wild tubers, flowers and leaves are generally done by the women. Iron smelting and basketry are mainly reserved for men but the women also do their share in working the bellows or in weaving a line or two of the basket when the men are busy elsewhere. Cooking and serving of food in the household are exclusively feminine activities. But at ceremonial feasts when a large number of the tribal people are to be fed it is done by one or more men who are experts in the art.

The Birjhias do not spin cotton nor weave cloths. They do neither make pottery. These things they usually get from the Hindu weavers (Baraik) and potters (Kumhar).

From a study of the different economic activities of the Birjhia-Asurs throughout the year it is found that from April to July the people have no crop to reap but that almost all the seed-crops have to be sown during this period. Mahua flowers collected in the previous months no doubt serve for some time but in June and July they get practically nothing to fill their stomach. Exodus to tea gardens to serve as labourers is no doubt a way to avert total starvation. But the demand from the gardens is said to have slackened very much in recent times and they are not the only people who are recruited for these gardens. Another way, and that is followed mostly, is borrowing money from petty money lenders. The interest charged by these unscrupulous usurers is simply shuddering. For a rupee borrowed two rupees are to be paid when the crops are gathered ; or if paddy is taken as loan double its quantity is exacted when paddy is harvested. But even with such high rate of interest the people do not get enough loans to meet their needs. The reason is that as people often fail to keep their words and do not repay in time the shrewd money-lenders give much less than what the borrowers actually need. It is also said that the money-lenders prefer repayment in grains to that in cash, because it brings a higher return. This is due to the fact that the repayment in grains is usually made during the harvest or immediately after it when the grains are sold at the cheapest rate. A couple of months later these grains are sold to the very same people at almost double the previous rate.

Indeed the economic conditions of the Birjhias appear to be more and more staggering as we go into the details of their life. It is inconceivable how these people pull on under such conditions. There cannot be any effective amelioration of their distress if they do not get better ploughable fields or if the restrictions over the cutting of trees on the spurs of hills are not relaxed. Cannot the provincial government concerned take some step in this respect and give relief to these wretched people who may not number more than a couple of thousand souls in all ?

Economic Uses of Fungi

S. P. RAYCHAUDHURI

Botanical Laboratory, Dacca University

FUNGI are associated with diseases of plants and animals. Whetzel (1918) refers to the earliest records of plant diseases observed in the days before 500 B.C. Information regarding blightings, blastings, rusts, mildews, and smuts can be traced in the writings of Hebrew writers. From very early times fungi were looked upon as enemies of the human beings. These however have a useful role in human activity.

The fungi are of immense importance in maintaining the fertility of the soil. They are responsible for directly breaking down all kinds of dead organic matter by biochemical processes until their constituent elements like carbon dioxide, ammonia, etc., are returned to the economy of nature so that the synthetic cycle may start again. The fixation of nitrogen in the soil which is accomplished by some of the fungi is an important factor in modern agriculture.

The fungi also play a very important role in the biochemical reactions in many industries, and without the existence of these lowly organisms those industries cannot have flourished at all. It is because of the presence of these organisms that we succeed in producing the different alcoholic beverages, cheese, bread and various organic acids of medicinal importance.

USE OF FUNGI AS FOOD

Mushrooms have been esteemed as food for centuries. Many references to them are found in ancient Greek and Roman literature. The cultivation of mushrooms, according to Rettew, Gahm and Divine (1938) was made during the reign of Louis XIV (1638—1715). By the year 1707 the cultivation of mushrooms was a popular occupation and the Frenchman Tourrefort published a complete description of the method of cultivation. The mushroom industry spread from France to England and other countries. The most extensive cultivation of mushrooms is carried out in France, and McRae (1910) reports that in 1901 almost 125,000 maunds of mushroom were sold in the central market of Paris.

The fungus *Morchella esculenta* (L.) Pers. is a very common food in Kashmir, and the mushroom (*Agaricus campestris*), the morel (*Morchella esculenta*), and the truffle (*Tuber*) are of frequent occurrence in the Punjab. *Volvaria terastria* B. and Br., *Lepiota mastoides* Fr., *L. albuminosa* Berk. and *Psalliota campestris* are regularly eaten in some of the villages in Bengal.

Unfortunately for the people of our country the idea of growing edible mushrooms on beds of horse-dung is very repulsive, and attempt has not yet been made to grow mushrooms on a commercial scale. Since a thorough knowledge regarding the utility of fungi is lacking among the cultivators, a useful source of some delicious dishes goes to waste. The mushrooms are cheap and have a nutritive value, and they can be used as a substitute for fish and meat.

It has been reported by Bose and Bose (1940) that about two hundred species of edible fungi are in existence whereas only about a dozen belong to the poisonous group. Those with a volva or sack, those with pink spores, those growing in woods, etc., should be avoided since they belong to the poisonous variety. The best method to avoid the poisonous ones is to get the mushrooms properly identified by a specialist before eating.

By chemical analysis it has been found that some of the Indian mushrooms are superior to the

English mushrooms; Bose (1921) has given the following tables:

INDIAN EDIBLE VARIETIES.

Name of the species.	Protein per cent	Carbo-hydrate per cent	Fat per cent	Ash per cent	Moisture
Volvaria terastrius ..	2·28	Trace	0·18	...	Analysed in dry condition
Collybia albuminosa ..	12·8	14·8	Trace	...	Analysed in dry condition
Agaricus campestris ..	2·736	1·6	0·37	0·15	95·2%
Puff balls (Gasteromycetes from Bankura, Bengal) ..	2·2	1·35	0·56	9·16	93·85%

ENGLISH EDIBLE MUSHROOM

(*Agaricus campestris*)

According to G. Masse.

Agaricus campestris ..	0·18	0·46	0·03	...	...

AMERICAN EDIBLE MUSHROOM

(U. S. Dept. Agric. Bull. 79)

Agaricus campestris ..	2·25	4·95	0·20	...	91·30%

FIG. 1. AN EDIBLE MUSHROOM, *Volvaria diplasia*, GROWN IN THE GREEN-HOUSE OF THE COLLEGE GARDEN, CARMICHAEL MEDICAL COLLEGE, CALCUTTA.
By courtesy of Professor S. R. Bose.

In 1908, Sir David Prain initiated a thorough enquiry into the possibility of mushroom industry in India, and it was found that there was a ready market for edible mushrooms in Burma, the Punjab, Kashmir and Afganistan.

Detailed accounts of the cultivation of edible mushrooms have been described by Bose and Bose (1940) and Padwick (1941).

MEDICINAL IMPORTANCE OF FUNGI

A few species of the fungi are used in medicine. Ergot or *Claviceps purpurea*, purging agaric or *Polyporus officinalis* and a few others are considered to be of immense importance. A variety of *Collybia albuminosa* (edible mushroom) is sometimes given to persons suffering from smallpox in villages, since it brings out the eruption.

INDUSTRIAL APPLICATION OF FUNGI

The biochemical activity of moulds is turned to good account in many industrial processes. The most important industrial application of the fungi lies in the fact that some of them, like the yeast, can induce alcoholic fermentation. Both the processes of brewing and of baking depend on the fact that yeast can convert sugar into alcohol releasing carbon dioxide.

Another very important economic use of the yeasts is found in the manufacture of alcoholic beverages by the fermentation of fruit juices, and grain malts.

The manufacture of mould-ripened cheese is another very important industry of unknown origin. There are two types of mould-ripened cheese, *viz.*, the soft cheese of the Camembert and Brie types, and the green or blue-veined cheese, of which Roquefort is of common use. Moulds like *Penicillium Camemberti* Thom., *P. caseicolum Bainier* and *P. roqueforti* are most commonly used for preparing the cheese mentioned above.

Several moulds are most extensively used in various industries for the production of organic acid as a result of fermentation. As early as 1891 Wehmer definitely established that *Aspergillus niger* is capable of producing oxalic acid. Similarly citric acid can be produced by the genus *Citromyces* (now included in *Penicillium*), gluconic acid by *Aspergillus gallomyces* as a result of fermentation.

Some of the fungi are capable of synthesizing fats from carbohydrates, and a few others can synthesize proteins.

FUNGI AS PARASITES ON INSECTS

Most of the crop plants are susceptible to insect attack, and there are several fungi which are capable of leading a parasitic life on those insects, thus killing the insects at a very early stage and saving the crop plant. These fungi are of much importance in the biological control of insect pests.

Human and animal life would have been seriously jeopardized if all these lowly organisms were not present. In the life cycle the part played by the lower fungi in breaking down dead organic remains and returning their constituent elements to the economy of nature is of paramount importance. Various industrial processes have flourished due to the activity of several moulds. These organisms are attracting the attention of scientists, and their biochemical reactions are a rapidly developing branch of modern research.

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HUMIDITY CONTROL IN MUSEUM

An unusual application of humidity control is to be seen in the Egyptian Department of the Boston Museum of Fine Arts. It is in connection with a 4600 year old limestone bust of Prince Ankh-ha-ef. As Egyptologists know, many limestone objects from Egypt are impregnated with salt which they have absorbed as a result of long burial in the tombs scattered about the country, often covered with sand. Since salt attracts moisture, the salt-impregnated limestone objects in the Egyptian Department first absorb moisture in damp weather and then give it off in dry periods. This results in the breaking down of the surface of the stone and in extreme cases, total disintegration. So the Museum's engineer and Dows Dunham, curator in the Egyptian Department, devised an apparatus to create for the bust, under a glass case, an artificial atmosphere in which the variations in humidity would be entirely eliminated, the relative humidity kept constant and thus allow the salt to be dormant. The case is connected by piping to a box of calcium chloride, a powerful moisture absorbent. A pump circulates the body of air in the case through the box. A gauge gives the relative humidity content of the air surrounding the bust at all times. Relative humidity is fixed to be kept at 30 per cent. A miniature gasometer connected by a tube with the inside of the case equalizes atmospheric pressure with the air outside.

—*Journal of the Franklin Institute.*

Notes and News

MEDICAL-PHYSICS LABORATORY OF THE UNIVERSITY OF CALIFORNIA

THE first medical-physics laboratory in the world is being built on the Berkeley Campus, and a five-man team of scientists will form the nucleus of a unique research division to explore the promising new fields opened by the atom-smashing cyclotron. The various branches of science are becoming so closely interwoven that no man can possibly cope with all the problems he will encounter in a single experiment. The new laboratory which will represent a union of physics and medicine and other allied branches, such as chemistry, bacteriology, biology and genetics will provide facilities to a number of specialists in different branches to concentrate on a single problem at one time. This will facilitate and intensify experimental work with radioactive substances and the neutron beam produced by the cyclotron in the new vast fields, such as the exploration of rudimentary life processes, the study of the normally functioning living body and the manner in which it absorbs foods, the investigation of the causes of various diseases including cancer and leukaemia. The research programme, which is being drawn up by Dr J. H. Lawrence, brother of Prof E. O. Lawrence, the inventor of the cyclotron, will be made possible by two important donations, first, a gift of 165,000 dollars to build and equip the building from the International Cancer Research ; second, a contribution of 50,000 dollars from the Columbia Foundation of San Francisco to support a five-year research programme. The medical-physics laboratory will devote entirely to experimental research and no treatment will be carried on there. The building will include chemical, physical, biological and biochemical laboratories, tissue culture laboratory and underground rooms for delicate radioactive measurements with electroscopes, electrometers and counters. The second floor will be turned over to physicists who will be working with the giant 4,900-ton cyclotron now being constructed on the Berkeley Campus. The primary tools in the new experimental programme will be the artificial radioactive substances produced by smashing atoms in the cyclotron. These have proved to be the most valuable research tool in the hands of biologists since the development of the microscope. Arrangements will be made in the new laboratory to take 'radio autographs'—self-photographs to demonstrate the distribution of radioactive elements in the tissues of animals and plants. In this technique the animals are fed with radio-elements and the tissue in which the distribution of the elements is to be determined is placed on photographic plate. The radioactive atoms leave their marks on the photographic plate and a picture of the actual distribution of the 'tagged' element in the tissues is obtained. Researchers at the Berkeley Radiation Laboratory have already made important discoveries and demonstrated that some of the accepted theories of body function were erroneous. Possibilities opened up by radioactive substances produced in the cyclotron are limitless.

CENTENARIES OF GALILEO AND NEWTON

BUT for the war scientists in Europe would celebrate this year the centenaries of some of the most famous men of science of all times. In happier circumstances, arrangements would certainly have been made for the commemoration of the tercentenary of the death of Galileo and the tercentenary of the birth of Newton on an international scale. But even amidst more urgent preoccupations it may be hoped that the nations of Europe will not allow the centenaries of two of the greatest scientific pioneers to pass quite unnoticed. It is well known how the researches and discoveries of these two great pioneers are closely interwoven and by strange coincidence in the same year in which Galileo breathed his last Newton saw the light of the days as if the latter appeared in the field just in time to take over the unfinished task of his illustrious predecessor.

