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The Social Implications of Science

THINGS that happen before our eyes from day to day tend to be accepted by the common mind as a matter of course—as things for granted—although they, in fact, may result in revolutionary changes in our modes of life. The truly phenomenal advances in science and technology during the last two hundred years have affected almost every aspect of our individual and social life. None of us to-day can have his food or take a step or write a line without using the inventions of science in one form or other. Nevertheless, even otherwise cultured men are not few who are ignorant of the elements of science and are not sufficiently conscious of the role that science is playing almost literally every minute in their life. This, by itself, would be a misfortune. But it is rendered all the more regrettable when it is considered that science, apart from working far-reaching changes in our social life, has now placed in the hands of man powerful engines of destruction which, if used by unscrupulous men or for unscrupulous purposes, can produce untold harm, and even wipe out whole communities.

The reality of the danger has never been so great to Western people generally as now. The rise of totalitarian States and the ruthless way in which the latest scientific discoveries are being used for aggressive purposes openly and unabashedly have struck terror in the minds of the people in the Western democracies,, who were relatively calm up till now. Mass dismissals of eminent scientific men in Central Europe for reasons of political conviction or [illegible] faith have unnerved the Western democrats and scientists who were hitherto unmoved by the suppression of scientific and scholastic careers in colonial countries on political grounds by the governments of these democrats themselves. They were still unaware that suppression of freedom in any part of the globe is potentially dangerous to freedom even in their own countries, even as slums in a city are dangerous to the richer people themselves, who are directly or indirectly responsible for the slums. To-day the Western intelligentsia have become alive to the problem. It is now generally admitted that scientists themselves are to a certain extent to blame for this state of affairs, not because, as is sometimes erroneously argued, scientists are responsible for the discoveries and inventions, but because scientists, being naturally absorbed in their own work, have not paid due regard to the social implications of their work. They, as a class, have not tried to inform and train the public mind with regard both to the good and bad potentialities of scientific kiowledge and to instruct people to adjust social and international relations to the progress of science and technology. Efforts are now being made in America and in England and also internationally to make scientists conscious of the duty they owe to society in this regard.

The International Council of Scientific Unions set up last year a Committee on Science and its Social Relations, which was instructed to prepare a report on the effects of science on human life and social relationships and present its report in 1940. For this work the Committee is expected to receive collabo-

ration from national correspondents and scientific societies in various countries. The Council of the American Association for the Advancement of Science has also formally pointed out in a resolution the changes in the physical and mental environment of man and the complexities of social, economic and political relations that are being brought about by science and technology. Both the British Association for the Advancement of Science and the American Association are seriously considering these social problems created by science. Views of representative scientific men in Great Britain on this question were sought recently by *Nature* and there seems to be a general concensus of opinion that a society for the study of the social relations of science is needed. A concrete scheme for the organization of such a society and for its lines of work is naturally more difficult of formulation, but it constitutes at least a re-assuring symptom of the growing awareness of scientific minds to the urgency of the question. We consider it desirable that the Indian Science Congress Association should discuss this question in a plenary session in the forthcoming Lahore Congress, and, if necessary, organize a Committee for the study of this question. The social implications of science are even more ignored in this country than elsewhere, as the mass of the people is ignorant and illiterate. But India is as much within the orbit of the action of deadly scientific weapons as any other country. India, as a nation, is really at the threshold of her scientific career, and if her scientific men organize their thoughts betimes with regard to social, economic and political questions, it may be possible to arrest drift and guide her destinies in the direction of social progress and peace. India, like many other countries, abounds in quacks—medical, political and spiritual and the help of sincere scientists trained to study problem with objectivity and without prejudice may help to steer her course evenly in a sea of passion and unscientific thought.

It is, however, clear from the above that those scientists who are willing to study social problems must bring a scientific mind to bear upon this study. It is not infrequent that scientists, who pursue a scientific way of thought in the laboratory, fail to retain the same attitude in other affairs, and in the study of social questions considerations inspired by prejudice and selfishness have a knack of coming in unobtrusively unless kept at bay by a vigilant mind. It must be borne in mind that the present dislocation in the entire world is the result of maladjustment between scientific development on the one hand and social and international relationships on the other. Scientific methods of communication have largely wiped off the significance of geographical and even of linguistic boundaries. Mankind inevitably, by the impact of science, is moulding itself into one community economically, but the mental separateness persists, racial and national rivalries exist and have even aggravated, religious intolerance has in some countries increased. The light of science must dispel this darkness and show the way for mankind. If Indian scientists can form themselves into such a body with such a task, they will deserve well not only of India but of the entire world.

Electrical Charge Distribution in Thunderclouds

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THE phenomenon of lightning has been, for a long time, known to be a case of discharge of electricity through the atmospheric medium. The nature of the distribution of electric charge in the clouds and its surroundings, the cause of such an accumulation of charge to produce the lightning discharge and the nature of the lightning process itself are even now under various experimental investigations. Although success in some of the items may now be rightly claimed, it cannot be said that the whole phenomenon has been thoroughly explained and properly visualized as yet.

Normal Electrical Condition of the Earth and the Atmosphere

Before proceeding to study the problem of thunderclouds and lightning, one must be fairly acquainted with the electrical condition of the earth and the surrounding atmosphere in fair weather. It has been observed that a level field, freely exposed to the sky, is negatively charged. This means that the potential V in the lowest layers of the atmosphere increases with the height, the rate of increase dV/dH being given by $F=4\pi\sigma$, where σ is the amount of charge per sq. cm. of the ground. The average magnitude of the positive potential gradient in fine weather is of the order of 100 volts per meter, corresponding to a negative charge on the ground of 3 e.s.u.$=10^{-9}$ coulomb per sq. meter.

The potential gradient soon begins to diminish, and before a height of 10 km. is reached the potential becomes almost independent of the height. Thus the potential, relative to the earth, of the whole upper atmosphere above regions of fine weather is less than one million volts. The normal vertical field of the atmosphere tends to drive positively-charged bodies downwards and thus gives rise to an air-earth current. The average air-earth current in normal conditions is about 2×10^{-16} ampere per sq. cm., that is, about 1,000 amperes for an area equal to the whole surface of the earth. The positive charge thus carried from the atmosphere to the ground in one minute is of the order of 1/10th the surface charge on the ground. It has, therefore, to be borne in mind that unless some other process has been working in a reverse sense, the earth would lose its whole negative charge in about ten minutes. The nature of this compensating process has long exercised the minds of physicists. One theory is that the lightning discharge brings a surplus of negative charge to the earth. In view of the fact that we have about 1,000 active thunderclouds over the earth at any instant, the continuance of the negative charge on the earth would be easily explained, if it could be shown that the discharge between the cloud and the ground gave negative charge to the ground and the thunderclouds induced an earth-air current of considerable amount.

Polarity of Thunderclouds

Whatever may be the process (the exact process has not yet been well established) which renders the thunderclouds electrically charged, it must be based on the fundamental idea that both positive and negative charges are created in the active sphere of a thundercloud and the two types of charges separate in different directions as in the charging of a condenser by the familiar *Wimshurst machine*. A thundercloud must, therefore, be electrically bipolar. If the charge in the lower portion of the thundercloud is *negative* the thundercloud is said to be of *positive polarity* and *vice versa*.

The general method of finding out the polarity of a thundercloud is to find out the electrical field on the surface of the earth in the presence of a thundercloud, whether near or distant, or the change in the

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ELECTRICAL CHARGE DISTRIBUTION IN THUNDERCLOUDS

field during a flash. The general method of finding out the field or the change of field on earth was devised by C. T. R. Wilson. In principle the method consists in determining the charge induced on an earth-connected conductor by means of a capillary electrometer. The earth-connected conductor could be of the form of a test plate lying on the ground and properly shielded or a copper sphere placed at a few meters above the ground and connected through the electrometer to the ground. If the capacity of the whole conducting system is known, the potential or the field is easily determined, from the reading of the electrometer.

Appleton and his co-workers, while studying the nature of the atmospherics, have used the cathode-ray oscillograph for the determination of the sign and magnitude of net changes of the earth's electric field due to a lightning. This, however, does not enable one to measure the steady field on the surface of the earth. The oscillograph yields, moreover, certain complex details, all of which have not yet been explained. Simpson tried to decide the question of polarity of thunderclouds on general grounds. He attempted to form a complete picture of the origin of charge distribution in a thundercloud, which automatically links up the question of polarity.

The origin of electricity in a thunderstorm was considered by Simpson to be due to the breaking up of water drops by an upward current of air. It was considered by him that, when a water drop is so broken up, the water particles acquire a positive charge and the air gets a negative charge. In the case of thunderclouds, generally, the air enters the cloud at its lower base and proceeds upwards in a slanting direction. The vertical component of the upward current of air increases as the air passes into the storm area and reaches a maximum at the lower half of the cloud. Outside the region again, the vertical velocity is less. Water drops cannot enter this region of maximum air current and are, therefore, checked, broken up and thrown upwards only to accumulate again and repeat the same process.

Some of these water drops, however, will slip downwards by the side of the region of maximum velocity. Regarding the electrical nature of the region it was considered that the process of breaking water-drops above the region of maximum velocity, *P*, gives a positive charge to the water drops in the area. The negative charge is carried away by the air and is distributed in the remaining cloud. The distribution of charges will, therefore, be as shown in the adjoined figure 1. We see from this figure that the heavy rain drops near the centre of the storm are positively charged and the rain

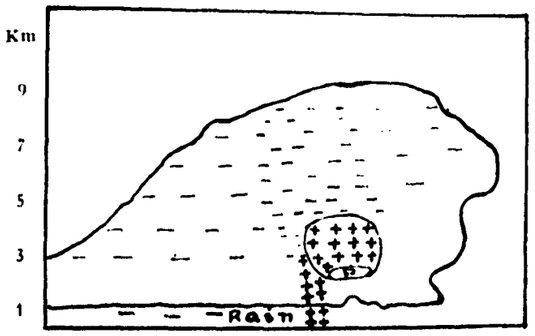

FIG. I.

drops in the region away from the centre are negatively charged. The separation of the charges convert the thundercloud into something like a huge condenser. Simpson says that the charge of the rain drops has sometimes been found to be positive and sometimes negative. Sometimes the rain drops have a mixture of positive and negative charges. This is, evidently, in accordance with his theory.

On the assumption that the air is unable to withstand more than a certain definite electrical intensity and that the mobility of the negative electrons is much larger than that of the positive ions, Simpson argued that a positive discharge is expected to create an intense field at the end of a *progressing* channel of positive charge, with a tendency to produce branches. A negative discharge, on the other hand, cannot produce a channel but forms a diffuse ionized region. Experimenting in the laboratory, he found a characteristic branched discharge from the positive terminal and a diffuse glow from the negative terminal. Further experiments with a positively charged plate to represent the earth and a negatively charged sphere to represent the cloud gave, at comparatively shorter distance, a thick discharge from the plate to the sphere. The general nature of lightning

photographs show many branched discharges and many unbranched thick ones, the majority being branched discharges downwards. Thus he came to the conclusion that the lower end of the active thundercloud is positively charged and the thunderclouds are, therefore, of *negative polarity*. This is evidently what the picture depicted by Simpson leads us to believe.

However elegant and complete the theory propounded by Simpson may appear, it has not stood the test of subsequent and more elaborate experiments of Schonland and other workers, who have definitely established that the thunderclouds are generally of *positive polarity*.

Experimental Tests on the Polarity of the Thunderclouds

The question of polarity of thunderclouds was first attempted by Wilson by studying the change of electric field on the earth due to a lightning.

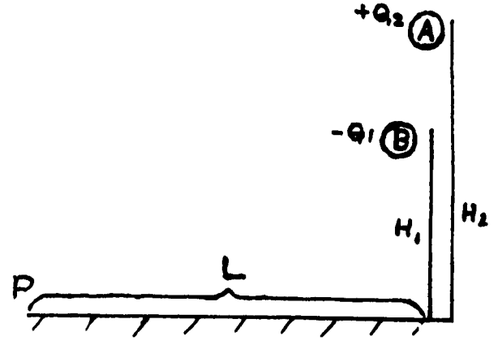

FIG. II.

From his observations he came to the conclusion that a great majority of the thunderclouds were of positive polarity, that is, the lower portion of the cloud was negatively charged. Experiments by Appleton, Watt and Herd with the oscillograph also supported the idea of positive polarity of the thunderclouds. Schonland and his co-workers are responsible for the elaborate and definite proof on the question of polarity of the thunderclouds. The recording apparatus used by Schonland was like that of Wilson, —a copper ball or a test plate worked along with a capillary electrometer. As a preliminary to the working theory, it is considered that thunderclouds are essentially bipolar. In a bipolar cloud of the ideal condition shown in the figure II, the field at the point of observation *P* is given by,

$$F=\frac{2\,Q_2\,H_2}{(H^2_2+L^2)^{3/2}}-\frac{2\,Q_1\,H_1}{(H_1^2+L^2)^{3/2}}$$

where Q_1 and Q_2 are the negative and positive charges and H_1, H_2 their heights from the ground, L is the distance from the base of the cloud to the point of observation. For distances L less than a certain critical value, the second term predominates and for large distances the effect of the first term predominates. *Thus with increasing distance L between the cloud and the station the field will change its sign.* In general, however, this may be difficult to observe due to the presence of several thunderclouds at varying distances.

Electrical nature of the cloud may also be determined by studying the change of field associated with a lightning discharge. We may consider three types of lightning discharges,—that between the positive or the negative charge and the earth, or between the two poles of the cloud. Writing *C* for the earth and *A* and *B* for the positive and the negative poles of the cloud, the sudden change of field resulting from the various discharges may be given by the following expressions,—

Discharge *AC* [positively charged part of the cloud to the earth],

$$\Delta F=-\frac{2\,Q_2\,H_2}{(H_2^2+L^2)^{3/2}}$$

" *BC* [negatively charged part of the cloud to the earth],

$$\Delta F=+\frac{2\,Q_1\,H_2}{(H_1^2+L^2)^{3/2}}$$

" *AB* [Lower Cloud negative], ΔF

$$=-2\,Q_2\left[\frac{H_2}{(H_2^2+L^2)^{3/2}}-\frac{H_1}{(H_1^2+L^2)^{3/2}}\right],\ Q_1>Q_2$$

$$=-2\,Q_1\left[\frac{H_2}{(H_1^2+L^2)^{3/2}}-\frac{H_1}{(H_2^2+L^2)^{3/2}}\right],\ Q_1<Q_2$$

It is evident as in the case of the steady field, previously discussed that the pole to pole discharge gives a reversal in the change of field observed as the distance changes. This can be tabulated in the form :—

Discharge.	Sign of sudden field change. Distant cloud of positive polarity.	Near cloud of positive polarity.
AB	Negative	Positive
BC	Positive	Positive
AC	Negative	Negative

It has been observed that the great majority of lightning discharges pass between the upper and the lower parts of the cloud. Discharges from the lower pole to the earth are less frequent, while the discharges from the top pole to the earth are rare. With a cloud of positive polarity, generally, all *distant* discharges within the cloud (*AB*) should produce negative change of field, while lightning discharge in a near cloud of positive polarity (*AB*) should produce positive change of field.