Italy is the land of birth of modernism in art and science. The modern period in science emerged out of the Renaissance and it was in Italy that the foundations of modern science were laid. Galileo,

the illustrious son of Italy revolutionized the world of thought by his researches and discoveries and was primarily responsible for ushering in the modern age in science. The greatest of scientific pioneers in modern times, he perfected the telescope and showed men the new worlds of the heavens. His achievements in the domain of mechanics and dynamics were even greater than his astronomical discoveries and in his work on the laws of motion he paved the way for Newton. For his discoveries and for his obstinate advocacy of the heliocentric theory of the solar system, he was imprisoned by orders of the Holy Inquisition and after recantation, was allowed to be home interned in his villa at Arcetri near Florence. The Italian government has founded a great observatory at Arcetri in commemoration of the event.

To Newton we owe our knowledge of the law of gravity, of the principle which governs the existence and movement of the whole universe of sun, moon, earth and stars. He was attracted to astronomy, according to one story, by his desire to find out the truth about 'Judicial Astrology'. This was a term used in medieval times to denote what we now call 'Astrology'. But his discovery was the greatest blow to 'Astrology', because it took away the bottom out of the astrologer's hypothesis, that planetary positions in some way reveal the fate of individuals—a superstition which was legacy of the great Babylonian civilisation (3000 B.C. to early years of Christianity). The Royal Society of Great Britain duly recognized his genius by annually electing him president of the Society for the last twenty-five years of his life. To call him the greatest English mathematician and scientist would be poor praise. We may recall the best tribute paid to the memory of the world's greatest natural philosopher by the the English poet Pope.

"Nature and Nature's Laws lay hid in night,
God said: 'Let Newton be' and all was light."

EXPERIMENTS ON THE 'SUB-ELECTRON'

NEARLY thirty years ago, Prof. F. Ehrenhaft claimed to have obtained evidence of sub-electronic charges carried by minute solid particles. His evidence could not be confirmed by others and physicists did not believe in the existence of the sub-electron. In his well-known book 'Electron, Proton, Photon, Neutrons and Cosmic Rays' Millikan has devoted considerable space to the disproof of Prof. Ehrenhaft's hypothesis of the sub-electron. Undaunted by unfavourable criticisms from all quarters, Ehrenhaft has published (*Philosophy of Science, 8, 3, 1941*) a resumé of the results, obtained by him during the last 30 years, of experiments on the charges carried by minute solid particles in gases. The article summarizes the extensive and protracted researches carried out by him first at his institute in Vienna and later abroad after his expulsion from the institute. The charges have been studied in various forms of apparatus both at normal and at high pressures. Particles of wax and selenium of perfect sphericity as viewed under the miscroscope were prepared and studied. The uncertainties associated with the use of Stokes's law as a means of determining the masses of these minute particles were avoided. Ehrenhaft worked out a microscopical technique for the direct determination of their diameters, and produces evidence that the density of the particles is identical with that of the same substance in bulk. The very ingenious microscopic technique of determining the masses of the minute spheres has been fully described. Prof Ehrenhaft found that in many cases the particles studied carry charges which differ from the fundamental electronic charge or integral multiples of the charge, by amounts well beyond the limits of experimental error. Prof. Ehrenhaft believes that the anomalous effects are genuine.

RELATIVITY PERFECTED

ALTHOUGH relativity has been accepted and applied in all branches of physical sciences, it has heretofore been proved for certain special cases only. At the Princeton Meeting of the American Physical Society, Prof. Albert Einstein announced the final development (after 20 years' work) of his gravitational theory, and showed by a general and rigorous mathematical proof that the theory is applicable in all cases. A small note about this appeared in the February, 1941 issue of the *Sky and Telescope* The publication of the full paper will be awaited with interest by all scientic workers.

DESTRUCTION OF THE PULKOVO OBSERVATORY

REPORTS have filtered that in course of the Russo-German conflict round Leningrad, the famous Pulkovo Observatory has been destroyed in November 1941. The amount of destruction is not yet known.

The Pulkovo Observatory situated at 60° N.L. (more correctly 59° 47′) was the Greenwich of Russia. Established by the famous astronomer F. G. W. Struve in 1839 through the patronage of Czar Nicholas I of Russia, it enjoyed a unique position amongst the famous observatories of the world. It celebrated its centenary only two years ago.

The destruction of the Pulkovo Observatory will rank as one of the greatest acts of vandalism comparable to the destruction of the famous Museum of Alexandria in 641 A.D. by Amru, general of Caliph Omer, or the destruction of the great library of Granada in 1492 by Cardinal Ximines under orders of His Most Christian Majesty, Ferdinand the Catholic of Spain.

The Pulkovo Observatory has been the beloved home of Russian astronomers for over hundred years, and was once described as the astronomical capital of the world. It maintained this position till 1900, when the great American observatories began to come into the field. Even in 1903, Simon Newcomb wrote, "The instruments which Struve designed sixty years ago still do as fine work as any in the world . . . . The air is remarkably clear, and the entrance to St. Petersburg (Leningrad), ten or twelve miles north, is distinctly visible. Struve told me that during the Crimean War (1855) he could see through the great telescope, men on the deck of British man-of-war bombarding Kronstadt, 30 miles away".

The Observatory has been the scene of the labours of four generations of Struve's descendants Belopolsky, Backlund, and Gerasimovic. In 1878, it was provided with a 30″ refractor, which was then the biggest in the world.

Pulkovo was threatened with destruction in 1919, when the White Russians under General Yudenitch trained their guns on the observatory, but happily the apparatuses were stowed underground. In 1937, came a Trotskyist purge, in which director Gerasimovic, Perepelkin and Dneprovsky and many other famous workers disappeared without trace.

Director Gerasimovic is best known for his work on the extension of Saha's theory of thermal ionisation to stellar atmospheres, and Perepelkin carried out a famous work on the strength of He-lines in the solar chromosphere.

One of the descendants of the founder, Otto Struve, then a young man, was taken prisoner by the Turks during the last World War, but was rescued by American professors at Constantinople, and sent to U.S.A. for education. He is now director of the Yerkes Observatory, and one of the leaders of astronomical science in the world.

GEOLOGICAL SURVEY OF INDIA

THE decision of the Government of India to establish a "utilization branch" of the Geological Survey of India marks an important stage in the development of India's mineral resources. The editorial in our last May issue contained a hint about such a move. At present, the Geological Survey of India discovers mineral resources. By the formation of the utilization branch, it will be able to carry the work a stage further and show the ways in which the less well-known of India's mineral resources can be utilized to the full. The country is being searched for minerals essential for war purposes and deposits which have been worked for many years are now being re-examined. The new utilization branch, under the general supervision of the director of Geological Survey, will be concerned with small-scale mining operations, and the construction and operation of experimental and even pilot plants for smelting, etc. These experiments will be continued till it is clear that large-scale production can be undertaken by an ordnance factory or by a commercial firm. This new branch, estimated to cost Rs. 12 lakhs in 1942-43, will provide the link between the possibilities envisaged in data provided in a geological survey report and the stage of commercial development. It will demonstrate the practicability of commercially establishing the production of minerals, ores, metals, etc., which have not previously been fully utilized in India. The exploratory work already done by the Geological Survey of India shows that the newly-formed utilization branch will in time lead to the fullest possible utilization of India's mineral wealth.

Although this organization has been set up to explore India's war potential in minerals, it will also make an important contribution to India's post-war potential, and may become a permanent part of the Geological Survey of India.

MINING OF SULPHUR IN INDIA

DEPOSITS of crude sulphur discovered in Baluchistan are now being worked by Government. The crude sulphur is carried to the nearest railhead for subsequent transport to other parts of India. In view of the extreme difficulty now being experienced in obtaining sulphur from America and of the high prices charged, consumers would be well advised to investigate the possibility of using crude Baluchistan sulphur. An organization for the sale and distribution of the ore is being set up under the supervision of the Directorate-General of Supply, Chemicals Directorate, New Delhi, to whom all inquiries and

applications for the ore are to be made. Every endeavour will be made to supply ore containing not less than 50 per cent of sulphur. The impurities which occur with the sluphur are not of a harmful nature and consist mainly of silicious material and calcium sulphate. Free sulphuric acid occurs to the extent of about one per cent. Arsenic is present in traces, generally determined as less than five parts per million. The crude sulphur is free from selenium and bituminous matter.

Indian sulphur can be utilized in sulphuric acid plants using the chamber process and also in sugar refineries, provided certain modifications are carried out to existing burners. For certain purposes, refined sulphur is essential and the Department of Supply is pursuing the question of erecting a refinery as soon as possible.

PROGRESS OF SCIENTIFIC STUDIES IN DIFFERENT COUNTRIES

IT is a difficult matter to asses an individual scientist or the scientists of a country quantitatively and qualitatively. The only gauge for such a measurement which may be acceptable is the Nobel Prize award. An analysis of the Nobel awards in physics, chemistry and medicine (including the biological sciences) has recently been made by an American professor. Since 1901 when the Nobel prizes were initiated Germany has won 37, Great Britain 21, France and United States each 15, Holland 9, Sweden and Austria each 6, Switzerland 5, Denmark 4, Italy 3, Canada 2, Spain and India 1 each. If these winners are to be catalogued against the population of the respective countries, the 'percentage attainment' runs as follows: Switzerland 417, Denmark 400, Sweden 300, Germany 185, Great Britain 175, Austria 120, France 115, Canada 67, Belgium 40, United States 38, Italy 23, and Spain 13. The American professor has further divided the total figures for 1901 to 1939 into two groups, 1901-1930 and 1931-1939. The last decade has seen a stupendous and far-flung development of scientific studies and the achievements during this period may provide a good pointer to evaluation of scientific genius of the present times. In the first group of years, little nations like Denmark, Sweden led the group, and in the past decade also the position of little nations has been maintained. Switzerland wins a 465 'percent attainment' and the others in order are Holland 217, Great Britain 175, Austria 162, Germany 135, United States 78, France 44, Italy 22. The analysis has pleased the American professor, because United States is forging ahead. Besides the isolated geniuses—Nobel prize winners' qalities may be logically assumed to be unvarying, whether Americans or Germans,—the output of American scientists is also increasing in quantity as the manufacturing corporations of that country have steadily widened their outlook in utilising scientific talents. They have encouraged pure science along with applied science, and developments in both have been found to react with great gains to the industries.

ANNOUNCEMENT

THE sixth annual general meeting of the Botanical Society of Bengal was held recently. The total number of members of the Society is 137, and the progress of the society was reported to be satisfactory. Prof. S. P. Agharkar delivered his presidential address on "A plea for better organisation of botanical research in India". After dealing with the necessity of planning for the production of food, fuel, drugs, clothing, dye stuffs and other industrial raw materials, he suggested that a National Committee of Botanical Research be formed for the purpose. This Committee will include among its members representatives of the universities, the relevant resarch organisations and scientific societies. He was against the inclusion of administrative officers among its personnel.

The following were duly elected office-bearers and members of the Council of the Society for the year 1942-43.

President—Prof. S. P. Agharkar; *Vice-Presidents*—Prof. S. C. Mahalanobis, Prof. G. P. Majumdar, Mr S. N. Bal, Dr K. P. Biswas, Prof. S. R. Bose. *Hony. Treasurer*—Mr I. Banerji. *Councillors*—Mr K. G. Bannerjee, Dr B. K. Kar, Mr M. B. Dutta, Dr N. K. Chatterji, Mr E. A. R. Banerji, Dr J. K. Choudhury, Mr R. M. Datta, Mr A. K. Sen, Dr S. R. Sen Gupta. *Hony. Auditors*—Dr S. Mukherji and Dr K. T. Jacob. *Hony. Secretaries*—Dr S. M. Sircar and Dr B. C. Kundu.

SCIENCE IN INDUSTRY

STOVE BURNING SAWDUST GAS

A BRIEF note in an issue of the *Scientific American* just to hand says that a new sawdust burner is in use on the West Coast of the United States which reduces the sawdust to a gas which in turn is burnt in the combustion chamber to give efficient heating for cooking purposes. Details of construction of the stove are lacking. In a hopper beside the stove the sawdust heated by the flame above is converted into gas. There remains a very small amount of ash on the grate and no creosote is formed. The sawdust burns continuously so long as the hopper is kept filled.