If the observed positive field changes due to distant discharges are all associated with discharges to the ground, *C*, then, it may be said that no positive field changes are associated with discharges between the clouds and the cloud is of positive polarity.

The steady fields due to near and distant storms are respectively positive and negative for negative polarity and negative and positive for positive polarity. In view of the superimposing fields this is, however, not an absolute criterion.

The records of observation definitely favour a positive polarity of the cloud.

(1) Out of 523 *distant* discharges *within* the cloud 517 were associated with negative field changes and 6 with positive. (Type *AB*).

(2) Out of 54 positive field changes of distant clouds 48 were associated with discharges to the ground. (Type *BC*).

(3) Positive steady fields were associated with distant storms and negative steady fields with near storms.

These observations of Schonland have been later verified by Halliday and others. Having thus established that the thunderclouds are of positive polarity, that is, the base of the cloud is negatively charged, it can now be explained why in spite of the steady air-earth current of normal conditions (positive charge moving to the ground) the earth maintains the constant negative charge on its surface.

Explanation of the Negative Charge on the Surface of the Earth

Wilson was the first to suggest that the exchange of electricity between the thunderclouds and the ground may be an important factor in the maintenance of the earth's negative charge, the replenishment of which, in view of the fine weather air-earth current, is an outstanding problem of atmospheric electricity. This exchange can take place in three ways, *viz.*, by the momentary currents due to lightning discharges between the cloud and the ground, by the total charge carried by the downpouring rain, and by the continuous current carried by the ions in the powerful electric field between the cloud and the ground. The last effect is expected as a result of point-discharges from trees and bushes below the cloud.

Occasions of strong positive fields below active thunderclouds are negligible. There is a preponderance of strong negative fields, which causes the point discharge current to be mainly upwardly directed. The earth must, therefore, gain a negative charge from this effect. It has been shown that the lightning discharge takes place between the negative cloud and the earth. The earth, thus, gets a negative charge from this effect also. The rain, on the other hand, may be expected to convey a positive charge to the earth, as the falling drops, whatever their initial condition, will intercept enough of the positive ions before reaching the ground.

In order to estimate the point discharge currents from trees and bushes below the cloud, Schonland selected some natural source of point discharge, which is a typical tree in the region in which the experiment was carried out. This was cut down at the base and mounted upon sulphur-ebonite insulators. The tree was joined to a current-measuring instrument, the connecting wires being properly shielded. A unipivot galvanometer was used as the current measuring instrument, which was earthed properly.

It could read to tenths of a microampere. The current observed rapidly increased with the increase of field, as will be seen from the following table:

Steady field on the surface of the earth Volts/meter.	Current in microamperes.
—3,500	·07
—5,500	·20
—11,000	1·00
—16,000	4·00

Positive fields being due to distant storms are never very powerful and, therefore, the current is always negligible. Measuring the average current due to the various storms at different distances and finding out of the chief sources of point discharges and their relative abundance, Schonland made a rough estimate of the total point discharge current between an active thundercloud and the ground. He found this current to be 2·1 amperes. The effect of momentary currents carried by lightning discharges is ·1 ampere in an upward direction, charged rain carries 0·02 ampere downwards.* In view of the abundance of active thunderstorms at any time, it is probable that the air-earth current is well balanced by the gain of negative charge by the earth due to thunderstorms.

Determination of the Electric Charge Distribution in the Thundercloud

In a very recent experiment, Simpson has measured the potential fields in the thundercloud itself, by means of sounding balloons and has found out the general nature of the charge distribution in the clouds. These results are in general agreement with the idea of the positive polarity of the majority of the clouds, thus tallying with Schonland's results and with those of others. Simpson has also modified his theory to suit the general nature of the charge distribution in the clouds as found now, and has carried out further laboratory experiments to justify his theory.

* Recently Dr S. K. Banerjee has reported that he has found the total charge carried by raindrops to be negative and of sufficient amount.

The main principle of his work was to attach a point-discharge system with a sounding balloon. The record of the discharge was imprinted on a chemical paper which was made to rotate by means of a clockwork. Arrangements for recording the humidity and the pressure were also sent along with the balloon. All the scientific instruments were released by means of a fuse at any desired height and these came down by means of a parachute. The soundings were generally made in thunderstorms or in showers.

The records show that at least two-thirds of the soundings give a negative potential in the lower regions up to 8 km., which is usually above the base of the thunderclouds. From the top of the negative gradient up to eight or nine kilometers positive gradients predominate. The evidences at greater heights point to negative potential again. There are, however, also cases on record, which start with a positive potential, change to a negative potential and again pass over to a positive potential. These records indicate that although generally the charge in the lower part of the cloud is negative and the upper part positive, there are some cases where the balloon meets a positive charge to start with and then comes to a negatively charged region followed again by positive charge. It has been further calculated that the centre of gravity of the main negative charge lies in the region of temperature above 0°C, while the centre of gravity of the positive charge lies in the freezing temperature region of -10°C. The specimen records are well illustrated by Z_1 and Z_2 in the following figure III,

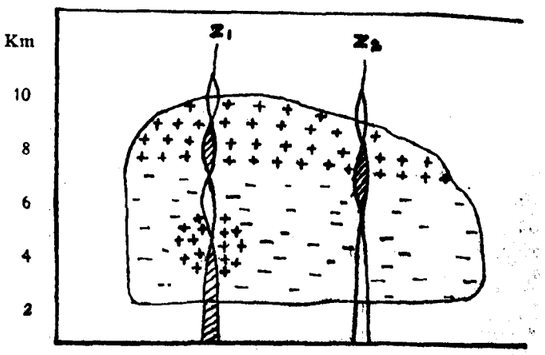

FIG. III.

where the shaded portion denotes the positive gradient and the unshaded ones the negative

gradient. The majority of the records are of the type Z_2. These records are explainable on the basis of the cloud charge distribution shown in the figure. The modifications necessary from the earlier theory of Simpson arise from the fact that there is a large positive charge at the top of the cloud and the negative charge in the general cloud is much denser. This means that the general nature of a thundercloud charge is positive above and negative below, while only under specially selected regions a concentration of positive charge is found embedded in the lower region. The previous breaking drop theory of Simpson had accounted for the concentration of positive charge in a limited lower region. As regards the upper positive charge, it is now suggested that the mutual impact of ice crystals results in the ice becoming negatively charged and the air positively charged. This is based on observations made in the Antartic by Simpson. In view of the fact that the upper region of positive charge is below the freezing point temperature, occurrence of ice crystals in the region is according to expectation. The general settling of negatively charged ice would then result in a separation of electricity with the positive charge above the negative. Simpson, however, points out that this explanation has not yet been confirmed by satisfactory laboratory experiments.

Conclusion

In conclusion, it may be suggested that there are two types of thunderclouds generally. One, that is associated with considerable amount of rain and the other, which is not associated with much of rain. In the whole series of experiments by Schonland in South Africa, during the three months in which a considerable number of thunderstorms were studied, only 2·02 inches of rain fell. Scarcity of rain suggests smaller water drops and, therefore, one should not expect the breaking of drops to occur in such cases. The absence of this mechanism would indicate that there is no accumulated positive charge in the lower region of the thunderclouds. In the case of thunderclouds associated with much rain one expects the breaking of water drops process to be in force and hence an accumulation of positive charge somewhere in the lower strata. By studying the potential gradient in these two different types of clouds, one could try to verify the theory of breaking-drops given by Simpson. As regards the suggestion that the ice crystals settle down gradually with negative charge, giving the positive charge to the air above, it is possible to try various laboratory experiments to test it and before the theory can be definitely accepted one must find out the verification. In view of the large number of thunderstorms occurring in India, we are in an advantageous position to make some contribution to this interesting problem before it is finally settled. .

Pluto May Be Larger Than Supposed

Pluto, the ninth planet of the sun's family, may be larger in size than now estimated. Sir James Jeans has suggested that this distant planet is so remote and cold that it is covered with a layer of liquid air.

Acting like a mirror, this supercold liquid air would give a minute image of the sun. This is what astronomers would see when they observe the planet. The sunlight from the outer portions of the disk would not reach the earth. The apparent brightness of Pluto would give a too conservative idea of its size. A size for Pluto larger than that of the earth, which might be possible according to this theory, would support the idea that Pluto exercises a noticeable effect on both Neptune and Uranus. This was the basis of the late Prof. W. H. Pickering's prediction of a ninth planet made before Pluto was discovered.

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The Origin of the Planets

James H. Jeans

As soon as the reasoning of Copernicus and the observations of Galileo had elucidated the nature and motions of the planets, hypotheses and speculations as to their origin were put forward in profusion. Theories were propounded by Descartes in 1644, by Swedenborg in 1734, by Thomas Wright in 1750 and by Kant, the philosopher, in 1755. Finally Laplace in 1796 put forward his famous "nebular hypothesis," which was destined to hold the field almost unchallenged for nearly a century.

Laplace's Theory of Nebular Origin

Laplace first noted that all the planets revolve around the sun's equator in the same direction, namely that in which the sun is itself rotating. This led him to conjecture that the matter of the planets had originally constituted, or formed part of, a vast atmosphere which enveloped the rotating sun and rotated with it, so that the sun at this stage had formed a vast gaseous nebula with the present sun forming a stellar centre. Gradually this nebula cooled. As it cooled it shrank, and continually spun faster and faster in accordance with the well-known principle of the conservation of angular momentum. Finally a speed was reached at which the nebula could no longer hold together as a single body; just as a fly-wheel breaks up if it is spun too fast, so the great nebula broke up, and out of the debris the planets were formed.

Laplace studied the method of break-up in some detail. The shrinking sun, he found, would continually leave matter behind in its equatorial plane. This would continue revolving round the sun at the speed at which it had rotated while it still formed part of the sun's equator, and so at a slower rate than that at which the sun was then rotating. He imagined that this slowly-rotating matter would condense in due course into a planet, after which the process would begin again, until a second planet was born, and so on.

Laplace was too good a mathematician to go wrong in his mathematical theory, but the Kinetic theory of gases was still unknown, and he went wrong in his physics. We know now that a stream of gas slowly liberated from the equator of a rotating sun would not condense into planets; instead, its atoms or molecules would scatter into space, precisely as the molecules do when we turn the gas-tap on in the laboratory, and for the same reason. It is true that structures are known in the heavens —the great spiral nebulae—in which the process imagined by Laplace is very probably in progress, but these are on an entirely different scale. Each of these nebulae contains about 100,000,000,000 times as much matter as the sun, and the difference of scale introduces essentially new factors into the problem. Condensation can, and must, occur when the matter is so abundant that its gravitational attraction outweighs the tendency to molecular scattering; it cannot occur on the relatively puny scale contemplated by Laplace.

Laplace pointed to the rings of Saturn as evidence that the process he had in mind could really occur, and a study of these rings takes us into the heart of the problem. Laplace thought that these rings were a satellite in its pre-natal stage; we now think, with reasonable certainty, that they are a satellite after its death. 1852 the French mathematician Roche made a study of the question which most astronomers of to-day find conclusive.

Roche's Theory of Tidal Origin

Let us begin by considering the ordinary every-day tides which the moon raises on our earth. These consist of tides in the ocean which are of moderate height, because water is easily pulled about, and of smaller "earth-tides" in the solid body of the earth-smaller because the earth is denser and more rigid than water. The earth must, of course, produce similar tides in the solid body of the moon;

these are larger than the foregoing, because the earth, owing to its greater mass, exerts a greater gravitational pull than the moon. If the moon were to come closer in to the earth, the earth's gravitational pull on the moon would increase, and these tides would become still greater. Yet Roche found that, in every such case, there is a limit to the height of the tides which will be raised on the smaller body; if this comes too near to the larger body it does not have mere tides raised on its surface, but is pulled in pieces. So far as we can foresee, the moon is destined in remote future ages to come closer and ever closer in to the earth. As it does so, the earth's tide-raising pull on the moon will for ever increase, until finally the moon will no longer be able to resist the strain; it will no longer hold together as a single body, but will break into fragments. We shall no longer have a single moon, but a swarm of minute satellites, like the rings of Saturn, revolving round the earth.

What our satellite will do in the future, we believe that a satellite of Saturn has done in the past. The orbit of this satellite must, we think, have continually contracted until the strain of Saturn's tide-raising gravitational field became too great for it, and it broke into the fragments we now see.

The sky exhibits what appear to be other instances of the same phenomenon. There are comets which have broken into several pieces between successive appearances; some have actually been observed in the act of breaking. Again, according to Bode's law, we ought to find a planet between the orbits of Mars and Jupiter; instead of this we find a whole swarm of minute planets—the asteroids—which most astronomers think were probably formed by the break up of a single planet in the way just described.

According to the tidal theory of the origin of the solar system—at any rate in the form in which I propounded it in 1916—the planets were formed by a somewhat similar break-up, although with one essential and important difference in the conditions. The imagined satellite of Saturn was, we think, broken up by the gravitational attraction of a larger mass round which it described a circular or elliptical orbit. The tidal theory supposes that the sun was broken up by the gravitational attraction of a second star, but round this it would of course describe a hyperbolic orbit. Now a hyperbolic orbit involves only a transitory visit to the region of danger in which break-up occurs, whereas an elliptic or circular orbit involves repeated visits to this region, or even a permanent stay inside it. Mathematical analysis shews that if the sun made a transitory visit into the region of danger of another star, the gaseous tides on its surface would rise continually higher, until finally a long filament of gas would shoot out towards the second star. When the two bodies receded from one another, this filament would be left suspended in space, with a motion of revolution round the sun which would prevent its falling back into the sun. It can be shewn that the filament of gas would condense into globules of gas which would be of the general order of size of planets. The theory suggests that these are in fact the actual planets. They would begin by describing orbits about the sun and if these orbits brought them near enough to the sun, they might themselves be broken up and give birth to systems of satellites.

Such, in its simplest form, is the tidal theory and it obviously explains many of the observed features of the solar system. We see at once why the planetary motions have reference to two planes—the plane of the sun's rotation, and the plane in which the outer planets revolve. Clearly the former must have been the plane of rotation of the original sun, while the latter would be the plane in which the second star passed by the sun. We see too why the largest planets, Jupiter and Saturn, are found in the middle of the sequence of planets, while the size tails off at either end of the sequence. For the matter out of which these central planets were formed would have been emitted when the two stars were at their closest approach, the stage in which matter would be emitted most profusely, and so might we may conjecture, form the largest planets. Further, these central planets, being the largest, would cool most slowly, from which it can be deduced that they ought to be surrounded by numbers of small satellites, while the smaller planets should be surrounded by a few relatively large satellites. Actually we find a regular sequence in the numbers of planetary satellites—0,0,1,2?,9,9,4,1,?. The tidal theory at least makes this regularity intelligible, while no other theory with which I am acquainted attempts to explain it.

Difficulties of the Tidal Theory

Dr Jeffreys and others have recently drawn attention to a difficulty which affects this theory in common with all other that suppose that the planets originally formed part of the sun. The sun rotates once in about twenty-six days, Jupiter once in ten hours. The matter which now forms Jupiter, and rotates once every ten hours must at some past time, so these theories suppose, have rotated once only in twenty-six days. What has produced the increased rate of rotation? It cannot have been mere shrinkage, since calculation shews that if this were the only cause in operation, the original Jupiter must have been larger than the sun. Clearly then some external force must have got a rotational grip on the matter and set it spinning faster. The difficulty is to find any external force of sufficient potency.

As the tidal forces from the passing star could at best set up only a very slight amount of rotation, it is usual to attribute the main part of this rotation to the falling-back into the planet of matter which had been drawn out of it tidally, but had not sufficient angular momentum to form satellites. Jeffreys has calculated that Jupiter's present rotation could be produced by the falling-back of matter totalling one-fifteenth of the whole mass of the planet.

This certainly seems a large mass. Jeffreys, considering it to be inadmissibly large, has proposed replacing the tidal action of a second star by a grazing collision with a second star. The matter near the point of collision would then be caught between the upper and nether millstones formed by the two stars, and set into rapid rotation. This brings us very near to the "collision" hypothesis which was propounded by Bickerton of New Zealand in 1880; either hypothesis gives adequate rotation to the planets.

Professor H. N. Russel has drawn attention to a second, and perhaps more serious difficulty, which emerges from a study of the angular momentum of the planets round the sun.

Calculation shews that, if planets were to be formed at all, the second star must have passed fairly close to the sun's surface probably within two or three radii of it. A less close approach would have resulted merely in a rise and subsequent fall of tides on the sun's surface. Knowing the distance within which the second star must have passed for planets to be formed, we can calculate an upper limit to the angular momentum per ton which this star could have had around the sun. It is hard to see how the encounter can generate more angular momentum per ton than this in the ejected matter, so that we should expect that this same figure would set an upper limit to the angular momentum per ton of the planets. But in actual fact the planets all have substantially more angular momentum per ton than this expected upper limit—Neptune twenty-two times as much, Saturn twelve times as much, Jupiter nine times as much, and so on. To state the difficulty in more physical language, the whole encounter on which the tidal theory relies must have taken place well inside the orbit of Mercury; what force, then, can have projected Jupiter, Pluto, etc., out to where they now are?

Lyttleton following a suggestion of Professor H. N. Russel, has tried to find an escape by supposing that the sun was originally half of a binary system, the other constituent of which has been captured by the second star of the tidal theory. He believes that this gives an adequate account of the angular momentum of the planets, but Luytons and Hill have challenged his analysis, and the issue is still in doubt.

Milne has recently developed a new and very revolutionary system of dynamics in which angular momentum does not stay constant in the absence of external forces, but increases steadily with the time. This of course removes all the difficulties which arise from excess of rotation and angular momentum, not only from this problem, but from many other problems of cosmogony. But it has not so far gained many adherents.

While it has to be admitted that these questions of rotation introduce certain difficulties into the tidal theory, the many successes of the theory seem to me to suggest that it is nevertheless fundamentally on sound lines.*

*Lecture delivered by the author at the Indian Association for the Cultivation of Science.

Chemical Composition and Nutritive Value of Bananas

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BANANA is an important crop most successfully cultivated in hot and damp climate of all tropical and subtropical regions.

The northern limit of its cultivation is reached in Florida, Canary Island, Egypt and South Japan, and the southern limit in Natal and south Brazil.

Description of the Plant

The plants are gigantic herbs with what at first appears like a tall stem but which in reality is the base of the leaves one closely enveloped into another. A true stem develops at the flowering period which grows up through the hollow tube formed by leaf sheaths. The emergent end bears a tuft of a large number of tubular flowers encircling the stem top in bunches with a patch of protecting bract over each layer of floral row. The flowers in due course take the shape of banana fruits which form dense clusters.

The cultivated form of the plant is propagated entirely vegetatively, since the fruit usually contains no seeds. In one variety seeds are often to be found as hard round bodies in the flesh of the fruit, but in the rest of the order they occur with merely perisperm or growth of the nucellar-tissue of the ovule.

The plants belong to the genus *Musa*, (natural order *Musacae*) derived indirectly from the word "Mocha".

Early mediaeval travellers generally used to call the fruit either "fig of paradise" or "fig of India."

The most generally used fruits are obtained from *Musa paradisica*, of which an enormous number of varieties and forms exists in cultivation. The subspecies *Sapientum* is the source of the fruit generally known as banana and eaten raw, while the name plantain is given to forms of the species itself (*M. paradisica*). The species is probably a native of India and southern Asia.

From the Indian standpoint some of the most important forms are:—Dâccâi, Martamân, Châmpâ, Kântâli, Râmkalâ, etc. The peel of the fruit while ripe generally exhibits brownish yellow colour, but there is a particular variety grown in India which retains its green skin when ripe. Râmkalâ, the characteristic high-class banana of Bombay, is of a very dark red colour while immature but it finally ripens into a yellowish red.

Bananas after mangoes are the commonest of all Indian fruits, while the coarser kind constitutes one of the staple articles of diet in many parts of India and Malay Peninsula. Just as wheat and barley have played their part in more temperate regions, so the banana has played its part in the tropics. It is said by some authors that the produce from one acre will support a much greater number of people than a similar area under any other crop. The fruit is obtainable in abundance at all seasons. In the winter months especially it provides an inexpensive food particularly needed in the diet often too low in fresh fruits.

In temperate lands a supply of fresh fruits is a luxury as a rule. The London poor have, however acquired the habit of giving their children bananas, because such fruit is cheap in London, which is the centre of distribution for the English fruit trade. Probably the first importation of bananas into the United States of America was made somewhat more than one and a quarter century ago. At that time thirty bunches were brought from Cuba to New York. In 1929 the

total importations were sixty-five million bunches. Similar figures may be cited for countries of Europe. These facts indicate that banana though a native of the tropics is getting to be more and more a popular food in America as well as in Europe. American and English market demands have greatly accelerated the cultivation of bananas in Jamaica.

Nutritive Constituents and Caloric Value

From the standpoint of nutrition the banana is essentially a highly edible source of carbohydrate, comparable in its richness of foodstuffs with the most popular of fruits. The fat and fiber are negligible. The ash is important both in amount and constituent.

The banana has a high fuel value, yielding over four hundred calories per pound. A single fruit weighs on an average 101 grams and contains 100 calories.

An interesting comparison of the edible portion (average) of the banana with that of other fruits is given at the next column from the Bulletin, U. S. Department of Agriculture, Washington.

	Water.	Protein.	Fat.	Carbohydrate	Ash.	Fuel value per lb. calories.
			%	%	%	
Bananas ..	75.3	1.3	0.6	22.0	0.8	460
Grapes ..	77.4	1.3	1.6	19.2	0.5	450
Cherries ..	80.9	1.0	0.8	16.7	0.6	365
Apples ..	84.6	0.4	0.5	14.2	0.3	290
Oranges ..	86.9	0.8	0.2	11.6	0.5	240
Peaches ..	89.4	0.7	0.1	9.4	0.4	190
Muskmelons	89.5	0.6	..	9.3	0.6	185
Strawberries	90.4	1.0	0.6	7.4	0.6	180

Protective Coating

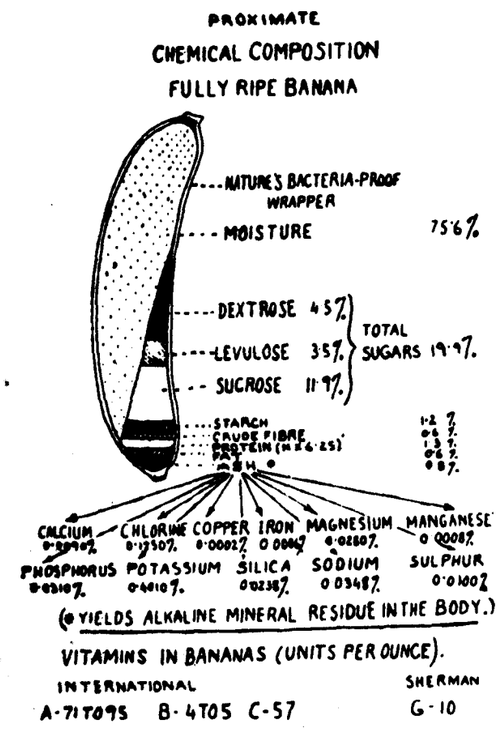
Extensive bacteriological examination of bananas has been made in different stages of their maturation, all of which justify the conclusion that the inner portion of the pulp of sound bananas is practically sterile. A banana properly handled is uncontaminated by dirt and pathogenic germs. Even when bananas were subject to the exceptionally severe test of being immersed in fluids containing cultures of known organisms there was no evidence of a penetration into the interior. The probability of infection through the peel is, therefore, very slight.

Proximate Composition

The following figures indicate proximate chemical composition of fully ripe bananas:—

	Refuse.	Water.	Protein (N. X. 6.25).	Fat.	Carbohydrates. Ash.	Carbohydrates. Total by differences incl. fibre.	Carbohydrates. Fibre.	Carbohydrates. Sugars as Invert.	Fuel Value. Acids as Malic.	Fuel Value. Per 100 gram. Cal.	Fuel Value. Per 100 pound. Cal.
	%	%	%	%	%	%	%	%	%		
Average	33	74.8	1.2	0.2	0.84	23.0	0.6	19.2	0.39	98.6	445
Probable error ..	2.6	2.4	0.2	0.2	0.11	..	0.3	1.7	0.08	..	..
Maximum	40	83.4	2.0	1.4	1.4	..	1.8	25.7	0.55	..	..
Minimum ..	23	65.4	0.8	.0	0.5	..	0.2	14.5	0.26	..	..
As purchased ..	..	50.1	0.8	0.1	0.6	15.4	0.4	12.9	0.3	66	300
No. of Samples ..	34	69	59	39	62	..	18	36	21	..	..

Bananas are richer in solids and lower in water content than other fresh fruits. But they have very little protein and fat. The green banana contains, in the part exclusive of the skin, about 1.5 per cent of protein, 20 to 25 per cent carbohydrate and almost all the rest starch. In the ripe bananas with the yellow-brown peel, the edible part contains somewhat less (16 to 19 per cent) of carbohydrate; but that which remains is now almost in the form



of soluble sugars. Broadly speaking, the ripe banana is about one-fifth sugar, the green one-fifth starch. Most of the remainder of the edible pulp is water. Its small quantity of protein and fat enables the dietarian, as is often necessary, to increase caloric values, without appreciably adding the protein content. This is of great value in diseases of the kidneys.

Whereas five parts of potato protein may replace four of body protein in establishing body equilibrium, the protein of bananas is not so efficient. Yet in the tropical countries, such as the seacoast of East Africa, the Congo and Pacific Islands, during the six months of the rainy season (in which the banana is ripe), it furnishes almost the exclusive diet of the natives. It is preferred to potatoes because it can be obtained almost without labour.

Mineral and Ash Content

Banana is rather similar to potato; the caloric contents are about equal; so are the nitrogen contents, the carbohydrate contents and the ashes.

The ash content of banana is higher than that of any other fruit. In the different varieties of banana mineral contents and acid remain nearly identical. Its mineral content is worthy of mention especially in view of the fact that iron, copper and manganese are present, iron being more readily assimilated in presence of the other two minerals. Chemical analysis shows that within 0.8% average ash-content of fully ripe bananas, mineral constituents are present in the following proportion as per cent of the banana:—

Calcium	0.0090
Chlorine	0.1250
Copper	0.0002
Iron	0.0006
Magnesium	0.0280
Manganese	0.0008
Phosphorus	0.0310
Potassium	0.4010
Silica	0.0238
Sodium	0.0348
Sulphur	0.0100

A Source for Haemoglobin Formation

There is a preponderance of calcium and magnesium over phosphorus which makes the ash alkaline and so bananas help to combat a tendency towards acidosis. The minerals of banana have blood-building properties.

Periodic haemoglobin determinations made on many babies indicated that they maintained a comparatively high haemoglobin percentage while on

banana-sugar feeding. This may be attributed to the iron, copper and manganese content of the banana sugar. Banana powder was examined for its available iron content both by a chemical method and by feeding experiments on nutritionally anaemic rats. The chemical dipyridyl method employed indicated a high degree of availability, 90 to 100 per cent of the total iron content (0.00245 per cent). The biological experiments showed that all of the iron in banana powder was available for the building of haemoglobin provided ample copper was supplied to permit complete utilization of the iron. The U. S. Department of Agriculture gives the following figures on the iron content of seven specimens of fully ripe, peeled bananas purchased in the months of February, April, and November;—

Iron per cent.
0.00031
0.00048
0.00026
0.00037
0.00173
0.0008
0.0005
average 0.00064

Alkalinity

A table of alkaline ash foods refers the degree of alkalinity of the banana as 5.56 c.c. *N*-NaOH per 100 gm. Bananas are included in a list of foods rich in sodium chloride.

The final products of metabolism of the banana in the body are alkaline. In diets in which banana forms a considerable part, the reaction of the urine is distinctly alkaline and for this reason it can be used to great advantage in cases of varying degrees of acidosis so commonly found among all classes of people.

Children from 5 to 13 years of age were studied in groups of four; two on mixed diet without bananas, and two on the same diet with 3 to 6 bananas substituted for a corresponding quantity of carbohydrate. After a suitable interval the diets of the pairs of a group were transposed. Representative samples of the food intake, the total urinary and faecal output of each child was collected for a four-day period. There was always a somewhat smaller daily volume of urine and a somewhat greater output of faeces in the banana-feeding than in the control periods, but never any diarrhoea on banana diet. The urine was always distinctly more alkaline with the banana food than with the control diets, as shown by *p*H values.

Meals with a high buffering-value help to hold, and liberate slowly acid which serves to kill bacteria ingested one or more hours after the taking of a meal. In order that the bacteria may be killed, it is important that the gastric contents develop an acidity as high as or greater than *p*H=2.