LARGEST AUTOMATIC SYNTHETIC PHENOL PLANT

THE annual production of 2,000,000 pounds of plastic in the United States in 1921 has increased two hundred times in the year 1939. Phenol, popularly known as carbolic acid, is an important constituent in this plastic industry. It used to be obtained from coal, the process releasing an enormous amount of by-products for every pound of phenol. The synthetic chemical industry has grown apace in recent years and by the new Raschig process the by-products in the synthesis of phenol amount to less than one-tenth of a pound for each pound of phenol. Durez Plastics and Chemicals Inc. have built a new plant at New York at a cost of $2,000,000 for synthesizing phenol from several common chemicals. The plant is the largest in the world, and in spite of its size and the intricate processes involved it can be operated at full capacity by six men only with a supervisor for each shift. Every operation is automatic and the workers are only to stand at the master control panels and switch in and off according to emergency. Duplicate equipment has been installed at every stage for use in case of trouble. For motor troubles also, which are signalled in the panel, duplicate equipment is operated from the fixed position of the workers.

The chemical process consists in passing a vapour mixture of benzene, hydrochloric acid and air through a catalyst. From the resultant chlorobenzene, monochlorobenzene is distilled off. The pure monochlorobenzene is mixed with steam and is passed through a catalyst. The result is phenol with regeneration of the hydrochloric acid. The whole process is continuous and most of the materials formed and the catalysts used are re-used. Tall towers and big distillation units mark the plant interconnected with 40 lines of pipe, three miles of which are made of glass, porcelain, or rubber to withstand the action of acids at high temperatures.

GASEOUS AMMONIA AS A FERTILIZER

NUMEROUS derivatives from crude petroleum have been reported in these pages. With it as a principal constituent a huge synthetic chemical industry has grown up supplying the needs of industrial chemists, medical men and cosmetic manufacturers. In the United States gaseous ammonia is being now produced from the petroleum gas and is blown into irrigation water for fertilizing the soil during watering of the crops. Gas from oil fields is a mixture of methane, ethane, nitrogen, oxygen and several others. The petroleum gas is first cracked, and carbon and other unwanted substances are removed by washing and electric precipitation. Hydrogen, which is separated in the process, is purified by passing it through iron oxide boxes, an oil scrubber, a water scrubber and two caustic soda scrubbers. Final purification is made by cooling the gas to 380 degrees below zero, after which the gas is washed through liquid nitrogen obtained from the air. After removing the last traces of oxygen and carbon monoxide from the hydrogen, in the synthesis plant nitrogen is mixed with hydrogen to form gaseous ammonia. An acre of ground fertilized with 400 pounds of ammonia has been reported to have produced 736 crates of celery as against 565 crates from an acre dressed with a ton of the ordinary mixed fertilizer.

A MAGNETIC ALLOY

AN alloy composed of 6 to 16 per cent vanadium, 30 to 52 per cent iron and 36 to 62 per cent cobalt has been made which holds more permanent magnetism than any other commercial material. From the molten state it is cast into an ingot, which is hot-swaged to ¾ inch diameter. It can be drawn and rolled contrary to the usual property possessed by

other permanent magnet materials of importance. Many thousands of its tape 1/500 of an inch and 1/20 of inch wide were used for sound-recording at the New York World's Fair and such tapes are now used as endless loops in the Bell Telephone weather-announcing systems. The alloy when in final form, is heat-treated to develop its magnetic qualities. The alloy is named 'vicalloy' and is a product of the Bell Telephone Laboratories.

MINUTE ENEMIES OF STEEL

AT a recent convention of the American Gas Association a paper was presented on the damages done to steel and iron pipes, reporting them to be due to certain bacteria living underground in absence of oxygen, which thrive on the metal pipes. These bacteria on a magnification of 850 times under the microscope look like spirals or curved rods. The bacteria when brought on the surface have been found to survive for long periods, and cultures have been grown from soil water taken from under-ice. They also have withstood temperatures as high as 176°C. Once the feast of the bacteria has begun, the pipes can have a maximum life of ten years, depending on their thickness. The rate of corrosion under the bacterial attack is nearly three times that of other types with the exception of carbon contact, stray electric currents, and concentrated acid.

SERICULTURE INDUSTRY IN BENGAL

THE department of industries of the Government of Bengal has brought out an exhaustive bulletin (in Bengali) on the sericulture industry (Bulletin No. 97) of the province, which has been carefully prepared by Mr C. C. Ghosh, the deputy director of sericulture. All the different stages in the manufacture of silk have been described in order, beginning with the life of silk worms. In addition, brief accounts have been given of other competitors of silk, namely, eri silk, 'tasar' and 'muga' and rayon. The bulletin is very welcome specially when it is written in a way appealing to the indigenous people of the province. Natural silk used to be of great economic value to the province and the recent interest in the revival of silk industry in Bengal will be stimulated by the publication of this bulletin. Many improvements for a sturdy growth of the industry are needed and for all the processes from the rearing of worms to the reeling of yarns, new methods which have been developed as a result of scientific study into the problems here and abroad have been described. The whole account will be of great help to the silk manufacturers and merchants and the book is expected to serve well as a reference manual.

A PAMPHLET ON WATER HYACINTH

WATER hyacinth has been a serious pest in the economic life of Bengal. Up till now no reliable biological or chemical control of it has been found suitable. A small book, recently published, in Bengali (*'Kachuri-pana'*) dealing with the history of this plant and suggesting means for its eradication, which are of necessity purely manual, prefaced by a botanical description, will be read with interest by our villagers, who suffer most from this scourge. Hints are given about the different uses to which the collected plants may be put. The book is fully illustrated and the different subjects have been presented in a style which will appeal to those who most need education on the problem. The present assistant director of rural reconstruction, Bengal, who has been closely associated with the study of this problm for a long time, has compiled the book.

VILLAGE FISHERIES SCHOOL IN BOMBAY

AS a step towards the development of the fishing industry in Bombay Province, sanction has been given by the Government to the establishment of two fisheries schools—one at Ratnagiri and the other at Karwar—in which a special type of instruction intimately related to the life of a fishing village will be imparted.

The course will cover a brief general survey of the fishery resources of Bombay waters; the life history of fishes, feeding and breeding habits and migrations; an account of the fishing nets employed by Bombay fishermen, their advantages and disadvantages and the possibilities of new methods which might be successfully employed; navigation; icing and landing of catches; preservation methods; fish waste and utilisation of valuable products; and transport methods.

Practical demonstrations will be given of the use of simple mechanical contrivances, such as the lever, pulley and anchor. The use of the thermometer and the barometer, the maintenance of daily weather records, and the principles of an aquarium and its management will also be taught.

Lessons will be given in different methods of curing fish at the model fish curing yard, in the manufacture of fish manure, in rope-making and weaving of nets, elementary carpentry and fresh water fishery. Senior boys will also be trained on the launches to work as captains and mechanics.

Attention will also be paid to botany, personal hygiene, care of the home, and village first aid and physical culture.

JAPAN'S SOURCES OF MINERALS

IN an earlier issue of this journal a note on the mining industries in Malaya pointed out how Japan had secured a foothold in that country by organising the industries there and had arranged a steady supply of some of the important minerals required for war. In a recent issue of the *Geographical Review*, is given an account of the rapid, almost dramatic, expansion during the past decade of the mining industries of the Phillippine Islands, which may explain the unprovoked attack by Japan in the early stage of her offensives. Gold is by far the most important single item in the mineral industry of the Islands. In 1939 the Philippines held fifth place among the gold-producing countries of the world, outranking Mexico and surpassed only by South Africa, Canada, the United States and Australia. The output of base metals and non-metallic minerals increased in value in 1938 by 700 per cent over that in 1934.

Production of iron increased from 3,302 metric tons in 1934 to 896,357 metric tons in 1938 and the total output was shipped to Japan. Japan also monopolised output of copper and manganese. In 1940 only the destination of exports of the latter changed to the United States. The only other important mineral of the country, namely, chromite was taken by the United States. In the year 1929, there was no export of minerals from tht Port of Manila, but in 1940 the situation changed and in the export figures of the port gold stood second to sugar.

As regards sulphur, a vital element in the production of munitions, Japan is self-sufficient, with the addition of sulphuric acid from pyrites. Most of Japan's production of raw sulphur comes from deposits associated with volcanism. Areas near to volcanoes have been mined for a long time. In 1936 there occurred a volcanic eruption of nearly pure molten sulphur in great quantity. For a period of eight months, at intervals of three to five days, more than forty or fifty thousand tons of sulphur in hot liquid state were erupted from a small hole in the crater and filled a valley about a mile in length. The 'parasitic explosion crater' went through a definite cycle of eruption of pure sulphur, eruption of hot acid water and steam, a geyser stage and finally a period of quiet.

ELASTIC DISLOCATIONS OF MATERIALS

PROFESSOR Enrico Volterra speaking about Science and World Order under the auspices of the British Association for the Advancement of Science gave a brief idea of the recent applications of the theory of elastic dislocations which according to him represented the basis of progress in modern civil engineering.

The two problems, which he considered required the co-operation of pure and applied science and which were intimately connected with each other, were the study of the conditions and nature of elastic—plastic equilibrium and that of pre-stressing of structures. The solution of the first of these problems enabled us to extend our knowledge of the plastic condition of a structure, that is the state of stresses, deflections, and deformations in the material itself when its elastic limit was overstepped. The term "plasticity" was taken to indicate the adaptation of a non-elastic nature, suffered by a material under the influence of external loading or impressed dislocations and deformations. Evidently the term covered a far wider and general field rather than the limited and common interpretation it had in the physico-mathematical dissertation on such problems.

The second problem which was considered by the speaker to have vast potentialities in the post-war construction was the problem of producing in a structure itself certain artificial internal stresses by means of special operations which resulted in a greater structural stability. This pre-stressing theory represented a new contribution in the domain of civil engineering and it found many important applications, the most favourable being in the design of concrete arch bridges.

S. K. G.

Some Recent Developments in the Manufacture of Malleable Castings

MALLEABLE CAST IRON AND ITS USES

ORDINARY grey iron castings have tensile strength of about 15 tons per sq. inch with about 2% elongation. There are numerous graphite flakes in this iron which are responsible for the poor properties. In white cast iron there are no graphite flakes but the metal is very hard and brittle because of large amount of cementite. To make castings malleable white iron castings are subjected to long

annealing processes. White Heart or the Reaumar Process is the original malleablising process and is still used widely in small English foundries and on the continent. Black Heart Process is used in U. S. A. and to an increasing extent in England.

Malleable castings are used where ordinary grey iron castings would be unsuitable because of its poor ductility and low impact value and for which steel castings or forgings would be too expensive, *e.g.*, agricultural implements, motor parts, fans, electric motors and generator parts, sewing machine parts, locomotive and wagon parts, manhole covers, pipe fittings, etc. In the White Heart Process, white iron castings are heated in a mild oxidising atmosphere with the object of de-carburising the castings throughout. Composition of white iron used :—

Carbon	3 –3·5%
Silicon	0·5– ·9%
Sulphur	+ ·1%
Manganese	+ ·3%
Phosphorus	+ ·1%

Castings are packed with an oxidising material, *e.g.*, scale or used powdered iron ore in boxes, and then heated slowly to 900—950°C, held at the temperature for 3 to 7 days depending on the thickness of the castings and then slowly cooled.

In the Black Heart Process the composition of the white iron castings is :

Carbon ...	about 2·5%
Silicon ...	·7 to 1·0%
Phosphorus ...	Preferably ·05%
Sulphur ...	Preferably ·05%
Manganese ...	+ ·4%

Castings in this case are generally packed in iron pots with some inert material like sand. The pots are then heated in a furnace as follows :—

Heated at 900°C. ...	in about 30 hours
Held at 900°C. ...	about 50 hours
Cooling to 720°C. ... (4°C. per hour)	about 45 hours
Cooling to room temperature ...	about 5 hours
Total time ...	5½ days

The structure of the Black-Heart iron consists of ferrite and temper carbon (globular carbon produced by the decomposition of cementite during the annealing process). In case of White-Heart iron complete decarburisation extends up to about ½" below the surface. In the interior the structure is similar to Black-Heart iron.

Properties acquired by the Black-Heart iron process are :—

Tensile strength ...	about 22 tons per sq. inch
Elongation ...	about 16%
Izod Value ...	14 ft. lbs.;

By the White Heart iron process :—

Tensile strength ...	20-25 tons per sq. inch
Elongation ...	5 to 10%

RECENT DEVELOPMENTS

By super-heating the molten iron before casting, higher silicon content of the pig iron can be used in making malleable iron without the danger of the iron solidifying as grey iron (containing flakey graphite). The higher silicon content then accelerates the precipitation of temper carbon from cementite during annealing. Here iron used contains carbon between 2 and 2½% and silicon between 1·2 and 1·6%.

The actual process is tabulated below :—

Heat to 950°C. ...	30 hours (in special furnaces without boxes, about 15 hours).
Anneal at 950°C ...	for 5 hours
Cool (at the rate of 20°C. per hour to 720°C.) ...	11½ hours
Cool to room temperature	5 hours.
Total time ...	51½ hours (36½ hours).

Structure again consists of ferrite and temper carbon but in much finer form.

Properties are better than the malleable iron made by slower processes.

Tensile strength ...	about 28 tons
Elongation ...	about 20%
Izod Value ...	about 16 ft. lbs.

PEARLITIC MALLEABLE CASTINGS

The strength of the malleable cast iron can be increased, of course, with some loss of ductility in the following manner.

Heat to 950°C. and soak for 5 hours, Cool *at 20°C. per hour to 800°C.*, and then cool freely outside the furnace.

At 800°C. most of the carbon in the iron is deposited as usual as temper carbon, but the iron still contains about ·6% of carbon in solid solution and during free cooling ferrite and pearlite are formed. The ferrite mostly crystallises round the temper carbon giving a bull's-eye structure.

The tensile strength of about 40 tons per square inch can be obtained with about 5% elongation. Better ductility of castings can be obtained with slight sacrifice of the maximum stress by lengthening the above process in the following manner.

Heat to 950°C. and soak as usual for 5 hours and then cool at 20°C. per hour to 770°C. instead of 800°C. Soak for an hour and then cool freely.

The structure of the alloy now consists of temper carbon and ferrite with a little pearlite. The tensile strength is then about 35 tons per square inch but the elongation is nearly 10%.

S. C. Lahiry.

MEDICINE & PUBLIC HEALTH

LOSS TO INDUSTRY DUE TO MINOR AILMENTS

IN England, it is estimated that industry loses some 31½ million weeks' work in a year through sickness, mainly colds, influenza and gastric troubles. The British Medical Association has expressed the opinion that, both on humanitarian and economic grounds, more emphasis should be placed on the preventive aspects of industrial medicine. It is suggested that medical supervision should be directed to three essentials: (*i*) a continuous supervision of the health of the individual worker in his industrial environment, (*ii*) the prevention as far as possible of physical and mental illness ; and (*iii*) a service for the initial treatment of injury. The Association also urges close co-operation between the industrial medical officer and the worker's own doctor, as well as a liaison between the factory and outside medical services.

A BALANCED SCHOOL LUNCH

IN England, it is estimated that the energy value of the food required by a healthy child is about 2,500 calories a day. A circular recently issued by the English Board of Education to local authorities suggests that the main midday meal should provide about 1,000 calories and also most of the necessary biological protein and much of the fat. As a general rule, such a meal should provide: energy, 1,000 calories ; biological protein, 20-25 grams ; and fat (in all forms), 30 grams. When all children are under 11, the quantity of individual foods may be reduced by 25% in energy value and by 33% if they are all under 8 ; but there should be no reduction in biological protein and fat. These points have been emphasized as it is thought that the amounts available in war time may be necessarily restricted.

BLOOD SERUM AND PLASMA

IN view of the immediate necessity of building up an adequate supply of serum and plasma to treat air raid casualties among the civil or military population in this country, we draw the attention of our readers to the following excellently summarised note by S. O. Levenson and R. Finkelstein in the January issue of the *American Journal of Nursing*.

"The red cell fraction of the blood occupied the principal attention in all transfusion work until very recent times. The limitations for whole blood with respect to preservation and ease of transportation stimulated research and investigation towards the development of a substitute for whole blood. It very rapidly became evident that with the exception of the anaemias, the liquid part of the blood was probably the fraction most important in blood transfusions. Thus in shock, burns, acute infections and hypoproteinaemia, the patients required either the liquid fraction of the blood (serum or plasma) for volume replacement in the circulation or antibodies in the serum for the infection. It had long been known that crystalloid solutions were not adequate for volume replacements because they did not remain in the circulation. However, plasma and serum is a colloid solution which does remain in the circulation and consequently is effective for volume replacement.

A vast amount of work has been done in the last few years, and plasma and serum as a blood substitute have assumed a foremost position in the field of transfusion work. With the exception of the anaemias where red cells are essentially required, it is felt that the administration of serum or plasma is an adequate substitute for blood and in many instances is to be preferred to whole blood.

Although the two materials are intrinsically the same, certain practical differences serve to make serum preferable to plasma. Serum is the liquid portion obtained from blood which has been permitted to clot spontaneously, while plasma is the liquid portion obtained from blood which has been prevented from coagulating by the addition of an anti-coagulant, usually sodium citrate. The differences between the two materials are at least fourfold :

1. Ease of preparation: Plasma is more easily prepared than serum. Because there is a greater

margin of safety, much less care is necessary in processing plasma. Serum must be prepared by specially trained workers.

2. Efficiency of the product: Since serum contains no diluent, it is, cubic centimeter for cubic centimeter, more efficient than plasma which has been diluted by the anti-coagulant, sodium citrate solution.

3. Fibrinogen content: Serum is free of fibrinogen which has all been converted into fibrin in the spontaneous coagulation of the whole blood from which the serum is obtained. This blood protein is present, however, in only small amounts in whole blood and it is generally agreed that its absence from serum is of no significant importance. The plasma theoretically contains all the fibrinogen of the original whole blood from which it is produced; practically, however, this fibrinogen is a liability rather than an asset.

4. Stability: Serum may be kept indefinitely, remaining clear and usable. Plasma, however, on standing, usually becomes unsatisfactory for intravenous administration. The fibrinogen in the plasma apparently is slowly converted into fibrin precipitates of varying degrees and form. Sometimes "veils" are formed; at other times, granular debris appears which is usually grossly visible and may be coarse or fine. It seems unwise, to say the least, to inject such material intravenously, and it is advisable that plasma either be used when still fresh before this granular deposition occurs or that it be thoroughly filtered before use. Since administration is an emergency measure, such filtration required for old plasma impairs its practicability and introduces obvious technical difficulties. Serum, on the other hand, is free of this serious objection; it remains clear and can always be used immediately.

Human blood serum or plasma can be given without delay, threby circumventing this serious drawback inherent in blood transfusion. This advantage of serum or plasma is due to the fact that the various procedures necessary with whole blood transfusion have either been carried out previously or may be disregarded. During the careful processing of serum or plasma, all serologic, bacteriologic, and safety tests have to be performed. Typing and compatibility tests necessary for whole blood transfusion, are unnecessary when serum or plasma is used.

There are other practical advantages in serum. After proper preparation and bottling, serum may be preserved for a long period of time, one year or more. It requires no particular care (refrigeration is not important unless antibodies are to be preserved), and can be transported, handled, and injected as simply as a container of saline solution."

TECHNIQUE OF BLOOD TRANSFUSION

"PREPARATION of serum or plasma requires meticulous care. Blood is secured only from healthy, fasting, afebrile donors, who are free of allergy and who give no history of tuberculosis or malaria. The more common technique of blood collection is to withdraw the blood into a closed centrifuge flask through sterile tubing, with the aid of gently applied suction. Within one hour after the blood is drawn, it is placed in a refrigerator and usually within twenty-four hours is centrifuged for half an hour at between 1,500 and 2,000 revolutions per minute. The supernatant plasma or serum is then withdrawn into another sterile bottle through a closed system. Each specimen is tested serologically and bacteriologically. When the tests prove negative, eight or more individual plasma or serum samples are pooled together in a large container. A preservative is added, and the material is then filtered through a Berkefeld filter for clarification and as an added precaution to eliminate chance contamination. Berkefeld filtration is not commonly employed when plasma is processed, because of the great difficulty in passing plasma through a filter. The pooled serum or plasma is then bottled in given quantities into final containers, and random samples of these final containers are tested both bacteriologically and biologically for sterility and safety.

It is best to store and ship either the serum or plasma at 2 to 4 degrees centigrade. However, both serum and plasma are quite stable, and transient exposure to ordinary temperatures causes no deterioration. As a matter of fact, in many places, the plasma is kept at room temperatures for periods of weeks or months.

The further development with plasma and serum as a blood substitute, has been its preparation in the dry form. Various methods of drying the material have been devised, the most effective at the present time being those which dehydrate the plasma or serum from the frozen state. Once the material is thus converted into a powder, it can be kept for years without any significant changes. Before use, distilled water is added to the powdered plasma which goes into solution.

There are certain objections to dry plasma or serum, the chief ones being the additional set-up and the expensive apparatus required for drying as well as the arduous task of redissolving the dried material with non-pyrogenic distilled water. In emergencies, this loss of time for reconstruction is objectionable. For this, and for other reasons a number of workers have proposed, and are using, frozen plasma. The liquid plasma is "shell" frozen rapidly and stored in a refrigerator around 10 degrees below freezing. In the frozen state, the serum or plasma may be preserved almost indefinitely and when it is needed for administration, it can be rapidly melted in water at 37 degrees C. It must be maintained in the frozen state, however, at subfreezing temperatures until ready for use. Consequently, if it is to be shipped, it must be shipped in the frozen form. The express companies have employed refrigerators designed for this use. The frozen plasma is placed in one compartment and dry ice in another, and this maintains the plasma in the frozen state until it reaches its destination. Serum and plasma thus treated do not have to have their physical or biological properties altered.

Plasma or serum is given to the patient, by employing the same precautions as in blood transfusions. It is of importance that the operator does not apply heat either to the bottle of plasma, or serum, or to the rubber tubing through which the material is flowing, because an excess amount of heat will either cause partial coagulation or denaturation of the serum proteins and resultant severe reactions.

The entire field of blood substitute therapy is still comparatively new and rapidly advancing. Many changes may be expected in the near future under the stimulus of wartime need for transfusions of blood and blood manufacture."

Planning Wartime Nutrition

A. C. UKIL

Member, Nutrition Committee and Sanitary Board, Bengal

INTRODUCTION

THE approach of the war to India's borders, the consequent loss of some territories wherefrom food used to be imported and the difficulties of shipping, along with the needs of the army and the evacuees, have focussed the attention of the Government, the political parties and the public on the food position and food problem in India. The seriousness of the position was discussed by the author as far back as December, 1939[1] and also at a symposium on food planning at the Indian Science Congress early in 1941[2].

81% of the cultivated lands in India is employed for the production of food grains and 19% for the production of non-food or commercial crops, from the proceeds of which the peasant has to meet the cost of clothing, fuel, housing, social needs, taxes, farm equipment, medical expenses and payment of debt. During 1900-1934, while the population has increased by 21%, the area under food crops has increased by only 9%, chiefly by the almost complete conversion of pastures into tilled lands, with the result that 50% of the cattle in India today is underfed. The consequent impoverishment of cattle and other causes, which need not be dilated upon here, have led to a gradually decreasing productive capacity of the soil, so much so that, within the decade 1931-1940 the production of rice per acre has fallen by nearly 100 lbs. India's internal food supply has thus gradually fallen short of her requirements and India has gradually become a food-importing country. The present war, by cutting short the imports, has aggravated the food position further.

PRINCIPLES OF WARTIME NUTRITION

A properly constituted diet should not only contain *energy-yielding foods*, like cereals (rice, wheat, barley, jowarbajra, oats, Indian corn, etc.), fats and sugar, but also *protective foods* or foods which protect the body against dysfunction and disease, such as proteins* (animal proteins,—milk and

[1] Ukil, A. C.—Food Planning in Bengal, Food and Nutrition Exposition, Calcutta Corporation, December, 1939.

[2] Ukil, A. C.—Opening Address at the Symposium on "Food Planning in India", Proceedings of the 28th Indian Science Congress, January, 1941, Part IV, p. 95, *et. seq.*

* For adults, it is desirable that one-third of the protein requirements, and for growing children at least 50%, should come from animal sources.

milk products, fish, eggs, meat ; vegetable proteins—pulses, peas, beans, lentils and nuts), mineral salts and vitamins, which are available from green leaf vegetables, root vegetables and fruits. Infants and growing children need relatively more animal foods, particularly milk and milk products and vitamins, than adults. Expectant and nursing mothers have also their special requirements.

Studies made at the Stanford University in U.S.A. (1941) have shown that there is a close correlation between the economic status of a nation and the degree of its dependance on wheat and other starchy foods. Starchy foods constitute less than 40% of the diet of seven countries—U.S.A., Canada, Australia, New Zealand, Great Britain, Sweden and Switzerland—all of which are rich countries. By contrast, starchy foods supply more than 80% of the diet of India, Java, Rumania, Russia, Philippines, China, Manchukuo, Ceylon, Indo-China, Madagascar and Nigeria. By this standard Japan ranks slightly higher than other Asiatic countries, for starchy foods (mostly rice) make up only 70-80% of the Japanese diet.