Albumen

After drinking contaminated liquids, the taking within a short interval of time another meal, perhaps well buffered and somewhat alkaline will tend to wash living bacteria, left behind in the nasopharynx or oesophagus by the infected meal, directly into the bowel. It has been found that banana pulp serves as a well-buffered meal to hold HCl in the stomach. 100 gms. of banana dry contain 1.5 gm. of albumen. If it is desired to serve a diet very low in albumen, some physicians resort to a daily *menu* of 1,400 gms. of banana pulp which give 19 g. of albumen, 1.8 g. of salt, 1,225 calories. This is specially required for patients afflicted with diabetes.

Sugars

Carbohydrate of bananas comprises about 22 per cent of the total weight of ripe banana. This consists of a mixture of sugars chiefly sucrose, dextrose and levulose, which is very well digested and absorbed even by infants and young children with gastro-intestinal disturbances. A typical analysis of the carbohydrate in edible portion of banana is given below:

Glucose	5.82%
Fructose	3.78%
Sucrose	6.58%
Starch	3.02%
Total available carbohydrate ..	19.20%

Transformation of Carbohydrate

The first product of photo-synthesis that can positively be identical in the veins of the leaves is saccharose. It then reaches the petiole concurrently with transformation into invert sugar. The inversion continues throughout the length of the petiole to such an extent that the saccharose, which predominates in the veins, forms but a small portion of the sugars present at the base of petiole.

From the base of petiole the mixture of soluble sugars is transported to the peduncle of the bunch, without undergoing any notable modification, and penetrates into the fruit.

The ripening process in banana is characterized by the starch which is present in the fruit pulp in large quantities, being gradually dissolved through enzymic influence and changed into sugar. In the ripe banana the originally harsh taste vanishes, and is replaced by the well-known and most agreeable banana aroma, due primarily to slight amounts of amyl acetate. Little acetaldehyde is present in frozen bananas, the ripening process of which has been interrupted; a much larger amount is noticeable in ripe bananas.

Studies on Ripening

Analysis has shown that during ripening the banana starch is transformed into cane sugar and the cane sugar into invert sugar, that there are important changes in the character of the tannin compounds, and that other changes occur, brought about by the production of aroma and flavour and in other ways. Studies made with banana-ripening by the help of respiration calorimeter show that the ripening changes progress regularly to a maximum and then decline, that at its greatest intensity heat produced is approximately one-half to one caloric per hour per kilogram of bananas. The heat liberated is a measure of the activity of one or more of the ripening processes.

Progressive maturity causes constant changes in the carbohydrate content from starch to sugar during the ripening process in a normal form even after the fruit has been detached from the stem. Inversion of saccharose, however, proceeds very slowly; it seems that the premature detachment of the fruit from the stem is responsible for this. Complete inversion will take place only under favourable temperature conditions.

Ripening experiments made on green bananas which were carried out in a large respiration calorimeter or in a specially designed ripening chamber indicate that the usual carbohydrate changes—saccharification of starch with formation of sucrose and invert sugar, and consumption of sugar in respiration—proceed with uniformity in bananas of different bunches. The period of most rapid respiration corresponded closely with that of most rapid starch hydrolysis. The quantities of ash, protein and ether extract undergo but slight changes during the ripening of the bananas. Pentosans decrease markedly in the pulp, but remain little changed in the peel.

Effect of Ethylene on Ripening

Bananas ripening in an atmosphere containing 1:1000 parts of ethylene turn yellow at a somewhat rapid rate than do the controls. Such bananas also show a slightly greater increase in sugars and decrease in starch from day to day than do the controls. Concentrations of ethylene ranging from 1:100 to 1:10,000 all seem equally effective in bringing about the small differences observed. Ripe bananas have 12-20 per cent of total sugars. 10-14 per cent of sucrose, and less than 1 per cent of starch. Respiratory activities of bananas treated with ethylene differ little or not at all from those of the untreated ones. Rarely is there found a bunch of bananas which is in a quasi-dormant condition and in this case ethylene stimulates an immediate commencement of ripening.

Enzymes

During ripening the starch in the banana is converted into sugars by means of enzymes. A ripe banana contains as high as 18 per cent of reducing sugars. The enzyme capable of hydrolysing the starch of banana and of converting cane sugar to invert sugar is destroyed by temperatures above 150°F. The properties of the gel obtained from banana extract by treatment with calcium-salts and alkali or with pancreatin and of banana sucrose were studied. It was shown that different substances

were involved in the gel formation and in the enzyme actions, although boiling the solution destroyed both properties.

The sucrose of unripe and ripe bananas was extensively studied. With ripe bananas both soluble and insoluble sucrose preparations were obtained. Conditions for converting the soluble into an insoluble form were found. The action of the sucrose preparations as far as the hydrogen ion concentration for maximum action relation is concerned is similar to the behaviour of the yeast and the potato sucrose. The optimum hydrogen ion concentration for the activity of sucrose from banana was found to be $pH = 4.0$. The banana sucrose is definitely retarded by the presence of citrate, phosphate, phthalate and acetate buffers. This retarding effect increases with increase in buffer concentration. It was found that the sucrose activity of banana extracts increased as much as 40-160 per cent upon standing for a short time and then decreased again. The nature and amount of increase was found to be dependent upon the state of ripeness of the banana at the time the extract was made. Cause for this increase could not be determined. Extensive investigation has failed to show the presence of amylase in the banana, although the conversion of starch to sugar in this fruit is remarkably rapid.

Malic Acid

Malic acid which is easily and completely utilized was found to be the only non-volatile organic acid present in the ripe banana.

During ripening of the banana the malic acid content increases to a peak, then gradually decreases as the fruit matures. At the stage of ripeness at which bananas are usually eaten the malic acid content is approximately 0.3%.

Fatty Acid

The amount of fatty acids liberated by the hydrolysis of banana starch free from extraneous fatty material has been determined to be 0.2%. The fatty acids have been found to consist of a mixture of palmitic, oleic, linoleic (linolic) and linolenic acids together with a very small amount of phytosterol.

Tannin

The tannin-content of bananas remains unchanged during the ripening process. Unripe bananas are characterized by their high starch content, their astringency, and lack of sweetness. The ripe fruit, on the other hand, has little starch and is not noticeably astringent. It is claimed that this astringency is due to tannin in the unripe fruit which is in the soluble form. As the fruit ripens the tannin becomes insoluble, or "fixed," and hence cannot be tasted in the ripe fruit.

Pectin

Pectin is usually classed with hemicellulose and cellulose as an unavailable carbohydrate.

The total pectin content of the banana is not great (about 1 per cent of the fresh pulp) but what relation this substance bears to the digestibility of the fruit is not very definitely known.

That the buffer action of the pectin plays only a minor part in the therapeutic action of apple and banana diets is proved by buffer curves. However, certain workers have given credit to the pectin of bananas and apples for the beneficial action of these fruits in the treatment of diarrhoea of both children and adults. The galacturonic acid content of pectin has naturally been assumed to have a detoxifying action similar to glucuronic acid. Other authorities find that no utilizable carbohydrate is derived from pectin by diabetic dogs, but that there is an antiketogenic action which indicates that pectin is not as unavailable as has been assumed. Some authors suggest that the resistance of banana-fed rats to orally ingested *B. enteritides* may be due in part to the pectin content.

Latex

When the peel of a green banana is punctured, a sticky, milky fluid oozes from the wound. This substance very closely resembles chicle.

Vitamin

Bananas contain fair amounts of vitamins A, B, C, G, and also some E. It is an excellent source of

vitamin A, a good source of vitamin B, but deficient in vitamin D.

THE VITAMIN TABLE FOR BANANAS

Vitamin A	.. ..	+ to + +
Vitamin B_1	.. ..	+
Vitamin B_2	.. ..	+
Vitamin C	.. ..	+ +
Vitamin D	.. ..	low
Vitamin E	.. ..	+ +
Vitamin G	.. ..	+ +

+ signifies that materials contain the vitamin;
+ + it is a good source of vitamin.

The following figures indicate vitamin rating for bananas:—

	per ounce. Units International.	per ounce. Units Sherman.	Sherman Units. per banana.	per lb. of bananas.
A ..	71 to 95	100	360	1600
B ..	4 to 5	8	..	..
C ..	57	5	20	80
D ..	..	..	..	..
E ..	..	..	..	..
G ..	..	10	35	160

Eighty-seven grams of banana yield about 250 units of vitamin A; 270 grams yield about 50 units of vitamin B (B_1). A similar quantity of banana gives about 30 units of vitamin C.

According to a table furnished by Jung 100 gms of banana contain 10-20 units of vitamin B_2. The vitamin C content of foodstuffs was calculated on the basis of guinea-pig units. Tillmann's table records 30 units for 100 gms of banana. Expressed in milligrams per 100 gms. of fruit, the vitamin C content of the banana is 2 milligrams per cent as opposed to 2.10 milligrams per cent with Tillmann's method.

György found a vitamin H, the lack of which is apt to produce cutaneous affections similar to seborrheic eczema. A special minimum substance was discovered which cured this affliction in the rat within two or three weeks. This substance is named H factor, and the daily curative dose present in the banana is 4 to 5.0 gms of fresh fruit.

The following figures are given showing the contributions to the diet of the banana, orange and apple (medium size):—

	Cal.	Pro.	Ca.	P.	Fe.	Vit. A.	Vit. B.	Vit. C.
Orange	0.8	0.5	3.1	0.7	0.6	1.4	2.1	92.0
Banana	1.0	0.5	0.4	0.7	1.2	3.6	1.0	17.0
Apple	0.8	0.2	0.4	0.4	0.8	0.7	1.2	10.4

The above figures represent "shares":—

1 Energy share = 100 calorics.
1 Protein share = 2.5 gm. or 10 calories.
1 Calcium share = 0.023 gm.
1 Phosphorus share = 0.044 gm.
1 Iron share = 0 0005 gm.
1 Vitamin A share = 100 Sherman Units.
1 Vitamin B share = 30 Sherman Units.
1 Vitamin C share = 1 Sherman Units.

Being rich in vitamin A, bananas help normal tooth development, are a dieletic factor in regard to the length of life. Experiments with young rats have shown that the disease preventing, or healing, component of the A-vitamin in the banana is very active, while the components which increase weight act rather more slowly, but are present in sufficient quantity. The daily dose for an experimental animal was 1 gm. banana per 50 gms. body weight. With a child of three years, whose weight is about 12-14 kilograms, the daily banana intake should be 240-280 gms or 4-5 bananas. Considerably smaller quantities, however, ought to be sufficient.

Banana and Milk

Combined with milk, banana produces an almost completely balanced ration. Milk is also a good source of Vitamin A. Bananas and milk offered a means for measuring the effect of increased intake of vitamin A obtained from natural food sources. While the fat content of the banana is negligible as a source of calories, it is important as a holder of the fat soluble vitamin A. Milk, although the most important and satisfactory article of food for growing children is far from a complete food. It is markedly deficient in carbohydrate. Furthermore, pasteurization destroys the important vitamin C.

Thus, it is necessary to supplement vitamins from other sources.

The following table shows how the addition of banana restores to pasteurized milk its vitamin values with increase of vitamin C:—

	Vitamin A.	Vitamin B.	Vitamin C.
Milk (Whole) ..	**	***	*
Milk (Pasteurized) ..	****	**	..
Milk (Pasturized) with banana ..	*****	***	**

Eddy and Kellogg state that the banana has about the same vitamin B value as tomato juice. Comparing the dry weights of materials, orange was found to contain one-fifth as much vitamin B_1 as yeast; tomato slightly less than one-tenth; banana one-twentieth, and apple still less. Orange, tomato and banana were found to be just less than one-tenth as rich in vitamin B_2 as yeast. The addition of vitamin B to the diet in the form of banana may cause a prompt and striking improvement of persons suffering from celiac disease.

Bananas, Orange juice and tomato juice are very rich in vitamin C. Patients suffering from chronic ulcerative colitis are given one very ripe banana, ½ glass of orange juice, 2 tablespoonfuls of vegetable purée, daily.

Lewis concludes that with a basal diet adequate in all respects except vitamin C, 10-15 gms. of raw banana per guinea-pig per day sufficed for growth and protection against scurvy. Givens, McClugage and Van Horne cosidered 10 gms. to be the minimum protective dose and the same amount was reported by Jansen and Donath for two varieties of Indian bananas. Eddy considers 5 gms. of banana to be the minimum protective dose, and 8-10 gms. the optimum dose for growth stimulation as well as scurvy prevention in guinea-pigs. Bananas baked with the skin retain their antiscorbutic properties better than when baked without the skin, probably on account of the protective action of the skin against oxidation. Eddy and Kellogg reported the cure of scurvy in eight months' old baby by a banana milk mixture made by whipping 200 gm. of ripe raw banana into 570 c.c. of milk. This was fed in 120 c.c. portions every four hours with no resulting digestive disturbances. Ripe bananas or if cooked when partially ripe are readily digestible even by infants and are valuable in modifying infant milk formulæ because of the unique combination of readily assimilable sugar and vitamin C, and are an aid against constipation. Experimental results showed that the smallest amount of banana which kept guinea-pigs (300 gms. weight) from developing scurvy, is 40 gms. a day.

There is no reason to assume that artificially ripened bananas are less rich in vitamin C than those which are almost ripened entirely on the tree.

Göthlin believes that the lowest protective quantity for prevention of scurvy for twenty-four hours would be present in 140-200 gms. of either apples or bananas in a raw state.

Only 5 gms. of yellow banana are adequate to prevent scurvy in guinea-pigs; this however, is not true in the case of red and green (the particular variety grown in India which retains a green skin when ripe) bananas. Ten gms. at least of red banana pulp were required for the purpose, while in the case of green banana pulp even 15 gms. proved insufficient.

Evans, Herbert McLean and Burr report that one-third of a banana daily, averaging 27 gms., when consumed *ad libitum* separately from the basic ration, bestowed fertility in cure experiments. In describing their animal experiments the authors report that three rats were reared on a modification of the basic ration and that after sterility was proved in each case by the occurrence of a resorption gestation, they were fed daily apart from the basic ration, fresh crushed banana *ad libitum* (the animal consumed about 27 gms. of the fruit daily). They were then bred to males of proved fertility, a normal gestation resulting in each case.

Effect of Taking Unripe Bananas

Inasmuch as bananas are commonly eaten uncooked, it is obvious that more or less starch will be ingested, if the fruit is not ripe, *i.e.*, if the skin has not begun to shrivel and darken. Raw starch may be singularly irritating to the alimentary tract

CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF BANANAS

of man and is at best poorly utilized, whether it be ingested in the form of uncooked potatoes, chestnuts, bananas or other native starch foods. No one would advise the use of uncooked potatoes; yet many people eschew a throughly ripe banana in the belief that this wholesome fruit is rotten when the skin becomes darkened, whereas they eagerly eat the yellow green starch bearing fruit at the stage of incomplete ripeness. Green bananas, like green apples, are unwholesome so long as the starch has not been adequately converted into sugars in the ripening process. The delicious and innocuous ripe banana should not be made to suffer in its dietetic reputation because of the ignorance of the consumer.

Besides taking in the raw form bananas are often baked and cooked, powdered and mixed with various vegetables, fruits and food of animal origin. These have got their particular degree of efficacy in increasing or decreasing the nutritive value and digestive property of the food produced. It will be too elaborate to deal with all these points here and probably a vast field of experimentation is still unexplored in this direction.

Extensive research work on banana therapy has been already published and it has been found that banana is very effective in combating scurvy, dysentery, diarrhoea, diabetes, kidney troubles and many other diseases.

From what has already been said it can be concluded that banana is a cheap fruit, available at all seasons, palatable, nutritious, easily digestible and of high therapeutic value.

Recent Advances in the Study of Plant Growth Hormones

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THE conception of a growth hormone can be traced as far back as 1882 to the work of Sachs, who suggested that leaves form "Organ-forming substances" and that plants contain specific substances which control the formation of roots. The conception has rapidly developed in recent years and the role of growth hormones in the growth of plants and root formation has been clearly demonstrated and a large number of synthetic organic compounds have been investigated which influence markedly the growth of plants. They are termed under the general name Auxins. Kögl[1] with his co-workers has been able to seperate, purify and determine the chemical composition of α-auxin C_{18} H_{32} O_5; β-auxin C_{18} H_{30} O_4; and heteroauxin C_{10} H_9 O_2 N, *i.e.*, β-indolyl acetic acid. They all have a similar effect on the stretching phase of the plant growth. Avery and co-workers[2] have added indole acetic acid, potassium indole acetate, indole butyric acid, potassium indole butyrate, naphthalene acetic acid, potassium napthyl acetate, and indole propionic acid as growth-promoting substances. Snow[3] has added benzoyl oxide and benzoyl peroxide. Crook, Davis and Smith[4] have reported β-thionaphthene acetic acid to be effective in concentration greater than one part in 70,000.

It has been shown that pure auxin prepared by Kögl and co-workers is active in root formation (Thimann and Went, 1934).[5] Out of the above-mentioned substances the effectiveness of β-indole acetic acid in root formation has been shown by Laibach,[6] Thimann and Koepfli,[7] and Fischnich.[8] In addition to a number of synthetic substances, Hitchcock and Zimmermann[9] and Pearse[10] have shown that indole butyric acid and α-naphthalene acetic acid are very effective in root formation.

Quantitative Test

Standard avena test (Went,[11])—It is known that a growth hormone, when applied to the stump of a decapitated Aven coleoptile, moves downwards into the plant tissue and causes the longitudinal growth of the coleoptile. But when applied to one side only, it causes a lateral growth on that side alone, which results in a curvature on the other side, *i.e.*, negative curvature. On the basis of this behaviour Went formulated his technique of auxin test. Oats are germinated in a dark room at 25°C and 90 per cent humidity. When the coleoptiles have grown to about 3 to 4 cms. in length, they are decapitated, about 0·5 cm. of the coleoptile tip being removed. Standard size agar blocks are prepared in which the growth hormone is allowed to diffuse from the material to be tested for the hormone. These agar blocks are then placed unilaterally to the decaptitated avena coleoptile for tests. After a time the curvatures are photographed and measured. It has been found that the angle of curvature under certain limits is proportional to the concentration of the hormone present[11], [12], [13]. An automatic Photokymograph has been described by Schneider and Went[14] to record the curvatures.

The standard method is modified by Van der Weij[15] who introduced a second decapitation one hour after the first to prevent further regeneration of auxin. Skoog[16] modified the standard test by removing the entire seed after two days of germination, with the exception of the lower half of the scutellum. He has suggested that by this deseeded method the possibility of regeneration of auxin-precursor in the seed is prevented and a more sensitive test plant is obtained.

Pea test method (Went 1934)[17]—is also based on curvature method. Here stems of etiolated *Pisum sativum* seedlings are obtained. 5 cm. of the tip of stem is removed and then 2 to 20 cm. long pieces are taken and split longitudinally at the tip for one to three cm. The two halves of the split portion curve outwards in aqueous solution; but in presence of auxin and at 25°C and after about half an hour the two halves begin to curve inwards. This test can be made quantitative by using a series of concentrations and finding the minimum concentration when the action just begins.

A test method for Rhizocaline.—described by Went[18] is based on the formation of roots in treated and untreated decapitated shoots of *Pisum sativum*. The stem is prepared by cutting the shoot when it has reached a height of 10 to 15 cm. germinated under controlled conditions of light and temperature. The first leaf appears under the third node and it is decapitated just below it. Thus a piece of stem is obtained containing the second and the third internodes. The base of the stem is then kept in water for four hours and then in 0.05 per cent potassium permanganate for four hours to free it from naturally occurring rhizocaline. After washing it free from potassium permanganate the apical portion is split longitudinally and then placed for 12 to 15 hours under standard conditions in rhizocaline solution. After rinsing the tip in water the base is supplied with a 2-percent sucrose solution for six days and then with tap water. After all this treatment the number of roots produced are counted 14 days after the treatment with rhizocaline. The rhizocaline unit Went described as the quantity of the substance which produces one root in excess of that produced in untreated control ones.

Sources and distribution

It has been demonstrated by various workers that terminal and lateral buds, cotyledons and leaves are among the most important sources of auxin. Thimann and Skcog[19] on *Vicia faba*, Uhrova[20] on *Bryophyllum*, Avery[21] on *Nicotiana*, Dollfuss[22] on *Podophyllum*, Goodwin[23] on *Solidago* and Avery and Co-workers[24] on *Aesculus and Malus* have shown the presence of auxin in leaves. The amount of auxin and its diffusion from the leaves is correlated with the age of the leaves. Diffusion is very small in early stages, then increases to a maximum which is coincident with the rapid growth of the leaf and then falls off with maturity. The concentrations of growth hormone at different periods in the life cycle of *Zea mays* have been studied by Laibach and Meyer.[25] Zimmermann[26] (1936) has studied the concentration of growth

hormone is several woody species. The presence of growth hormone in stem is not yet definitely known.

Studying the distribution of growth hormone in the coleoptile and radicle of Avena seedlings Thimann[27] has found the presence of growth hormone in appreciable quantity in the lower part of the coleoptile. The concentration decreases regularly from the tip to the base from 0.69 units to 0.19 at the base. The same is the case with the root, falling from 0.43 at the root apex to 0.26 in the physically uppermost region of the root. Root-forming hormone has been obtained from rice polishing, urine, wheat embryos and from leaves of *Helianthus Prunus and Malva* (Thimann and Went).

The presence of growth hormone in shoot tips is associated with growth and light. There is a close parallelism between growth intensity and growth hormone concentration (Zimmeramann).[26] Growth hormone is detectable in increasing amount during the swelling of terminal buds of *Aesculus* and *Malus* (Avery, Burkholder and Creighton).[24] Elsewhere Avery and co-workers[27] have demonstrated the disappearance of growth hormone in darkness and in depleted food supply. The plants under normal day and night conditions but under reduced CO_2 supply also form smaller quantities of growth hormone. Under reduced CO_2 but in continuous light of defferent intensities, growth hormone production is proportionately greater in higher intensities of light. Higher growth substance concentration is found under exposures of red and blue part of the spectrum.

Transport

It has been known from a long time in ringing experiments root formation takes place at the upper end of the ring supporting the view that the root forming substance travels downwards in the phloem from the apical region and accumulates at the upper end of the ring. In all cases of auxin it is found that auxin travels downwards from the apical region even in cases where initial auxin concentration in the basal part is three times that in the upper (Van der Weij).[28] So transport is here independent of the concentration gradient. Olson and Buy[29] reported that a growth substance is present in the egg cells of *Fucus* and plays an important part in its polarity. In relation to the seasonal activity of Cambium to growth hormone (Snow)[3] a concentration gradient has been observed. Pearse[10] also observed a concentration gradient effect and root formation throughout the length of *Salix vitellina* (Willow plant) cuttings when indole butyric acid in lanolin was applied at the apical portion, the number of roots gradually decreasing from apex towards the base.

Function of Auxin

Auxin plays a decisive part in the stretching growth of stems, apical swelling and root formations. But an inhibitory action in the case of lateral buds of *Vicia faba* has been noted by Thimann and Skoog[30],[10] and Skoog and Thimann.[31] They have found that auxin formed in the apical buds is responsible for the inhibition of the lateral buds. When the apical bud is removed and agar block containing auxin of the same concentration which would have been present in the apical bud, is applied, the lateral buds are also inhibited. Growth hormone is associated with lateral buds only when they are in active stage of growth. When the lateral buds grow and produce auxin it is found that adjacent buds are retarded in their turn. The significance of this inhibitory action is discussed later under the nature of auxin reaction.

As many workers, Priestly,[32] Wight,[33] Brown,[34] have shown that resumption and seasonal activities of cambium is closely associated with bud development, it is therefore to be expected that in addition to other factors, growth hormone may play a definite role in the activation of cambial activity. It has been demonstrated that the cambial activity is initiated at the level of the terminal buds in the spring and spreads basipetally. Along with this is also observed a gradient of hormone concentration down the stem (Snow).[3] The hormone produced in the expanding buds move basipetally in stems before there is any indication of cambial cell division. Hence it is probable that growth hormone initiates cambial activity.

Nature of Auxin Reaction

Much cannot be said on the mechanism of auxin reaction in relation to the incidence of growth in

plants. That is of a very complex nature is undoubtedly true, consisting of a chain of reactions brought about by more than one factor. The view of the stimulatory nature of auxin is advanced by Fitting.[35] It is said to cause the liberation of energy in the system. But the evidence obtained from a detailed study of auxin behaviour is against it. It has been found in almost all cases of growth substance that per mol. they all cause the same amount of growth under strictly comparable conditions. It leads therefore to the conclusion that the reaction is of a chemical nature where auxin molecules take part (Went),[14] and not of a stimulatory nature. Went[11] gave the idea of a second factor—"Zellstreckungs-Material" *i.e.*, cell stretching material supplied by the roots and moving from the base to the apical region, which is necessary for the auxin reaction. Laibach[6] and Skoog[16] also held the opinion of a second factor to which they suggested the name of auxin precursor. Therefore it is suggested that a second factor is necessary for the auxin reaction and auxin alone cannot cause the elongation of stem or swelling of bud and root formation. In connection with this food factor the interdependence of auxin and sugar for growth has been shown by Schneider[36] Went[14] and the role of salts in the response of Avena cleoptile to auxins has also been pointed out by Thimann and Schneider.[37] The food factor or auxin precursor, whatever name we give it, is not a simple factor, but a very complex one and sugar is a very important component of this food factor complex. Schneider demonstrated that for sub-optimal concentration of sugar and auxin, an increase in concentration of either gives an increase in the growth rate and its magnitude is proportional to the products of the logarithms of the concentration. Sweeny and Thimann[38] working on the effect of auxins on protoplasmic streaming have shown that low concentration of auxin (which is capable of growth acceleration) also accelerates streaming; but in higher concentration and in presence of limited oxygen supply it is retarded. They suggested that in the system an oxidative process is accelerated by auxin which controls the rate of protoplasmic streaming. As protoplasmic streaming is associated with growth, it is probable that it controls the growth rate and the substrate for this process is probably sugar. They held the view therefore that in auxin induced reaction the effect on protoplasmic streaming precedes that on growth. Similar view is put forward by Bonner[39] (1933, 1936) that the action of growth hormone in *Avena* coleoptile depends upon a process of respiratory nature though of a relatively small magnitude.

Recently Went[14] explained the auxin reaction on a double factor scheme. He suggests that the action of auxin is of secondary nature, depending upon independent specific factors. These factors he names Calines which are of hormonal nature and are formed and stored in one part of the seedling and are effective in another part, eg. caulo-caline (factor for elongation and swelling) is formed in the roots and cotyledons have only a small storage; phyllo-caline (leaf growth factor) is stored in cotyledons, but is also present to some extent in stem. Went has demonstrated the presence of these calines by decapitating different parts of seedlings (removing the sources of calines) and found deficient growth of these parts even in presence of auxin. So auxin is effective only in presence of these calines. The relation of auxin to different calines is not clear, but the relation of auxin to rhizo-caline and caulo-caline is clearly demonstrated by experiments. Thus the root formation at the base of lemon cuttings (Cooper)[40],[41] and in Willow cuttings (Pearse),[10] when auxin is applied at the apex is due to the accumulation of rhizocaline at the base of root formation. So the auxin gradient in the stem causes an accumulation of rhizo-caline which is responsible for root formation. Auxin therefore only brings about a redistribution of root forming hormone.

The phenomenon of inhibition of lateral buds observed by Timann and Shoog is explained on this basis of redistribution of caulo-caline by auxin. If auxin produced in the apical buds causes caulo-caline to move upwards in the stem and to accumulate at the place of auxin production, that is, apical buds, then the lateral buds which do not get caulo-caline cannot grow. But when apical buds are removed the lateral buds with their slight auxin production can direct caulo-caline and begin to grow. The close relation between sprouting and root formation is also therefore evident (Cooper).[41]

On the assumption of this second growth factor, Calines, it is possible to explain some of the observed facts; but the modification in Went's view from Zellstreckung-Material to food factor and recently to calines of hormone nature, shows that much more experimental work on this aspect is needed before an analysis of the different processes induced by auxin can be appreciated. The association of auxin with active growth, the rate of which is controlled by a set of internal and external factors is a complex physiological process and to explain such a system by assuming the presence of another set of hormones, the existence of which we cannot at present directly prove, are problems which obviously require further investigation and elucidation.

Summary

1. Many synthetic substances have been added to the list of growth hormones. Modified Standard Avena Test has been recommended by having a second decapitation one hour after the first. It is also suggested that a desceded seedling gives a more sensitive test plant.

2. Auxin is always associated with growth, and is formed and stored in one part and is effective in another part. The terminal buds, the lateral buds, the cotyledons and leaves are amongst the most important sources of auxins in plants. The amount of auxin and its diffusion from the leaves is correlated with the age of the leaf.

3. Auxin always moves basipetally down the stem from the apical region even when the initial concentration at the base is higher than that of the upper part. While moving downwards it forms a concentration gradient.

4. The association of cambial activity and bud development suggests the possibility of the influence of hormone in cambial initiation in the spring.