The objective of war food policy should, therefore, be to supply (*i*) a sufficient quantity of the protective foods, and (*ii*) a sufficient quantity of the energy-producing foods. It has been found that food requirements of men joining the fighting services need to be increased by 25-30%. The same holds good in the case of persons engaged in the heavy industries. Apart from the requirements of food per head of the population, it will thus be seen that the total requirements of food in wartime in any country have to be increased by at least 5-10%. In planning the protein supply, the dairy cow should have priority over the more costly items, like eggs and meat†. The aim should be to encourage the production of *a few* well-selected items of food required for balanced nutrition rather than allowing uncontrolled production of food at random, as is permissible in peace time. There should be a well-determined balance between the production of the food and the cash crops. A sufficient quantity of those cash crops should be grown which can have an immediate internal market now, in order to enable the peasant to purchase the other necessities of life from his cash return. If we must increase food production, it is necessary to produce only such items of food as will conserve the nutrition of the people and will at the same time be within their purchasing power. Even when the production of food is increased, the difficulties will not be solved unless arrangements are made to ensure an equitable distribution of the food. The potentialities of a co-operative system of production, storage, transport and distribution of food should be fully explored. The Government in England is spending £50 millions a year to ensure this and to keep down food prices.

† Fish should not be considered as a costly food in a country so rich in rivers and so completely encircled by sea. A scientific development of fisheries may supply a cheap source of animal protein to a large percentage of the underfed population.

The war has increased the necessity of ensuring that the diet of the whole nation should be adequate for health. Victory goes to the nation which shows a physique free from illness and possesses the greatest stamina and powers of endurance. The Hon'ble Mr N. R. Sarker, member for Education, Health and Lands with the Central Government, has rightly pointed out that "a well-considered policy in reference to food production is an integral part of a successful War Effort". According to President Roosevelt, "Food is a weapon as much as munitions, and it will continue to be a weapon in all efforts towards ensuring a more orderly, prosperous and peaceful world".

Food production implies the production of the right type of food in adequate quantities and where this falls short of requirements, nutritionists and scientific workers should think of alternate sources of food, such as the introduction of soya bean, a rich source of protein and a crop of great commercial value, the "Ersatz" food of Germany, the use of natural or fortified foods, or the conversion of inedible food into edible food, etc. Fortified bread (*i.e.*, bread which is enriched with vitamin B_1, nicotinic acid and iron) is now on sale in Britain and America.

SOME FLAWS IN THE PRESENT "GROW MORE FOOD" CAMPAIGN

One following the reports of the various conferences on food production and control of prices, recently held under the auspices of the Central Government and the provincial authorities, will find to one's regret that, while they are advocating the slogan "Grow more food for man and animals" on a regional self-sufficiency basis, they have not taken into consideration the physiological requirements of food for the population according to age, sex and the nature of work, and have not taken into consideration the diminishing fertility of the soil and its suitability in different parts of the country for growing substitute food crops which may fill up the gaps in nutritional deficiencies caused by the war. For

example, the Central authorities have confined the consideration to four important crops, *viz.*, rice, wheat, jowarbajra and gram ; Assam has thought fit to encourage the production of rice and potato—both carbohydrate foods ; Bengal is encouraging the production of rice, dal (pulses), mustard oil, spices, potato and, if possible, wheat. In the re-planning of crops and the drive for increased food production during the present war, sufficient attention has not been paid to the nutritional requirements of the different sections of the human population and of cattle, nor to the requirements of irrigation and manure required for intensive cultivation, which should be particularly encouraged at the present moment.

Unless infants and growing children are supplied with enough milk, the whole of the future generation will be physiologically crippled. If it is intended to increase the production of milk and manure, cattle should receive more and better food. Nutritional studies in India have shown that a greater proportion of "energy-yielding" foods is consumed by the population than what is needed, in the absence or at the expense of essential "protective" foods. There is not so much shortage of "energy-yielding" foods as of "protective" foods in the dietary of the Indian population today. The drive should, therefore, be more, towards an increased production of the "protective" foods. Since milk, the best type of animal protein, cannot be made available for the whole population, priority of supply, out of the available production, should be given to infants and growing children. The adult population can make up for its deficiency by increasing the quantity of vegetable proteins, such as are present in pulses, peas, groundnuts and soya beans. A striking increase in the production of milk and milk products may be difficult to ensure at the present moment, but there is no reason why the deficiency in protein and other components of diet cannot be supplemented by the incorporation of suitable substitutes. For example, it has been shown in the Philippines that a combination of 80% rice and 20% soya beans[3], with the incorporation of such vegetables as are possible to grow in the compound of every house, make a balanced diet for the adult population. It has further been shown that milk consumption, both in adults and children, can be reduced to half by mixing equal parts of milk and steam-processed soya beans. Whole-meal wheat flour and hand-pounded coarse-grained parboiled rice have been shown to be more nourishing than polished grains. It has further been shown that if the rice water is not thrown away, the actual consumption of rice can be reduced by 25%. *Misuse and waste*, which are too common, both before and after cooking, and which account for a loss of 10% or so, should be prevented. *Cooking* should be so adjusted as to conserve the nutritive properties of food to the maximum. Overcoming ignorance and conservatism regarding food by propaganda and suitable education should be one of the planks of the Government approach to the problem of food crisis.

[3] For more detailed information, please refer to the following papers :—

(1) Ukil, A. C.—Soya Bean as a component of balanced diet, SCIENCE AND CULTURE, 7, 111, 1941-42.

(2) Soya bean in infant feeding—from the Section of Physiological Hygiene, All-India Institute of Hygiene and Public Health, SCIENCE AND CULTURE, 7, 563, 1941-42.

There is a great deal of force in the suggestion given by Mahatma Gandhi (*Harijan*, January, 25, 1942) that food taken in excess of the biological requirements is not only food actually wasted but puts an undue strain on the organs of digestion, detoxication and elimination which ultimately leads to ill-health. Another economy recommended by him is that half the quantity of grain as wheat or rice will meet the dietetic needs when not taken in sloppy form. He has advocated the use of raw salad vegetables and fruits and advises the elimination of sweet dishes altogether. Since the poor people cannot afford to have much of animal protein, he advises rich people, who are accustomed to take milk, cheese, eggs or meat, to eliminate pulses and oils from their food, so that the poor people can get a better supply of pulses and oils.

CROP PLANNING

In the light of the principles enunciated above, always remembering that the cost or cheapness of the food is directly related to the purchasing capacity of the population, it may be possible to map out suitable areas for the cultivation of a limited number of selected food crops, in terms of the nutritional requirements of the people, to curtail the cultivation of cash crops which had a mainly export market and to encourage the production of substitute dual purpose crops (*i.e.*, suitable both for food and commercial use), like groundnuts, soya beans etc. Such seeds should be used for cultivation as will grow easily and profusely under diverse climatic conditions and which possess the nutritive qualities for the food of a particular group.

If it is found that the available cropped area is inadequate or too infertile for producing the different components of food for the population, there are two alternatives open to us : (1) to increase the production on the available acreage by 2-3 times, as has been done in other countries, by intensive cultivation and

crop rotation with the help of easily manufactured manures, and thus to liberate enough land for the cultivation of food and cash crops and fodder, or (2) to increase the acreage by utilising current fallow and culturable waste lands by reclaiming them, where necessary, with the help of irrigation and drainage. Of the two methods, the former is suitable for a short-term planning and the latter for a long-term planning. In any case, a minimum but fair price should be guaranteed to the farmer, while the production should be so regulated that the population can get the optimum requirements at the minimum price.

A judicious crop planning implies the introduction of improved varieties of seeds and of improved methods of manuring ; an equitable distribution of grain, fodder, money and soil-recuperating crops on the available land ; a better control of pests and diseases ; the encouraging of a wider cultivation of those crops which are likely to make up the deficiencies in national diet, if necessary by offering concessions in money or remission of revenue assessment ; and finally, the introduction of suitable marketing and distributive machinery by means of co-operative seeds stores, storage and selling organisations. The middle-man should be kept away as far as possible, otherwise disturbances in supply of food and equitable economic return to the peasant may be created. The Government should be well advised to pay adequate attention to the development of industries which are subsidiary to agriculture. In Japan, this accounts for a considerable augmentation (20%) of the income of the agricultural classes. Spinning and hand-weaving have got immense potentialities in this direction.

In times of food scarcity, adulteration is a much greater danger than in peace time. This should be controlled by suitable education of the public and the punishment of miscreants.

Further, crop planning should be so directed that it serves the needs of the enormous starving livestock population we have in India today. Whereas in other countries, cattle manure is fully returned to the soil to enrich its fertility, in India the major part is burnt as fuel. This should be prevented by law. The enormous possibilities of using human excreta as manure have not been tapped in India, as have been successfully used in northern China and Japan. Composting and utilisation of town wastes for manurial purposes have remained practically untapped.

A press communiqué, published on the 22nd April, 1942, tells us that the Govt. of Bengal proposes to purchase 54 million maunds of rice, dâl and some other commodities, which they consider essential but which can be easily produced in the province, at a cost of Rs. 25 crores. While the cultivators are crying for better irrigation, manure and seeds, it would be an economically unsound policy to spend such a large amount for buying off the meagre excess produce from the fertility-depleted soil of the province. Such funds may better be utilised in ensuring a larger produce of planned crops, in keeping down prices and in buying such essential foods for nutrition as are not possible to produce in the province. Happily the announcement has since been repudiated by the Government in a subsequent statement.

The food shortage and the economic crisis may deepen as the war goes on. The problem is so vast and complex, requiring education, persuasion and judicious compulsion, that successful results can only be achieved if the Government and the people, irrespective of party affiliations, join hands and put their shoulders to the wheel.

The agriculturists, who form the bulk of the population (70%), are mostly illiterate and bound by old ideas of cultivation, crop planning and food habits. It should be possible to re-orientate their ideas in the present crisis with the combined aid of the State officers and leaders of the people. Where these efforts fail, a judicious restriction *cum* extension in crop planning might have to be enforced by law. Finally, rationing might have to be resorted to, but in this, we hope, the administrative authorities will keep in mind the nutritional requirements of the different groups of population.

The present war has focussed attention on food shortage during the war, but during the transition from war to peace afterwards when we shall be required to move from war economy to peace economy, we shall have to face tasks of human relief and rehabilitation on a colossal scale. It is extremely necessary now, therefore, to mobilise a body of experts in agriculture, technology, agricultural and animal husbandry, geography, nutrition, several branches of economics and political science, transportation, marketing and price behaviour, whose job it will be to study the problems in all its details and interrelated spheres until the food and socio-economic position is stabilised.

A PLEA FOR THE MORE EXTENDED CULTIVATION OF SOYA BEANS[4]

Experiments carried out in India have shown that soya beans contain about double the quantity and a superior quality of proteins as compared with pulses which are far inferior industrially. It grows easily and quickly on most types of soil and it enriches the soil while it grows. After steam processing and extraction of the oil, it can be turned into a perfectly edible food, both for man and cattle. The oil may be employed in making butter and lard substitutes and soap, while the expressed juice from soaked seeds can yield vegetable milk, cheese and curd. The range of byproducts is almost incredible, the chief of them being cattle food, enamels and varnishes, rubber substitutes, linoleum, rayon, printing inks, celluloid, explosives, glycerine and some parts of motor cars. Production and processing of soya bean in the United States have developed into a multi-million dollar industry according to the 1939 census of manufacturers.

It is thus not only a valuable food and forage crop but also a commercial crop of enormous possibilities, suited for both domestic consumption and export. Besides, it is one of the best soil-recuperating crops. There is no other crop which can feed, clothe and support the peasant from its production. Soya bean cultivation must be accompanied by the processing industry ; otherwise the conversion of the beans into human food and the utilisation of the numerous byproducts will not be facilitated.

It may be argued that the population in India generally are not yet accustomed to the use of soya beans in food. Education and demonstration, along proper lines, regarding cultivation and methods of preparation of food may remove the difficulties to a great extent. When the potato and groundnut crop were introduced into India doubts were expressed about the possibility of the people taking up their agriculture seriously, but experience has shown them to be false. It may not be possible to fit in the cultivation of soya beans in a short term planning during the ensuing season, but the possibilities of a long drawn-out war should be kept in mind and hence steps should be taken well ahead of further difficulties with regard to food supply. The Government should make arrangements for the distribution of soya seeds in the first instance, before the peasants learn to select the seeds themselves. The Agriculture Departmental Store in Kashmir sells the local, Itoson, and Manchurian varieties of seeds at Rs. 5/- per maund, which is cheaper than the cost of pulses in Bengal.

FOOD PLANNING IN BENGAL

The Government of India has declared that "a food production drive is primarily the responsibility of Provincial and State Governments". Although regional self-sufficiency and the maintenance of an equilibrium of prices should be the aim, a certain amount of inter-provincial co-operation and co-ordination in production and supply will be found to be of mutual advantage. Only the surplus crop of an area should be allowed to move into another area by such transport methods as are easily available locally. Hoarding foodstuffs should not be permitted except through consumers' co-operatives under State supervision. It would be of great advantage to the peasants if the production and supply methods are organised through the help of co-operative organisations. Such methods have proved themselves to be of great use in wartime China.

Let us now look at the problem in Bengal so far as the essential requirements are concerned. It is sad to think that Bengal does not produce enough food for her population and has to depend on outside areas not only for rice, but also for wheat, salt, sugar, pulses, butter and ghee, mustard oil, spices, many vegetables, groundnuts, eggs, fish and fruits, besides being compelled to import a large amount of tinned foods and dried fruits from foreign countries. The province has to import Rs. 30 crores of food materials every year. Some of these supplies have been dislocated, others may be jeopardized at any moment in course of this war.

The population of Bengal, according to the 1941 census, exceeds 60 millions, which marks an increase of 20% over the 1931 census. Of this number, approximately 5 millions belong to the age group 0-3 years, 3½ millions to the age group 3-5 years and 13 millions to the age group 5-15 years ; the remaining two-thirds of the population constitute the adult population. The number of expectant and nursing mothers would be about 3½ millions. It has already been pointed out that the latter section of the population and the infants and growing children require special nourishment for their health and growth.

Out of 30 million acres of net cropped area in Bengal, 19½ million acres are devoted to the cultivation of paddy. Bengal accounts for 29% of the all-India production in rice. Only 7% of the cropped area is irrigated and only 6 million acres are double-cropped. 12½ million acres of land are lying waste as current fallow and culturable waste. 14% of the total area in the province is under forests. Bengal has a vast water surface which is lying untapped so far as fish supply is concerned.

It has been shown that agriculture cannot support more than 250 persons to the square mile, and Bengal has an average density of 650 persons to

[4] For a more detailed consideration, please refer to the following paper :
Ukil, A. C.—A plea for an extended cultivation of soya beans in India, SCIENCE AND CULTURE, 7, 351, 1941-42.

the square mile. There is thus not only a shortage of cultivating and cultivable land but the actual production falls far short of the requirements of the population.

Among agricultural families, 22% live on agricultural wages, 12% live as *bargadars* or share-croppers, landless labourers number about 30 lakhs, while non-working dependants number 4 millions. It is estimated that only 20% of the people are well nourished.

An average adult belonging to Bengal requires for his daily diet 12 ounces of rice, 3 ounces of other cereals, 4 ounces of milk, 2 ounces of pulses, 4 ounces of non-leafy vegetables, 4 ounces of fresh leafy vegetables, 2 ounces of fats and oils and 2 ounces of fruits (including tomatoes), and if he can afford, a couple of ounces of fish and/or meat.

Let us now think in terms of some of the main nutritional requirements of the population.

MAIN NUTRITIONAL REQUIREMENTS

Milk.—With regard to the total milk production in an area, priority of supply should be given to infants and children up to 15 years of age and to expectant and nursing mothers. It will be doing a great good to them if a sufficient quantity of shark liver oil, which can be cheaply produced in this province, is supplied to them. Calculating the daily requirements of milk to be ½ seer per head up to 3 years of age and ⅓ seer per head up to 15 years, 60% of the milk produced in Bengal will have to be reserved for these groups, before the remainder is released for consumption among adults. 52,000 maunds of milk are used daily in the production of coagulated milk or *chhana*, which is chiefly employed in the manufacture of sweets, which are consumed by the richer sections of the adult population. The whole amount of the whey containing valuable nutritive materials is thrown away, which is a grave waste in the face of severe shortage of milk in the province. The production of *chhana* may be stopped, by law, during the war. This, of course, refers to our immediate requirements on a short-term basis. It is a much better plan to pay more attention to the dairy cow, in the larger interests of nutrition and agriculture.

Rice.—Deducting 550,000 tons for seed requirements, the shortage of food with regard to rice is estimated to be 2,000,000 tons. Until the occupation of Lower Burma, 1½ million tons of rice used to be imported annually into Bengal. We should encourage the cultivation of soya beans, so that the people may be induced to mix 20% of soya beans with rice. This will not only provide a much better or balanced nutrition to the people but will also entirely redeem the shortage of rice caused by the stoppage of exports from Burma. Fine milling of rice may be prevented by law. Proper educative propaganda should be made to ask people to take parboiled rice and not to wash rice and to throw away the water in which rice is boiled.

Wheat.—On an average, 300,000 tons of wheat are consumed every year in Bengal, as against a production of only 74,000 tons (=a shortage of 226,000 tons).

Pulses and beans.—Approximately 1,53,570 tons of these vegetable proteins are imported annually into Bengal. As regards mustard oil, the province produces only one-tenth of her requirements. A certain amount of maize (=6½ million maunds) is consumed, mostly by poorer people residing in the hills. A certain amount of pulses and oil cakes has to be reserved as protein food for cattle. Taking various factors into consideration, we suggest that the 2,000,000 acres of land released by the restriction of jute cultivation in the current year be employed as follows: 1,000,000 acres for the cultivation of soya beans, 500,000 acres for the cultivation of two varieties of pulses which grow easily and are cheap in price (*e.g.*, Bengal gram and *mati-kalai*), 250,000 acres each for the cultivation of mustard and groundnuts.

Sugarcane and potato: Vegetables.—In the dietary of a starch-consuming population, sugarcane and potato do not hold an important place. Hence, their cultivation may be considerably restricted. The consumption of *gur* may be encouraged, if necessary, in preference to vitamin-free sugar. If necessary, the consumption may be restricted by rationing and stoppage of imports. 250,000 acres can easily be spared out of the restriction of cultivation of these crops. Half of this area can be devoted to the cultivation of wheat and half to vegetables, especially green leafy vegetables, carrots, tomatoes and the other usual vegetables which grow easily in the country during different seasons of the year.

A large consumption of vegetables supplies valuable minerals and vitamins A and C in wartime but its need is not sufficiently realised by a large majority of people. It has been shown that a consumption of 30% more vegetables can make good the deficiency of fruits. It has been shown in England that vegetables grown on 300 square yards of land can supply the nutritional requirements expected from vegetables

for a family of five. Such vegetables should be encouraged which are easy to grow, have a sturdy crop and possess a good storing quality. If it is found at any time that the supply of vitamins from natural sources proves inadequate for the needs of the population, synthetic vitamins may be manufactured and supplied to them.

Fruits.—It is not possible to grow fruits at short notice, but the existing fruit production may be preserved by drying and canning, where possible. Wastage, which is far too common, should be discouraged. Among the cheap and easily available fruits, *amla* or *amlaki* is a rich source of vitamin C.

In estimating the acreages and the production, consideration has been given in the preceding pages to *the question of intensive cultivation and crop rotation.* If this is done, Bengal can not only obtain self-sufficiency as regards her food requirements, but may probably have a surplus. One serious defect which is not easy to overcome is with regard to the production of milk. The daily per capita consumption of milk in Bengal is 6 ounces, as compared to 40 ounces in Great Britain and 45 ounces in Australia. The annual production of milk per head of cattle in India is 30 gallons, as compared to 387 gallons in Denmark and 380 gallons in Switzerland. It is estimated that the number of animals per acre of grazing in Bengal is from 30 to 69, while the proper number should not exceed two or at most three. Such ill-nourished cattle of inferior breeds, instead of supporting the peasant, have proved a drag on him. Since most of the pasture land in the province has been misappropriated by man to satisfy his hunger, the State should investigate whether the cultivation of fodder crops on spare forest land can meet the situation, in addition to a more extensive use of leguminous forage and oil cakes which will be available as a result of the drive suggested above. Further extension of tea cultivation should be restricted, if possible, and any available land in the tea gardens should be utilised for growing cash crops and soya beans.

With her extensive sea face, Bengal ought to be self-sufficient with regard to salt, an essential commodity. Although Rs. 40 lakhs worth of spices are imported into Bengal every year, we have refrained from giving it a special consideration, as we think their use should be considerably restricted and, if necessary, one should be able to do without them in wartime.

It will be seen that we have omitted the consideration of the more costly foods like meat and eggs. Provided adequate milk supply is assured, their use need not be encouraged among the low-income sections of the population. Bengal, can, however, afford to be generous with regard to fish, if only the Government takes up the question seriously.

Finally, an appeal must be broadcast to the public to be thrifty, to have a smaller choice of the essential food ingredients needed for balanced nutrition, to modify cooking in such a way that less fuel and less time is needed for cooking, and not to waste any food that can possibly be conserved. One should not grumble at these temporary restrictions but rather boldly face the situation we are now confronted with. We should remember that, in spite of a considerable rationing in wartime Britain, the nutrition and health of the people over there are as satisfactory as can be conceived, for there science has been brought to the service of man in tiding over an emergency.

LETTERS TO THE EDITOR

[*The editors are not responsible for the views expressed in the letters.*]

K-EMISSION SPECTRA OF Si AND C FROM SiC

O'Bryan and Skinner[1] have suggested that in a typically homopolar compound like SiC, the K-β band of Si and K-α band of C in that compound will show identical features.

In SiC, we have examined the K-β band of Si by concave crystal (Gypsum) method in the 2nd order. This band consists of three humps. Beginning from the short wavelength side, the first hump (6714 XU) is very weak and occurs nearly at the foot of the band system, the second one which lies at the middle of the band, is the strongest and its wavelength is found to be 6725XU ; while the third band, though weak, is surely stronger than the first one and the wavelength of this latter band is 6745XU. Of course some satellites are also observed on the longer wavelength side of the main band of this compound. It is curious to note that the K-β band of *metallic Si* consists of two humps ; the wavelength of the strongest peak which lies on the shorter wavelength side is 6731XU which is really different from that found for Si in SiC (6725XU). The other weak band of the metallic Si has a wavelength 6745XU which is the same as found for the hump in the longest wavelength side of Si in SiC. It may be mentioned here that the *band at 6745XU* found both for metallic Si and SiC *corresponds to the K-β band of Si in SiO_2*.

The experimental results force us to conclude that the weaker band in SiC or in pure Si metal is really due to partial transformation of Si into SiO_2 in these substances under experimental conditions, but the weakest band in SiC (6714XU) has no counterpart either in metallic Si or SiO_2. The structure of K-α band of C in SiC as obtained by O'Bryan and Skinner is somewhat different from that found by Siegbahn[2]. However this spectrum (C in SiC) consists of three humps, the weakest is on the short wavelength side of the band, the strongest is at the middle while the weaker one lies in the longest wavelength region. The general characteristic of this spectrum is thus similar to that found for the K-β spectrum of Si in SiC assuming of course that the band at 6745XU in SiC, as mentioned before, is really due to this compound and not due to SiO_2.

The energy difference in e.v. between the two extreme humps of K-β spectrum of Si in SiC is 8·3 volts while the same difference in the carbon K-spectrum in SiC is 8 volts. The total band-width of SiK-β band in SiC is 14 volts while that of the carbon K-α in SiC is 15 volts. It is interesting to note that in spite of genuine uncertainty as to the origin of the hump at 6745XU in the *Si* K-β band from Si C, this experiment suggests the general correctness of the hypothesis that in a homopolar compound it may be assumed that one band of valence levels is held in common by all the lattice points and the density distribution of *p-electrons* in the valency levels is similarly reflected *in the K-spectra of these elements* forming the compound.

K. DAS GUPTA

Khaira Laboratory of Physics,
University College of Science,
92, Upper Circular Road,
Calcutta, 6-5-1942.

[1] *Proc. Roy. Soc.*, *176*, 239, 1940.
[2] *Erg. Naturwissenschaften*, *16*, 104, 1937.

ON THE SUM OF 'n' OBSERVATIONS FROM DIFFERENT GAMMA TYPE POPULATIONS

It is well known that the univariate gamma type (Pearsonian Type 3) distribution law,

$$df = \frac{a^{\lambda}}{\Gamma(\lambda)} . x^{\lambda - 1} e^{-ax} dx \quad . \quad . \quad . \quad . \quad (1)$$

possesses the mean conserving property, *viz.* the mean or sum of n observations from this law obeys a similar law with certain changes in parameters. It

is also known that even if λ is changed for each observation the above property holds. The object of the present note is to point out that the mean conserving property does not hold if the parameter a is varied from observation to observation and to find the exact distribution of the sum of n observations in this case.