5. The nature of auxin reaction has been recently explained by Went on a double factor scheme. He suggests independent specific factors of hormone nature, naming them different Calines responsible for stem elongation, bud development and root formation and auxin playing a secondary role in diverting and redistributing these calines in plants. On this basis the formation of roots, the inhibition of the lateral buds by auxin and the close relation between sprouting and rooting have been explained.

6. It seems on the basis of our present knowledge that auxin induces a chain of reactions in a system where many internal and external factors play part and it has been demonstrated that sugar at least is one of the necessary components of such a system.

References

[1] Kögl, F.—refer to *Phytohormones*, (Went and Thimann) Macmillan Co., N. Y., (1931-34).

[2] *Ibid.*, *24*, 4 (1937).

[3] Snow, R.—*New Phyt.*, *34*, 347, 1935.

[4] Crook, Davis and Smith—*Nature*, *139*, 154, 1937.

[5] Thimann, K. V. and Went, F. W.—*Proc. Kon. Akad. Wetensch. Amsterdam*, *37*, 456, 1934.

[6] Laibach, F.—*Ber. d. bot. Ges.*, 53, 359, 1935.

[7] Thimann, K. V. and Koepfli, J. B.—*Nature*, 101.

[8] Fischnich, O.—*Planta*, *24*, 552, 1935.

[9] Hitchcock, A. E. and Zimmermann, P. W.—*Contr. Boyce Thom. Inst.*, *8*, 63, 1936.

[10] Pearse, H. L.—*Ann. Bot.*, *2*, (New Series), 227, 1938.

[11] Went, F. W.—*Rec. Trav. Bot. Neerd* *25*, 1, 1928.

[12] Nielsen, N.—*Jahr. Wiss. Bot.*, *73*, 125, 1930.

[13] Thimann, K. V. and Bonner, J.—*Proc. Roy. Soc.*, **B**, *113*, 126, 1933.

[14] Went, F. W.—*Plant Physiol*, *13*, 55, 1938.

[15] Weij, H. G. Van der—*Proc. Kon. Akad. Wetensch. Amsterdam*, *34*, 875, 1931.

[16] Skoog, F.—*J. Gen. Physiol*, *20*, 311, 1937.

[17] Went, F. W.—*Proc. K. Akad. Wetensch. Amsterdam*, *37*, 445, 1934.

[18] Went, F. W.—*Proc. K. Akad. Wttensch. Amstedam*, *37*, 547, 1934.

[19] Thimann, K. V. and Skoog, F.—*Proc. Roy. Soc.*, **B**. *114*, 317, 1934.

[20] Uhrova, A.—*Planta*, *22*, 411, 1934.

[21] Avery, G. S. Jr.—*Bull. Tor. Bot. Club*, *62*, 313, 1935.

[22] Dollfuss, H.—*Planta*, *25*, 1, 1936.

[23] Goodwin, R. H.—*Amer. Jour. Bot.* *24*, 43, 1937.

[24] Avery, G. S., Jr. Burkholder, P. R., and Creighton, H. B.—*Amer. Jour. Bot.* *24*, 51, 1937.

[25] Laibach, F. and Meyer, F.—*Senckenbergiana*, *17*, 73, 1935.

[26] Zimmermann, W. A., *Zeitschr. Bot. 30*, 209, 1936.

[27] Thimann, K. V.—*Journ. Gen. Physiol*, *18*, 23, 1934.

[28] Weij, H. G. Van der—*Rec. Trav. Bot. Neerlandes*, *31*, 810, 1934.

[29] Olson, R. A. and Ruy, H. G. due—*Amer. Jour. Bot.*, *24*, 611, 1937.

[30] Thimann, K. V. and Skoog, F.—*Proc. Nat. Acad. Sc.*, *19*, 714, 1933.

[31] Skoog F. and Thimann, K. V.—*Proc. Nat. Acad. Sc.*, *20*. 480, 1934.

[32] Priestley, J. H.—*New Phyt.*, *29*, 316, 1930.

[33] Wight, W.—*New Phyt.*, *34*, 163, 1933.

[34] Brown. A. B.—*New Phyt.*, *34*, 163, 1935.

[35] Fitting, H.—*Biol. Zentral*, *56*, 69, 1936.

[36] Schneider, C. L.—*Amer. Jour. Bot.*, *25*, *4*, 258, 1938.

[37] Thimann, K. V. and Schneider, C. L.—*Amer Jour. Bot.*, *25*, *4*, 270, 1938.

[38] Sweeney B. M. and Thimann, K. V.—*Jour. Gen. Physiol*, *21*, *4*, 437, 1938.

[39] Bonner, J.—*Journ. Gen. Physiol*, *17*, 63, 1933; *Ibid.*, *20*, 1, 1936.

[40] Cooper, W. C.—*P. Physiol.*, *11*, 779, 1936.

[41] Cooper, W. C.—*Bot. Gaz.*, *99*, 599, 1938.

The Nature of "Agaru" Formation

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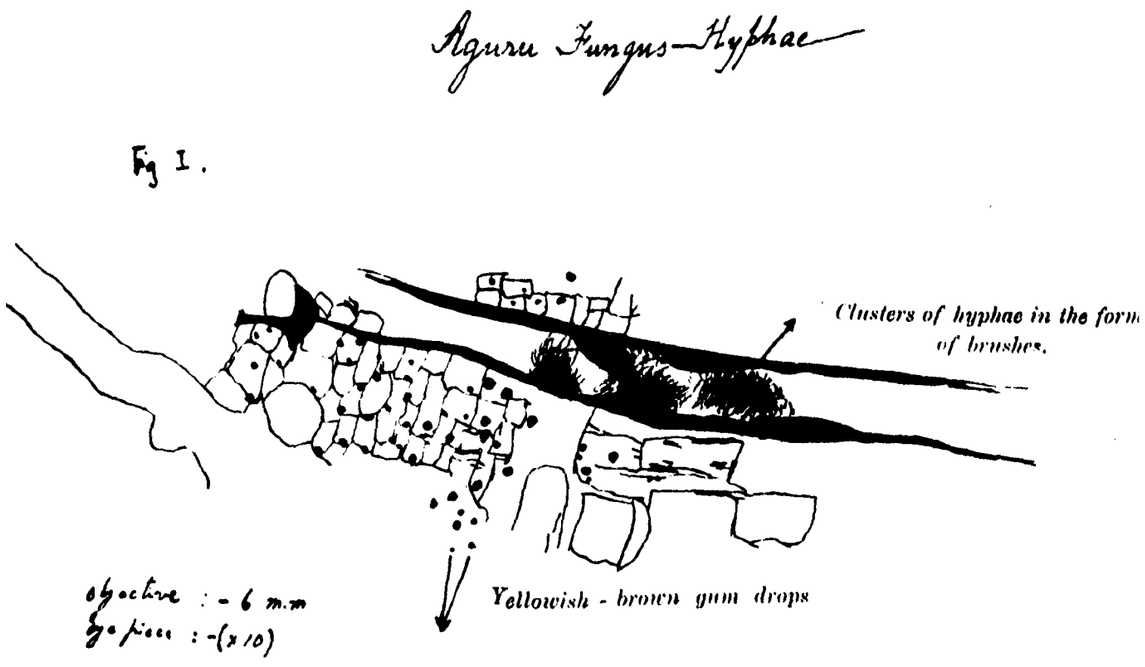
Agaru is collected from trees of *Aquilaria agallocha* Roxb. (Nat. Order *Thymelæaceæ*), which are sparingly distributed in Assam-Garo Hills (Tura), Sibsagar, Sylhet, Tipperah Hills, Bhutan and Martaban Hills (Burma). Healthy trees of *A. agallocha* do not bear *agaru*, the *agaru*-bearing tree has a distinct diseased appearance at the top and in the side branches, and *agaru* is collected in quantity only when such tree is either completely or partially (*i.e.*, branches, top etc.) killed. It is the opinion of local Garos who work with *Agaru* that the tree producing *agaru* ultimately dies, and as a matter of practice, no tree is usually cut or felled unless it shows outward signs of disease. But sometimes by mistake they cut and destroy a number of healthy trees suspecting *agaru*-formation; thus, the number of trees in the forests, which are limited and usually grow at distances from one another, is being gradually reduced and there is no regular plantation to increase their number. I learn that recently a nursery of about 100 shrubs has been raised. In a tree *agaru* is usually found in forks or at the junctions of branches with the stem. The disease usually takes some time to make itself manifest, hence *agaru* is hardly found in young shrubs. *Agaru* is highly prized in the market, true *agaru* is sold at Rs 16 to Rs 20 per seer, at present it is a chance-product as no means of artificially increasing its production are yet known.

Dr Hooper, late Reporter on economic products of India, has recorded in the *Agricultural Ledger*, 1904, No. 1 that the wood of *Aquilaria agallocha* under certain conditions becomes gorged with a dark resinous aromatic juice and that the portions thus impregnated constitute the commercial *agaru*, which is esteemed in proportion as it abounds in resinous matter. The average yield of a mature tree is 6 to 8 lbs. and an exceptionally good tree may afford as much as Rs. 300 worth of *agaru*. The exact cause of its formation has not been ascertained yet.

Some years back in 1925 at the instance of Mr F. Trafford, the then Conservator of Forests of Assam, I began investigation of *agaru* wood; samples of wood from different localities and local information about *agaru* were sent to me from time to time by late Mr B. Sen Gupta, Mr J. N. Das, Dr N. L. Bor, Mr C. J. Rowbotham, Mr C. G. M. Mackarness, Mr W. R. Martin, Mr A. R. Thomas and other officers of the Forest department of Assam. On enquiry I learnt that the Bengal Chemi-

cal and Pharmaceutical Works of Calcutta get their supply of *agaru* wood from Sylhet (village Sujanagore). Sections of the diseased wood showed drops of yellowish-brown gum almost in every cell, a fungus-mycelium was found close to the clotted areas where there was a massive accumulation of gum-drops; in the cavities produced by the disintegration of wood-elements there were clusters of thin and narrow hyphae here and there in the form of brushes (fig. 1). Sections were cut from



various parts of pieces of *agaru* wood from different localities and in each case the same fungus with closely septed hyphae of dirty-brown colour could be traced. The wood of the clotted areas showed delignification by patches (fig. 2), dark and white layers regularly alternating. The general effect on wood agrees in all particulars with that produced by wood-destroying fungi on timber-trees (*c.f.* A. S. Rhoads, New York State College of Forestry, Syracuse University, *Technical Publication*, no. 8, vol. XVII—March 1917 and D. V. Baxter-Pap. *Michigan Acad. Sci*, Vol. III-1923). The fungus was successfully grown in artificial medium (malt-extract agar) and its complete life-history was studied; it belongs to the group of ***Fungi Imperfecti.*** A short account of the investigation was communicated and read at the Bombay sitting of the Indian Science Congress in January 1926, it has been published at p. 224 of the *Proc.* 13th. Ind. Sc. Congress. Inoculation-experiments to produce the formation of *agaru* in healthy trees by this fungus-attack could not be carried out for want of *A. agallocha* trees in Bengal; some seedlings were imported from Assam and planted in our College-

FIG. 2.

Objective—no. 7 of Leitz eye-piece—(×10). Long. Section of the Agaru-wood showing delignification, septed hyphae represented in deep-black.

Garden but they did not thrive well and ultimately succumbed. Pure cultures of the fungus were from time to time sent to the forest-officers of Assam (Garo-Hills, Sibsagar, etc.) for inoculation on trees in their vicinity, but they could not satisfactorily proceed with the work. For the ultimate solution of the problem a number of trees should be available close to our place. It is very encouraging that the present Superintendent of the Royal Botanical Garden, Shibpur, Dr K. P. Biswas, is trying in right earnest to grow some plants from Assam in his garden and also at Mungpoo Cinchona-plantation for my work with the kind help of the Conservator of Forests, Assam and Mr A. Das I.F.S. (retired) now working at Shillong on "Flora of Assam." Of course, it will take a number of years hence before they are fit for the inoculation-stage.

Records of the Royal Society of London

THE Booklet, *Notes and Records of the Royal Society of London*, No. 1, April 1938, published by the Royal Society of London replaces the former publication of the Royal Society, titled *Occasional Notices* which described the activities of the Society, because it was felt that 'such a periodical might usefully include information of historical interest which would not be printed in either *Philosophical Transactions* or *Proceedings.*' It will be issued in April and October of each year, the former number being devoted to an account of the Anniversary Dinner, elections to fellowship and general information relating to the winter half of the session and the latter to an account of the two soirees and general information relating to the summer half of the session.

The *Notes and Records* will prove to be of considerable interest to those who have passed through the last four years' thrill of Academy-building in India. The information that it seeks to give is divided into 21 heads. It includes a list of the 20 new fellows elected on March 7 and also one of those among the fellows who died during the year (15) Last year's loss to the Society due to the death of its fellows was specially severe in view of the passing away of such eminent scientists as Lord Rutherford, Sir J. C. Bose and Dr G. E. Hale.

The society received during 1937 about £6116 in cash and the residuary estates of the late Dr J. H. Stothert and E. T. Browne as bequests. It is announced that the Pilgrim Trust has endowed funds for six years for two annual lectures—one to be delivered in London by a Fellow of the National Academy of Sciences, Washington, and the other by a Fellow of the Royal Society in America, the object being to promote good relations between the two English-speaking nations. The first lecturer under this scheme is Dr Irving Langmuir of the General Electric Company, America.

In the Anniversary Dinner held on the 30th November the guest of honour, Sir Jhn Simon, in proposing the toast of the Royal Society, gave [illegible] valuable information about origin of the [illegible] Society. We learn that its beginnings were laid at a meeting of some enterprising men at the Wadham College, Oxford. Sir John described in picturesque language the three governing ideas of the Society.

It was some space after the end of the Civil Wars at Oxford, in Dr Wilkins his Lodgings, in Wadham College, which was *then* the place of resort for Vertuous and Learned Men, that the first meetings were made, which laid the foundation of all this that follow'd.

'Allow me, My Lords and Gentlemen, to remind you for a few moments of the remarkable character and achievements of Warden Wilkins. He preserved his position as the Head of the College both before and after the Restoration. He commemorated the Commonwealth by marrying a sister of Oliver Cromwell, but his latitudinarian views were found not to be displeasing to Charles II. He wrote a treatise to prove that the moon was habitable, and another one to discuss how

it would be possible to make the journey thither. He invented, and made considerable use of, a universal language. He wrote a learned work, as was appropriate to a future Bishop of Chester, to prove, from the dimensions given in Holy Writ, that Noah's Ark was big enough to contain all the animals on earth. Aubrey described him as "the principal reviver of the new philosophy at Oxford"—that is to say, natural philosophy pursued by methods of experimental science. And he had the extraordinary good fortune, when Head of this small College at Oxford, to have among his undergraduates a young gentleman named Christopher Wren—that universal genius who was mathematician, chemist, biologist and architect, all rolled into one. Associated with Wilkins, too, was that remarkable physicist the Honourable Mr Robert Boyle, whose portrait you see reproduced on the card of this Dinner.

'Let me read you a passage from Evelyn's *Diary*, under the date of 13 July 1654, which shows how solid and well-founded is the claim that it was within the walls of Wadham that this new learning was cultivated and pursued:

We all din'd at that most obliging and universally curious Dr Wilkin's at Wadham College. He was the first who shew'd me the transparent apiaries, which he had built like castles and palaces, and so ordere'd them one upon another as to take the honey without destroying the bees.....He had also contriv'd an hollow statue, which gave a voice and utter'd words by a long conceal'd pipe that went to its mouth, whilst one speaks through it at a good distance. He had above in his lodgings and gallery variety of shadows, dyals, perspectives, and many other artificial, mathematical, and magical curiosities, a fly-wiser, a thermometer, a monstrous magnet, conic and other sections, a ballance on a demi-circle, most of them of his owne and that prodigious young scholar, Mr Chr. Wren, who presented me with a piece of white marble, which he had stain'd with a lively red, very deepe, as beautiful as if it had been natural.

'In 1660 it was resolved at a meeting of twelve persons that Society should be formed "for promoting physico-mathematical experimental learning." That was in London, and the Society, of course, is the institution whose health I am proposing.

'So much for origins. And when one considers the achievements of this splendid institution, whose record now stretches continuously over two and three-quarter centuries, one may detect running through its work three governing ideas, which I venture to formulate to-night.

'First, your founders and those who came after them have held firmly by the doctrine that the business of the investigator is to pursue his experiment, wherever it may lead, without any regard to orthodox tradition.

'Secondly, from the very first down to to-day, this organized instrument for the pursuit of knowledge has been used by its members with no idea that scientific discovery would necessarily be of immediate practical utility, but because the truth is worth finding out for its own sake. And as a result, to a perfectly incredible degree, these new discoveries have in fact been found to contribute immensely to the benefit of mankind. Names such as Davy, Kelvin, Rayleigh—and another name which stirs in us a poignant feeling to-night, the name of Rutherford—to mention merely these instances, have established that claim for the Royal Society for all time.

'And thirdly, the practice and precept of this Society embody the great principle that it is by the *interchange of* scientific ideas between scientific men of different kinds that progress is best achieved, notwithstanding the intense specialization of the age. I was interested to notice, in looking through Thomas Sprat's book, that he expressed this last view in these curious words:—

If I could fetch my materials whence I pleas'd to fashion the Idea of a Perfect Philosopher: he should not be all of one clime, but have the different excellencies of several Countries. First, he should have the Industry, Activity, and Inquisitive humour of the Dutch, French, Scotch, and English, in laying the ground Work, the heap of Experiments: And then he should have added the cold, and circumspect, and wary disposition of the Italians, and Spaniards, in meditating upon them, before he fully brings them into speculation. All this is scarce ever to be found in one single Man: seldom in the same Countrymen: It must then be supply'd, as well as it may, by a Public Council; wherein the various disposition of all these Nations, may be blended together. To this purpose, the Royal Society has made no scruple, to receive all inquisitive strangers of all Countries, into its number.

'Science has thus a special claim for the respect of those whose working life is largely concerned with public affairs. It is completely international; it speaks all languages and it knows no frontiers. It is capable of being an ambassador of peace and goodwill for the whole world.

'Literature—and I speak as a humble and devoted worshipper of the Muses—has often been the vehicle for national passions, and perhaps for national prejudices. Tennyson's *Maud* was published during the Crimean War,

and it cannot have been a contribution to peace to call the ruler of Russia "a giant liar" or to write the line: "And Jack on his ale-house bench has as many lies as a Czar."

'Art, too, has often been misused for purposes of national rivalry and ridicule. But the work of men of science in pursuing the truths of Nature is in its essence a contribution to the things which are capable of binding together the nations of the earth.

'The Royal Society has a fine record in this respect. I recall two incidents in the history of your Fellows. In the middle of the Napoleonic Wars Davy was awarded by the *Institut de France* a great prize of 3000 francs. There were those in both countries who criticized either the award or its recipient. But it was a fine gesture that, when these two countries were locked in the conflict of war, learned men on the one side of the Channel gave honour to a learned man on the other. Davy himself claimed that the influence of a man of scientific reputation "can soften the asperities of national hostility." The other incident to which I would refer occurred when the Peace of Amiens suddenly broke down. At that moment there were many Englishmen travelling on the continent of Europe. Some of them were arrested by the French authorities as alien enemies and detained as non-combatants within the confines of France. They applied for their release. One of these was Edward Jenner. When Napoleon examined the list, it was the finger of Josephine who pointed to the name of Jenner, and Napoleon declared: "We can refuse nothing to that man."

'Great then are the contributions in the public and international sphere which it is in the power of men of science to make. May their contribution be used for the benefit and advancement of mankind, and not abused to add to the destructive powers of the world. I wish all that is good to this splendid institution, the most famous and ancient of its kind, not only because I have been brought up to reverence learning and to respect knowledge, but because the work which you, Mr President, and your Fellows are doing is capable of spreading peace among the nations of the earth.'

The President of the Society, Sir William Bragg, in replying remarked:

'Sir John has spoken of the part which Science may play in drawing the nations together and so contributing to the peace of the world. The relations between knowledge and the unity of mankind are indeed most important. It is well to draw attention to them. Long ago the Greek philosophy held that knowledge and the exchange of knowledge differentiated the reason of man from that of the animals. The exchange was essential; success in the pursuit of knowledge was a social matter. A modern writer[1] has reviewed the questio in the light of the events of the thousands of years tha have elapsed since then. He has observed that there is certain correspondence between the period of maximu scientific activity and maximum realization of unity Thus the Greek construction of science and philosophy may b connected with the formation of the Greco-Roman world, a the head of which were men trained in Greek philosoph attempting to apply the rules of reason to an accumulatio of sociological knowledge. Again, the revival of science i the fifteenth and sixteenth centuries is allied to the discover of the New World and the expansion towards the West. An once more, towards the end of the eighteenth century th rapid increase of science led to a new linking up of th world eclipsing all that the earlier centuries had to show.

'The question, however, which most nearly concerns us i this: Does the increase of knowledge of Nature bring abou that unity which makes for peace? No doubt it bring the nations together in the sense that they become more awar of each other, that their intercommunications have increased and that they trade with each other more freely. But d jealousies and hatreds and causes of conflict disappear? am afraid that history shows no such happy result. Wa there ever a more quarrelsome set of little States than thos that grouped themselves about Athens and Sparta? Did Europ settle down to peace when after the Renaissance experiments methods expanded the knowledge of the natural world? Th eighteenth and nineteenth centuries were full of war in spit of their scientific activities. And worst of all, since th last great war, though natural knowledge has grow astonishingly, the present world is seething with unrest; bot in Europe and in Asia bitter wars are in progress. Th clouds overhead are dark and heavy.

'Yet I think that if we look at another part of th sky we can see rifts in the clouds; and the wind is blowing from that direction.

'Let me define the position as it appears from another point of view.

'Man, they say, has raised himself above the beasts by his success in making tools, which have given power to his hands, and opportunity for the development of their skill. Much later came the sharpening of his senses due to the construction of instruments of observation, and the consequences have been and are tremendous. First came the measuring instruments of the old astronomers and geometers on which Greek and Egyptian science was based. These gave accuracy in the comparison of angles and distances, and through astronomi

[1] F. S. Marvin, *Studies in the History and Method of Science*, edited by Charles Singer.

cal observations a certain knowledge of the passage of time. From these the knowledge of the natural world derived its increase for more than fifteen hundred years.

'Then towards the end of the sixteenth century came the microscope and the telescope, the pendulum and the thermometer, and science leapt forward with powers vastly increased. The telescope set far back the bounds of the universe, and the microscope opened up a world of the very small hitherto beyond the powers of the unaided senses. The pendulum provided a convenient and accurate measurement of time and the thermometer an estimate of temperature which outclassed the natural capacities of touch and feeling. It is odd that the common use of single lenses for 300 years should never in all that time have led to the use of lenses in combination. Spectacles had been in use in Europe since 1300. There used to be a gravestone in a Florentine church which bore the quaint inscription: "Here lies Salvino d'Amarto degli Amarti of Florence, the inventor of spectacles. May God forgive him for his sins. He died Anno Domini 1317."[1] Bernard de Gordon, physician of Montpellier, in his *Lilium medicinae* (1305), mentions them in recommending his own eyewash which renders spectacles useless! In Holland, at about the end of the sixteenth century, Jansen invented the microscope, and shortly afterwards Lippershey was commissioned to make telescopes for military use.

'But it was Galileo who first made revelation of the immense powers of the new instruments. Following him came a long list of scientific workers of the seventeenth and eighteenth centuries who used their sharpened and strengthened senses in the building of a new experimental science. Early in the nineteenth century electrical and magnetic instruments came rather to add new senses than to improve the old. In recent years the X-rays, radioactivity, the ionic valve, the cloud chamber and other new instruments have furnished yet further means of observing the world in which we live. As a result the boundaries of that which is observed by unaided eyes and ears and other senses have been far overpassed; our familiar world has become but a spot in the middle of an expanse whose horizon is constantly receding.

'Now it is to be observed that the knowledge of this wider world and of its contents is of vital importance to us. Our interest in it is not merely academic. We live in it and are part of it. We are, so to speak, citizens not only of the town in which we have lived without acquaintance with what lies outside the town walls, but citizens also of a wider country. We know that we must obey the municipal laws. We now find that there are country laws, of which we have had no knowledge hitherto, and these also must be obeyed under penalties which may be of the utmost severity. Indeed we have in the past suffered heavily because we have unwittingly broken them. If this seems to us unjust, it must be remembered that in our ignorance our judgment is of no value. Moreover the country of which we are now aware is full of resources, which we can gather according to our powers, and use according to our will.

'We are in a continuous state of adjustment to the conditions in which we find that we are living. We cannot shut ourselves within the town walls and refuse to look outside. We must step out into the open, and this is in effect what men are doing. The more they do so, the more they forget the divisions and quarrels of the town, the more the nations find that they must act together. Consider the various activities of mankind at the present time and see what is happening.

'To begin with, there are the activities of the search for knowledge, inspired simply by the wish to know and understand without thought of application of what is discovered. In this the nations act as one body. In every branch of science, knowledge is fully interchanged: men from all nations meet continually in conference and speak in one language though their vocabularies may differ. As knowledge grows, conference becomes more frequent and the feeling of comradeship grows also.

'There are the vast subjects of medicine, surgery, hygiene. Here also is the same search in common: the same collaboration between the men engaged in it. The governments of the nations are now deeply concerned. What government would not gladly communicate to any other a discovery which made for health? Indeed, the health of the world becomes a matter in which all nations must take counsel together, framing laws to govern such matters as the spread of infection, the provision of remedies, quarantine and so on. The health of the animal world in land and sea, of the vegetable world, pests and antipests, all that concerns the production of food and other necessaries of life grow more and more international the more account is taken of the new knowledge.

'The same is true of the trade of the world. In all the complicated arrangements that the nations in council must make for the conduct of traffic on the seas and in harbour, for lighting, direction finding and other aids to navigation, for charting, for the examination of goods in transit, for transportation on land, an in very many other matters, the new knowledge permeates the whole business. The nations are obliged to act together, and they do so.

[1] Loc. cit. p. 399.

'Knowledge of the wider world has transformed the means of communication of intelligence, by mails travelling over land or sea or in the air, by telegraph and telephone, by wireless. The nations cannot use the new means unless they confer. Hence the many conferences, and the continued exchange of information, and the consultations of the directors of the various activities.

'The same is to be said of meteorology, a study which is based on observations of the modern kind, and is only possible when the whole world contributes to it in ways that are determined in a world council.

'Equally true is this of standards of weight and length and time, of illumination, of electrical and magnetic and many other quantities and qualities. Here again the various countries of the world must, and do, confer: and the information which they exchange is expressed in terms that the unaided senses cannot appreciate. So also the tests of materials that are used in the vast and varied constructions of the world must be determined by common action. In the spring of this year a great international conference assembled in London, at which these matters of world importance were discussed. It was notable that the discussions turned continually on observations belonging to the wider world of the aided senses, and it was the width and depth of the questions discussed that had brought the nationalities together.

'The point I would make is this, that modern science and modern applications of science are leading to a vast amount of international effort. The new knowledge of Nature is opening up activities of which man is eagerly making use: and the character of these activities is such that co-operation between the nations is necessary to success. As a consequence co-operation already exists, and is increasing. The old assertion is being fulfilled, that the progress of knowledge is a social affair, demanding co-operation and harmony. Knowledge of Nature in itself does not so much bring peace as the common pursuit of that knowledge.'

The *Notes* on the Foundation and History of the Royal Society will be of interest to those who have witnessed the National Academy Controversy in India.

We learn from this chapter that the Royal Society was one of the earliest practical fruits of the philosophical labours of Francis Bacon, who in his *New Atlantis* advocated the foundation of a Philosophers' College. On Sept. 22, 1641 there arrived in London, a celebrated (Czechoslovakian Philosopher, Jan Amos Komensky, better known as Comenius on the invitation of Samuel Hartlib, an influential citizen of London, and a friend of Milton. Comenius, who had been a bishop, but was expelled on religious grounds, had written a book "*Pansophie Prodromus* (Essay towards complete wisdom) which made a great appeal to the earnest-minded men of the times and was translated in several European languages. Hartlib in inviting Comenius ended with the words "Come, come, come: it is for the Glory of God: deliberate no longer with flesh and blood." Comenius met in London a number of prominent English Leaders, Pym, Selden, Lord Brooke, and others.

During his residence in London, Comenius explained his plans in a tract entitled *Via Lucis* which he described as

'a reasonable disquisition how the intellectual light of souls, namely Wisdom, may now at length at the approach of the eventide of the world be happily diffused through all minds and peoples.'

He further wrote

'It is hardly necessary to describe how indispensable a School of Schools or Didactic College would be, in whatsoever part of the world it were founded: even if there be no hope for the actual establishment of such a college—corporations being left wherever they are, the design itself should be cherished with a holy faith among the learned, pledged as they are, to promote God's glory in this very matter. These men should make it the object of their combined labours to establish thoroughly the foundations of the sciences, to spread the light of wisdom throughout the human race with greater success than has heretofore been attained, and to benefit mankind by new and useful inventions. For unless we desire to remain ever in the same position, or even to go back, we must take care that our successful beginnings lead on to further advances. For this no individual, and no single generation sufficeth, and it is therefore essential that the work should be carried on by many persons, working in concert and using as a starting-point the researches of their predecessors. This Universal College would bear the same relation to other schools that the belly bears to the other members of the body, that of a living laboratory supplying sap, vitality, and strength to all.'