If $x_1, x_2 \ldots x_n$ are Gamma variates with parameters $(a_1, \lambda_1), (a_2, \lambda_2) \ldots (a_n, \lambda_n)$; then $Z = x_1 + x_2 \ldots + x_n$ is found to follow the law,

$$\text{Const} \; . \; e^{-aiZ} . Z^{n\lambda - 1} \sum_{l=0}^{\infty} \frac{l! A_l Z^l}{\Gamma(n\lambda + l)} dz. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $n\lambda = \lambda_1 + \lambda_2 \quad . \quad . \quad . \quad + \lambda_n$

$$A_l + \frac{d^l}{da^l} \left[\prod_{j=1}^{n} \{1 - \overline{a_j - a}.a\}^{-\lambda_j} \right]_{a=0}$$

$$\text{Const} = a_1^{\lambda_1} a_2^{\lambda_2} \quad . \quad . \quad . \quad a_n^{\lambda_n}.$$

(2) can be written in n ways depending upon the value of a_i which we want to retain in the exponential. The case of equal a's is directly deducible from this, for $A_l = 0$, $l > 0$; $A_l = 1$, $l = 0$, hence (2) becomes

$$\frac{a^{n\lambda}}{\Gamma(n\lambda)} \; e^{-az} . \; z^{n\lambda - 1} dz \quad . \quad . \quad . \quad (3)$$

which is well known.

An interesting property about (2) is that it belongs to a family of distribution laws which possesses the mean conserving property. A particularly interesting case is the distribution of the sum of two Gamma variates which comes out as,

$$df = \frac{a_1^{\lambda_1} a_2^{\lambda_2}}{\Gamma(\lambda_1 + \lambda_2)} \; e^{-a_1 z} \; z^{\lambda_1 + \lambda_2 - 1} dz$$

$$\times \; {}_1F_1 [\lambda_2, \lambda_1 + \lambda_2, \overline{a_1 - a_2} z] \quad . \quad . \quad . \quad (4)$$

The moments, semi-invariants and recurrence laws of this distribution have been found out and the suitability of this curve for graduation has been studied. It has been found that it can be used for graduation for points of β_1 and β_2 lying close to and on either side of the line $2\beta_2 - 3\beta_1 - 6 = 0$ on the Pearsonian (β_1, β_2) chart. It may be noted that the Bessel function curve discussed by S. S. Bose[1] was found suitable for points lying in a certain cone below the above line.

C. RADHAKRISHNA RAO

Statistical Laboratory,
Presidency College,
Calcutta, 7-5-1942.

[1] S. S. Bose : On a Bessel function population, *Sankhyā*, Vol. 3, Part 3.

INCOMPLETE BLOCK DESIGNS FOR EXPERIMENTS INVOLVING SEVERAL GROUPS OF VARIETIES

In agronomy we usually come across experiments involving v varieties which could be classified in two or more general groups according to certain characteristics. For instance, the varieties may be classed under two groups, one consisting of local strains and the other of some newly introduced strains. If such an experiment is conducted in randomized blocks of k plots $(v > k)$, it may be of some interest to search for designs where our prime concern will be to achieve equal accuracy for comparisons between all pairs of varieties belonging to the same group. Combinatorially, this requires that the designs should possess the following properties:

Let there be m groups with $v_1, v_2, \ldots v_m$ varieties in them so that $\sum_1^m v_i = v$. Let each variety of the i-th group be replicated r_i times and b be the total number of blocks so that $\sum_1^m v_i r_i = bk$. Let each pair of varieties of the i-th group occur in λ_{ii} blocks ; and let each pair of varieties one of which belongs to the i-th group and the other to the j-th group occur in λ_{ij} (or λ_{ji}) blocks, so that

$$\sum_{j=1}^{m} v_j \lambda_{ij} = r_i (k - 1) + \lambda_{ii}$$

$$(i = 1, 2, \ldots m).$$

Examples of designs satisfying the above conditions can be had when, in Yates' balanced incomplete block designs, one or more blocks are missing[1]. Many designs can also be obtained by mixing up three or more of some of Yates' balanced designs, each of which has the same value for k. Any number of designs with $k > v_i$ and having same number of replications for each variety can be obtained by replacing each variety of a partially balanced incomplete block design by a group of varieties. Other methods are also available for construction of these designs.

The statistical analysis appropriate for these designs presents little difficulty, if only intra-block information is sought to be extracted ; and becomes particularly simple when $m=2$. Thus, if Q stands for k times a varietal total minus sum of the totals of the blocks where that variety occurs, we have, for the effects of each variety belonging to either group—

$$v_{1i} = \frac{1}{v_1\lambda_{11} + v_2\lambda_{12}}\left[Q_{1i} + \frac{(r_2\lambda_{11} - r_1\lambda_{12}) \sum_1^{v_1} Q_{1i}}{bk\,\lambda_{12}}\right] \quad \ldots\ldots\ldots (1)$$

$$v_{2i} = \frac{1}{v_1\lambda_{12} + v_2\lambda_{22}}\left[Q_{2i} + \frac{(r_1\lambda_{22} - r_2\lambda_{12}) \sum_1^{v_2} Q_{2i}}{bk\,\lambda_{12}}\right] \quad \ldots\ldots\ldots (2)$$

and $$r_1 \sum_1^{v_1} v_{1i} + r_2 \sum_1^{v_2} v_{2i} = 0 \quad \ldots\ldots (3)$$

The sum of squares for varieties is

$$\frac{1}{k}\left[\sum_1^{v_1} v_{1i} Q_{1i} + \sum_1^{v_2} v_{2i} Q_{2i}\right] \quad \ldots\ldots (4)$$

The variances for the three different types of varietal comparisons are :—

$$V(v_{1i} - v_{1j}) = \frac{2k\sigma^2}{v_1\lambda_{11} + v_2\lambda_{12}} \quad \ldots\ldots (5)$$

$$V(v_{2i} - v_{2j}) = \frac{2k\sigma^2}{v_1\lambda_{12} + v_2\lambda_{22}} \quad \ldots\ldots (6)$$

$$V(v_{1i} - v_{2i}) = \frac{\left[(v_1\lambda_{11} + v_2\lambda_{22}) + (v-1)\lambda_{12} + \frac{\lambda_{11}\lambda_{22}}{\lambda_{12}}\right]k\sigma^2}{(v_1\lambda_{11} + v_2\lambda_{12})(v_1\lambda_{12} + v_2\lambda_{22})} \quad \ldots\ldots (7)$$

A systematic study of these designs is in progress and it is hoped to publish a full account shortly.

K. RAGHAVAN NAIR
C. RADHAKRISHNA RAO

Statistical Laboratory,
Calcutta, 8-5-1942.

[1] K. R. Nair, *Sankhyā*, 5(3), 317, 1941.

THE PRESENCE OF THE HEAVY ISOTOPE OF HYDROGEN IN THE SOLAR ATMOSPHERE

An examination of the abundance of different elements in the solar atmosphere shows that hydrogen is the major constituent. It is of great interest to know if the heavy isotope of hydrogen is also present in any appreciable proportion. With this purpose the atomic spectrum of heavy hydrogen and the rotational lines of the band spectrum of OD in the ultra-violet are compared with the Fraunhofer lines in the solar spectrum.

Though the lines of the Balmer series of hydrogen have been traced up to the 37th member in the flash spectrum of the chromosphere, the ordinary Fraunhofer spectrum of the sun shows only the first five lines. The following table indicates the correspondence between the first four members of the Balmer series of heavy hydrogen and the nearest Fraunhofer lines in the solar spectrum :

TABLE I

Wavelength of Balmer lines of heavy hydrogen.	Wavelength of nearest Fraunhofer line.	Intensity of Fraunhofer line on Rowland scale.	Identification of Fraunhofer line as given in Rowland table.	λ Sun minus λ Lab
6561·00	6561·11	−2	atm. wv	+0·11
4860·00	4860·02	−3	—	+0·02
4339·28	4339·26	0	Fe	−0·02
4100·62	4100·58	−2	—	−0·04

The wavelengths of the Fraunhofer lines are taken from the Revised Rowland Tables. The wavelengths of the Balmer lines of heavy hydrogen are taken from Urey, Brickwedde and Murphy[1] who have calculated the wavelengths assuming that the nuclear mass of heavy hydrogen is twice that of ordinary hydrogen. They have also photographed the discharge through concentrated mixtures of heavy and ordinary hydrogen and find good correspondence between the observed and calculated displacements.

The last column in the table gives the difference between solar wavelength and that of the particular Balmer line. This difference for the D α line is as much as 0·11 A. The absorption line at 6561·11 in the solar spectrum has been identified with the absorption due to atmospheric water vapour. It is often found that when two equally strong absorption lines are close together the centre of the line is shifted. But in this case the line is too weak to extend such influence to 0·1A on either side as to mask another line. This suggests that the satisfactory coincidence

of the following lines is accidental. This is confirmed by an examination of the intensity of the four lines in the solar spectrum.

The electronic bands of OD have been analysed by Ishaq, Rao and Sastri, and Sastri. Ishaq[2] has photographed the bands at λ3065 which form the sequence $\Delta v = 0$ and which are also the strongest in the OD spectrum. The photographs were taken in the 4th order of a 10 foot concave grating, giving a dispersion of about 1·3A/mm in the region. Ishaq has catalogued 364 lines. The wavelengths of all these lines are compared with those of the Fraunhofer lines in the solar spectrum. Differences of not more than ± 0·02A between laboratory measurements and solar wavelengths have been reckoned as coincidences. The coincidences expected from chance are calculated using the formula of Russell and Bowen[3],

$$C = N\left(1 - e^{\frac{-2x}{I}}\right)$$

where N is the number of lines available for identification in the region under investigation, I the average interval between the lines in the OD spectrum and the larger difference permissible. The results obtained are summed up in table II.

TABLE II

Total number of lines in the OD spectrum ...	364
Observed coincidences (with previously identified and unidentified lines in the solar spectrum) ...	107
Observed coincidences with previously unidentified lines	43
Number of coincidences from chance	91

$$N = 582 ; x = 0{\cdot}02 ; I = 0{\cdot}246.$$

The observed number of coincidences is only slightly in excess of what is expected from chance and only less than half of the observed coincidences are with lines previously unidentified. These considerations show that no significance can be attached to the coincidenses.

This conclusion is supported from physical considerations also. The stability of the hydrides in the solar atmosphere is due to the great abundance of hydrogen which arrests the decomposition of the hydrides. The intensities in the sun of the probable lines of atomic heavy hydrogen show that even if heavy hydrogen is present, which is unlikely, it is not so abundant as to give rise to a sufficient number of OD molecules.

V. PARAMASIVA RAO

Solar Physics Observatory,
Kodaikanal, 13-4-1942.

[1] Urey, Brickwedde and Murphy : *Phys. Rev.* 40, 1, 1932.
[2] Ishaq : *Proc. Nat. Inst. Sc. Ind.* 3, 389, 1937.
[3] Russell and Bowen : *A. P. J.*, 69, 196, 1929.

PRESERVATION OF BOOKS AFFECTED WITH INSECTS

Twenty-two books affected with insects (white ants and silver-fish) were treated against the insects by the writer in May, 1940. The material of the books were ordinary paper, leather and old clean cloth piece. They were fumigated by 40% formaldehyde solution[1] for five minutes and were then taken out of the chambr. A countrymade preservative powder—orris root (*bach*), cloves (*labanga*), black pepper (*golmorich*) and cinnamon (*darchini*) in equal proportions—was prepared. Each of the things was powdered separately in a mortar and after mixing was put in a small cloth bag. The bag was placed on the shelf where the books were kept, and the books have up till now shown no new signs of attack.

MINENDRANATH BASU

Asutosh Museum Laboratory,
Department of Anthropology,
University College of Science,
Calcutta, 3-5-1942.

[1] SCIENCE AND CULTURE, 6, 188, 1940-41.

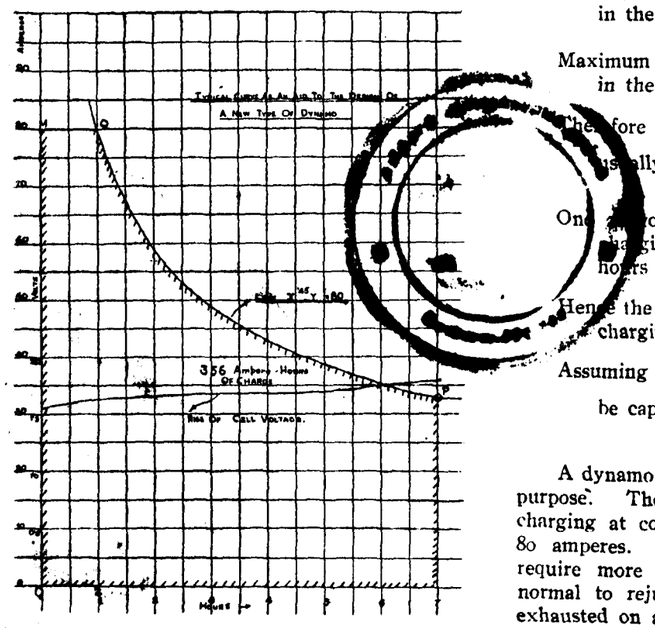
TYPICAL CURVE AS AN AID TO THE DESIGN OF A NEW TYPE OF DYNAMO

Electric power for the lighting of railway carriages and running fans, if any, is obtained from direct current dynamos fitted under the carriages themselves. All the carriages in a train composition are not, of course, fitted with dynamos, their number depending on the amount of electric power required for the purpose. These dynamos are essentially the same in principles as those installed in power stations for the supply of electric energy for domestic and industrial purposes, but they provide great differences in technical details of design. They are usually standardised to generate current at 24 volts and are driven by means of belts from the motion of the railway carriages. Consequently with the change in direction of the movement of the train, the direction of rotation of the dynamo alters. Amongst the peculiarities in the design of a dynamo for this purpose, the most outstanding is that the direction of flow of the current generated does not change even if the direction of rotation of the dynamo is altered.

In addition to the dynamos, storage batteries are also fitted on the carriages. These batteries supply current for the lights and fans in the train while it is at rest and consequently the dynamos cease to

generate. It is thus easily realised that these dynamos should serve the dual function of supplying electric current for the lights and fans as also the charging current for the storage batteries. Hence they must be capable of generating a quantity of current equal to the total current required for these two purposes at the desired voltage.

It must be noted here that in cold weather electric fans in trains seldom work. No lights also burn during the day. The storage batteries, therefore, are not required to supply any electric current during haltages of the train during these periods. But they continue to receive charging current from the dynamo while the train is in motion. They are therefore likely to be overcharged. This overcharging may impair their useful life. A principle of evolving a new design has been suggested here, which may obviate the above difficulty. This principle is illustrated by means of a typical curve.



The curve indicates the variations of the generated current so that as the battery comes nearer to full charging state, the rate of charging diminishes. The limits of maximum rate at the commencement of the charge and the minimum rate at the end of the charge have been so chosen that the battery will be fully charged during the period as laid down by the manufacturer. The current required to be delivered by the dynamo should be so adjusted that with all lights and fans of the vehicle in use, a quantity of charge equal to the discharge capacity of the battery may be given to it.

For the purpose of arriving at the curve, a hypothetical selection of a generator based on the following data has been made:—

(1) The railway coach is fitted with double sets of Edison A6H type (alkaline) batteries, each 24 volts.

(2) Current required for running all fans = 35 amperes.

(3) Current required for lighting all lamps = 25 amperes.

(4) Number of lights and fans usually in use = 60% of the total number of lights and fans in the train.

Maximum current required for all lights and fans in the carriages = 35 + 25 = 60 amperes.

Therefore current required for lights and fans usually in use $= \frac{60 \times 60}{100}$ or 36 amperes.

One 24 volt Edison A6H type battery requires charging for 7 hours at 42 amps. or 294 amp-hours change.

Hence the total current required for lighting and charging = 36 + 42 = 78 amps.

Assuming 95% efficiency, the generator should be capable of delivering $\frac{78 \times 100}{95}$ or 82 amps.

A dynamo of rating 80 amperes is chosen for the purpose. The maximum current available for charging at commencement is, therefore, obviously 80 amperes. Alkaline type storage batteries also require more ampere-hours of charging than the normal to rejuvenate the batteries when they are exhausted on account of excessive discharge in case the train haltages cover long periods or the generating equipments fail in course of the journey of the train. With this end in view 20% additional charge is proposed to be given. This would mean 353 ampere-hours of charge instead of 294 ampere-hours. Thus to enable the battery to receive the former quantity of charge, the lower limit has been fixed arbitrarily at 33·6 amperes.

The curve 'PQ' is the typical curve and follows the law $X^{0.45}Y = 80$.

It will be seen that charging commences at 80 amperes and is maintained at that current for an hour and then gradually falls to 33·6 amperes at the end of the charge. From the curve showing the rise of voltage of the battery it will be observed that the charging current diminishes as the battery advances towards its fully charged state.

The total quantity of charge will then be the area PQMON. Calculated vectorially it will be seen that appx. 356 ampere-hours of charge can be given to the batteries. This can also be deduced mathematically as follows:—

$$\text{Area PQMON} = \text{Rect. OQ} + \text{Area PQZN}$$

$$\text{Rect. OQ} = \text{OM.OZ} = 80 \times 1 \text{ or } 80 \text{ ampere-hours} \quad \ldots\ldots (1)$$

$$\text{Area PQZN} = \int_1^7 Y.\,dx$$

$$\text{but } Y = 80 \cdot X^{-0.45}$$

Hence,

$$\text{PQZN} = 80 \int_1^7 X^{-0.45}\,dx = 80\left[\frac{X^{-0.45+1}}{-45+1}\right]_1^7$$

$$= \frac{80}{55} \times \left(7^{0.55} - 1^{0.55}\right)$$

$$= \frac{80}{55} \times \left(2.916 - 1\right)$$

$$= \frac{80 \times 1.916}{55}$$

$$= 278.4 \text{ ampere-hours} \quad \ldots\ldots (2)$$

$$\text{Hence Area PQMON} = 80 + 278.4$$

$$= 358.4 \text{ ampere-hours.}$$

A. C. DE

*Calcutta, 9-4-1942.

CHEMICAL STUDIES ON THE HIMALAYAN SPECIES OF *BERBERIS*

Most of the European species of *Berberis* are found to contain commonly the alkaloid, berberine,[1] $C_{20}H_{19}O_5N$, while the chemical examination has revealed that the Himalayan species of *Berberis* contain umbellatine, $C_{21}H_{21}O_6N$, an alkaloid which has a nucleus similar to that of berberine.

Umbellatine was first isolated from *B. umbellata* Wall.[2] and has been subsequently identified from other species of the *Berberis*, e.g. *B. insignis* Hook. f.,[3] *B. lycium* Royle, *B. Wallichiana* DC. and *B. nepalensis* Spreng., growing in high altitudes of the Himalayas. A garnet red crystalline alkaloid, which in all probability appears to be a new base, has also been obtained from *B. nepalensis*, and the name, neprotine, is proposed for it.

Neprotine decomposes without melting above 200°, and is optically inactive. It forms elongated prisms on slow crystallisation. It is easily soluble in alcohol and water. It forms an orange red hydrochloride, an orange coloured picrate, a yellow coloured sulphate, a yellow nitrate and a yellow amorphous chloroplatinate. It loses weight amounting to 3·5 molecules of water and retains 1 molecule of water of crystallisation even on drying in vacuo over P_2O_5 at 100°. The results of the analyses of neprotine and its salts did not show a definite molecular formula for it. The formula, $C_{18}H_{21}O_6N$, is given to neprotine provisionally, as it is found to tally with most of the analytical results of neprotine and its salts.

B. nepalensis has been put in *Mahonia* section of the *Berberis* and is also called *Mahonia nepalensis* DC.[4] A comparative botanical study of both *Mahonia* or *B. nepalensis* and *B. vulgaris*, a species of true *Berberis*, shows that internal microscopical structures of both plants are similar; the external characteristics of their stems and specially leaves differ only to a limited extent. Since *M.* or *B. nepalensis* and the true species of the Himalayan *Berberis* yield umbellatine, they might be also said to be similar on chemical grounds. With due reference to classification of plants on chemical basis[5], it might be suggested that the name of *B. nepalensis* be retained for the said *Mahonia* species, and other *Mahonias*,[6] yielding berberine, the major alkaloid of the true *Berberis* growing in Europe, might preferably be classified as *Berberes*.

The chemical investigation of the rare species of the Himalayan *Berberis* is in progress.

R. CHATTERJEE

St. Joseph's College,
North Point,
Darjeeling, 14-4-42.

[1] Henry, "The Plant Alkaloids", Edn. 1939, page 335-56.
[2] Chatterjee, *Jour. Ind. Chem. Soc.*, *17*, 289, 1940.
[3] Chatterjee, *Jour. Amer. Pharm. Assoc.*, *30*, 247, 1941.
[4] Hooker, "Flora of British India", Vol. I, page 109.
[5] Manske, *Can. Jour. Res. Sec. B.*, *17*, 51, 1939.
[6] Parsons, *Pharm. J.*, *13(iii)*, 46, 1882-83, Rüdel, *Arch. Pharm.*, *229*, 631, 1891; Castro, Santos and Valenzuela, *Univ. Philip. Nat. appl. Sci. Bull*, *2*, 401, 1932.

INFLUENCES OF MEAN ANNUAL RAINFALL AND ALTITUDE ABOVE SEA-LEVEL ON THE COMPOSITION OF CLAY FRACTIONS OF INDIAN LATERITIC SOILS

Robinson and Holmes[1] examined the relationship among the mean annual rainfall, temperature and the chemical composition of 45 different clays, as exemplified by the molecular ratios

$$\frac{SiO_2}{Al_2O_3+Fe_2O_3} \text{ and } \frac{CaO+Na_2O}{Al_2O_3+Fe_2O_3}$$

from soil samples obtained from 30 centres in the United States. The samples represented the more important types of agricultural soil having a wide range of texture, with large geographical distribution and varying conditions of soil formation. Only special soil types such as peats and laterites were omitted. They found an inverse relationship between both of these ratios and the rainfall, but they could trace none with the temperature. Crowther[2] has separated the effects on soil formation of rainfall and temperature by a statistical examination of the data of Robinson and Holmes and has shown that the existence of a high positive correlation between annual rainfall and mean annual temperature in the agricultural areas of the United States accounts for the failure of Robinson and Holmes to recognise the influence of temperature on clay composition. Crowther has shown that the ratio of silica to alumina in the clay fraction is correlated negatively with rainfall and positively with temperature.

It appears however, that the effect of altitude above sea-level on the composition of the clay fraction, has not been examined so far, at least in the case of Indian lateritic soils and it was therefore felt desirable to consider whether any mutual correlations exist between annual rainfall, altitude above sea-level and the chemical composition of the clay fractions of Indian lateritic and red soils, where the $\frac{SiO_2}{Al_2O_3}$ and $\frac{SiO_2}{Al_2O_3+Fe_2O_3}$ ratios of the clay fractions are fairly low. Preliminary examination of the temperature data indicated that temperature has no significant correlation with the $\frac{SiO_2}{Al_2O_3}$ ratio of the clay fraction. The mean annual rainfall and altitude data and the $\frac{SiO_2}{Al_2O_3}$ ratios of the clay fractions of lateritic soil samples of surface layers from twentytwo different localities of India, were considered. The relative importance of the rainfall and altitude effects on the compositions of the clay fractions was estimated by evaluating the standard errors of the individual regression coefficients and applying Student's test to the twentytwo samples.

TABLE.

Regression Equation for clay compositions on Rainfall and Altitude.

R = Mean Annual Rainfall in inches.
H = Mean Altitude in feet above sea-level.
S = Molecular ratio of SiO_2 to Al_2O_3 in the clay fraction.
SE = Standard error.

		Regression coefficient.	
		SE	t
S = 3·882457 − ·015153R ...	S on R	·006735	2·25
− ·000258H ...	S on H	·00009617	2·68

5% value of t for 19 degrees of freedom = 2·093. Hence both the regression coefficients are significant. It may thus be concluded, that so far as lateritic soils of India are concerned, both annual rainfall and altitude above sea-level data possess significant negative correlation with the $\frac{SiO_2}{Al_2O_3}$ ratios of the clay fractions.

The full paper will be published elsewhere. The thanks of the author are due to Mr Mukunda Chandra Chakravarti, M.Sc., for his kind help in the calculations of the standard errors of the individual regression coefficients.

S. P. RAYCHAUDHURI

Chemical Laboratory,
Dacca University,
Dacca, 23-4-1942.

[1] Robinson, W. O. and Holmes, R. S., U. S. Dept., *Agric Bull.* No. 1311 (1924).
[2] Crowther, E. M., *Proc. Roy. Soc. B.*, *107*, 10, 1931.

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