On commenting on Comenius ' part, Dr F. Young M.A. (Oxford), corresponding member of the Royal Bohemian Society of Sciences, Prague writes

'The visit of Comenius to London in 1641-2 marks an important stage in the development in this country of the idea of a great institution for scientific research, which resulted in the organisation of the "Invisible or Philosophical College" by Theodore Haak and others in 1645, and the foundation of the Royal Society in 1662.'

The Invisible College which was the immediate precussor of the Royal Society was however no Pansophic University, carrying out the dreams of Comenius

It was merely a club of young men, some of the intelligentsia of that day, brought together by common college backgrounds and many common interests for rest and refreshment from the political, theological and military turmoil of the times.' The Invisible College (the name was first used by Boyle) included a small group of friends—Wallis, Wilvins, Goddard Ent, Scarborough, Glisson, Merrit, Boyle, Foster and Haak—whose ages ranged from eighteen to forty-eight. Theodore Haak, a Calvinist refugee, had joined with Hartilib in welcomeing Comenius to England in 1641: the other members of the group were none of them named by Comenius as his friends or patrons who were older men.

The history and constitution of election methods of fellows of the Society which proved to be a matter of some controversy, make a very interesting reading

Unlike the Academies of Science in most other countries where they exist, the Royal Society is not restricted by the terms its Charters in the number of candidates which may be admitted to the Fellowship. The selection and election of candidates is left to the absolute discretion of the President, Council and Fellows of the Society. The manner in which they have carried out this duty in the past is of special interest in studying the growth of the Society.

From its foundation the Society was absolutely dependent upon its own resources, for it had neither a subvention from the State nor were its publications printed by an official printing press, advantages which other national academies have usually enjoyed. The subscriptions of its Fellows and occasional gifts and bequests were all that the Council could look to for meeting the growing expenses of the young Society. The development of an adequate membership was therefore imperative, and long engaged the Council's attention.

The number of Fellows at the Anniversary 30 November 1663 was 131; this rose to 199 a few years later, and then fell off to 116 in 1691; by the end of the century there were 125 besides 37 foreign members. Admissions to the Fellowship during these years were on the average only nine in each year, and this was hardly enough to maintain the membership near its original figure, but with an average of twelve admissions in the decade 1701-10 and of eighteen in the next decade the membership began to rise. In these totals of membership and in those which follow the Royal Patron and Royal Fellows are not included.

About this time interest in the Society and its aims seems to have waned temporarily since in 1680, the attendance at the meetings was so meagre that the Society was in danger of being dissolved. Evelyn writes to Pepys begging him to attend the weekly meetings 'even if you cannot be there until 6 or 7 o'clock." Hooke, too, in his diary comments on several occasions on the meagre attendance. But things soon began to mend, and the election of Newton to the Presidency in 1703 may well have had considerable influence in bringing about the rise in the number of Fellows which occurred in the early part of the eighteenth century. The average number of candidates admitted to the Fellowship, which had hitherto been nine in each year, rose to fifteen for the twenty years 1701-20. For the remaining eighty years 1721-1800 the average was twenty three; the number varying from 19.9 in 1751-60 to 25.7 in 1771-80. Consequently the number of Ordinary Fellows rose steadily from 121 in 1697 to 195 in 1721, 303 in 1741, 352 in 1761, 479 in 1781, reaching 545 in 1801.

Foreign members, who numbered 24 in 1697 and 37 in 1701, continued to increase in number as though the qualifications of such candidates were not scrutinized closely enough by the Council. By 1721 their number had risen to 64, and by 1766 to 170, or about half as many as the Ordinary Fellows of the Society in that year. By 1761 the Council felt that the Foreign Members, who then numbered 154, were becoming too numerous, and enacted a Statute providing that their certificates should be signed by at least three 'Foreign Fellows' as well as 'by three Fellows named in the Home List.' In 1765 Council further resolved that no Foreigner be proposed for election who is not known to the learned world by some publication or invention which may enable the Society to form a judgment of his merit; also that until the number of Foreign Members be reduced to eighty not more than two be admitted in one year. In the Statutes of 1776 the restriction of two elections a year is omitted, and ten years later the number of Foreign Members was limited to 100, which was altered to 50 in 1823. The result of this was that the number of Foreign Members in 1801 was 77 only, or about one-seventh of the number of the Ordinary Fellows of that year.

[1] Pepys, vol. ii. p. 337, by A Bryant.

At the outset scientific men had only constituted about one-fifth of the membership of the Society, the rest of the Fellows being drawn from the educated classes of the time and not necessarily from any of the learned professions. This continued to be the constant practice of the Society for many years so that its membership consisted, firstly, of men of science, and secondly, of those who from their position in society or their fortunes it might be desirable to include as patrons of science. The proportion of these two classes varied from time to time but it was not until the middle of the nineteenth century that the general principle was revised.

As the Society became more firmly esstablished and better known, candidates for election became more numerous. Throughout the whole of the eighteenth century there was a steady rise in the number of Fellows, which reached 545 in 1801; it continued to increase year by year until 1848. There is no means of analysing the membership at any point in the eighteenth century in order to determine what proportion of the Fellows were men of scientific standing, but the ready admission of others, most of whom apparently paid a composition fee of £40 instead of an annual subscription, suggests that those who were elected not for their scientific eminence alone were in the majority. To quote a single case: Sir Roderick Murchison, the geologist, was elected a Fellow of the Royal Society in the spring of 1826; for this honour, as the President, his old friend Sir Humphrey Davy, told him, he was indebted not to the amount or value of his scientific work, but to the fact that he was an independent gentleman having a taste for science, and with plenty of time and enough means to gratify it.[1]

Numerous pamphlets and other publications criticising the administration of the Society appeared during the early part of the nineteenth century and from one of these the proportion of scientific Fellows to the rest can be deduced since the author gives an analysis of the communications from Fellows which were published in the *Philosophical Transactions*. Of the 662 Fellows who formed the Society in 1830 only 106 had contributed at least one communication which had been published in the *Philosophical Transactions;* and of this number 44 of them had contributed only a single paper.[2] The great majority of the Fellows, therefore, were doing very little to promote the advancement of Natural Knowledge.

[1] *A Memoir of Sir Roderick Murchison*, by A. Geikie.

[2] *The Royal Society in the Nineteenth Century*, by A. B. Granville, F.R.S., London, 1836, pp. 33—39.

This problem had long been before the Council and as early as 1674 'the ejection of all useless Fellows' had been proposed by Newton, but this raised too many difficulties. Many discussions, both in the Council and informally among the Fellows themselves, took place as time went on, and in 1831 the Council appointed a Committee to re-examine the whole question. The Committee reported that any alterations in the Charters would be difficult and expensive to carry out; and for this reason they recommended a revision of the Statutes by which six signatures of Fellows instead of three on the certificate of each candidate should be required; also that elections should take place only at the first ordinary meeting in December, February, April and June, instead of at any meeting. These remedies proved quite ineffectual; by 1834 it was found that four meetings did not suffice for carrying out the election of the candidates under the procedure then in use, and therefore this restriction was dropped. No reduction in the number of candidates had been effected, for the records show that 50 were elected in 1834; nor does it appear that any critical selection of those who were the most suitable for their scientific knowledge had been introduced. Moreover, during the forty years 1801 to 1840 the elections numbered 1081 while the deaths were only 776, so that the membership was still increasing steadily.

It may well be that the large number of Fellows who compounded for their subsriptions presented a financial problem of some difficulty. In 1847 there were 480 who had compounded as compared with 284 who were paying an annual subscription; and there is good reason to suppose that non-scientific Fellows formed the great majority of those who had compounded. If the average annual number elected was to be reduced from 27 as it then was, to 15 as had been suggested in 1846 and as was actually done in the following year, the Society's annual income might suffer to the extent of twelve composition fees of £40 each. This may well have caused Council to hesitate before taking such a step. In 1831 the Treasurer's report was printed and published in full for the first time, and in it we see that the receipts from composition fees from 27 out of 29 newly elected Fellows brought in £1080, while subscriptions for the year amounted to only £296.

In May 1846, in consequence of a proposal made by W. R. Grove, F.R.S., another Committee was appointed by the Council to examine and report upon the Charters and Statutes; they held several meetings and presented their report to the Council on 16 June 1846, together with a draft of new Statutes which included certain alterations proposed by the Committee. This report was considered by the Council at several meetings and was finally adopted on 10 February 1847 when orders

were given to print and circulate to the Fellows the revised Statutes. The two most important provisions were (i.) that the election of candidates for the Fellowship should take place once a year only, and (ii.) that the Council should select not more than fifteen candidates whom they cosidered suitable and should recommend them to the Society for election. During the discussions in Council amendments to replace the number 15 by 17, or by 20, were proposed, but the original number 15 was finally adopted. The effect of this was at once apparent; the admissions for the years 1841-47 had amounted in all to 176, or 25 yearly on the average; in 1848 and in the subsequent years up to 1930, 15 only were elected.

The Statute which, with two alterations made in recent years, has been in force until now, in no way alters the right of the Fellows, which is conferred on them by the Charter, to elect whomever they may please and as many as they please at a general meeting of the Society.

For the twelve months 1 December 1846 to 30 November 1847, the Membership of the Society included: Patron and Royal Fellows 13, Foreign Members 47, Ordinary Fellows who had compounded 480, Ordinary Fellows paying an annual subscription 284, so that the total number of Ordinary Fellows was 764. Numbers now began to fall steadily; in the twenty years 1848-68 the number of Ordinary Fellows had fallen by 218, and in the next twenty years, 1868-88, by 77, bringing the number of Ordinary Fellows to 469 in 1888.

It is instructive to note that this large reduction affected the list of compounding Fellows almost exclusively; while in 1847 those who had compounded numbered 480 and the annual subscribers 284 only, the corresponding numbers in 1868 were 289 and 257, and in 1888 they were 182 and 287. The total number of Ordinary Fellows has since then not varied greatly, but the annual subscribers have increased by about 120 at the expense of those who preferred to pay the composition fee which was at first £40, then £60, and is now £75.

This restriction on the number of candidates to be admitted annually to the Fellowship, and the demand for adequate scientific qualifications which was the natural consequence of it, constituted the most important change in the administration of the Society which had been made since its foundation. It changed it at one stroke from being an eminent body of cultivated men only a proportion of whom were devoting their lives to the advancement of Natural Knowledge to one in which the promotion of science was the first aim, and for admission to which a certain standard of scientific eminence was obligatory.

In 1875 a Committee was appointed by Council to consider 'whether it is desirable or not to make any alterations in the Statute relating to he Election of Fellows.'

They recommended that the duty of selecting the candidates should be left in the hands of the Council, and that the number to be selected and recommended annually to the Society for election should continue to be fifteen.

Since then, the number of candidates to be recommended for election in each year has been altered twice; it was raised to 17 in 1930 and to 20 in 1937, at which figure it now stands.

The membership on 30 November 1937 was made up of:

Patron and Royal Fellows	4
Foreign Members	50
Fellows	453

The number of Ordinary Fellows has only varied between 442 and 459 during the last fifteen years. It is of interest in this connexion to note that in the early years of the nineteenth century Dr W. H. Wollaston expressed the opinion that about 400 would be a suitable number for the fellowship.

The experience of England in organising her National Academy of Sciences (for the Royal Society of London is recognised as such by the British Government, in spite of the existence of other Royal Societies, Academies, and Societies devoted to particular subjects in the United Kingdom) will be invaluable to those in India who are now trying to organise the senior scientific men of India into a national body, capable of weilding sufficient influence amongst scientists as well as with the Governments.

Review of the Rockefeller Foundation for 1937

We have for some time past with us a booklet titled *The Rockefeller Foundation—A review for the year 1937*, by Raymond B. Fosdick, President of the foundation. It will be remembered that the late J. D. Rockefeller, who died at the age of ninety-eight on May 23, 1937, made gifts for philanthrophic purposes to the staggering amount of 530 million dollars, *i.e.*, nearly 160 crores of rupees in Indian money. The yearly income would appear to be nearly 7 crores of rupees, exceeding the total budget of the province of Bihar. The ways and means by which J. D. Rockefeller made his money were not, according to some critics, always clean and above board. The curious reader may turn to the lucid account given by H. G. Wells in his *Wealth and happiness of Mankind*. But if money was ever well-spent, here is the case!

It is estimated that since their foundation, the various Rockefeller foundations have spent nearly 665 million dollars, *i.e.* nearly 200 crores of rupees, for philanthropic purposes.

There ought to be a sound philosophy, and method behind all manner of charities, otherwise these may be entirely futile, as so many of them are in India. Infact, the late Mr Carnegie, whose charities came next to that of Rockefeller (400 million dollars), used to say 'It is more difficult to spend money than to earn,' and consistent to this maxim, he devoted the last twenty years of his life to the administration of the funds created by him, as the constitutional head. Let us therefore see what the philosophy behind the Rockefeller charities was and how the funds have been administered. We learn from the report

Mr. Rockfeller always made his gifts after thorough study and careful planning; and its is perhaps appropriate at this time to mention one or two principles which guided him. These principles were not necessarily formulated at the beginning of his career; rather they were the result of his long experience in philanthropic activity.

In the first place, he trusted the future. He did not think that benevolence and wisdom were confined to his generation. He was not under the illusion that what seems important to-day will necessarily be important to-morrow. He did not believe in tying up foundations to rigid and unchangeable purposes. He was familiar with English as well as with American experience in the creation of trust funds, and he would have agreed with Sir Arthur Hobhouse in the latter's comment on medieval foundations that "a nation cannot endure for long the spectacle of large masses of property settled to unalterable uses."

The wisdom of the last passage is illustrated in the futility of those charities which were after temple and monastery foundations, and no country suffers so much from the evil effects of these as India, which has a large amount of property, or is supporting bands of men who are not, to say the least, useful to society. In Europe, such foundations have been dissolved by State decrees or by some other drastic method. Witness the closing of monasteries in England by Henry VIII and Cardinal Wolsey. But who is going to do that in India?

The sole purpose of the Rockefeller Foundation is stated in its Charter to be

"to promote the welfare of mankind throughout the world."

If any restriction was laid, this was removed by Mr Rockefeller writing to the Trustees of the general Education Board in 1920.

"If in any gifts heretofore made to you by me there are any restrictions or limitations as to the specific purpose for which they are to be used, I hereby revoke such restrictions."

No Perpetual Endowment

The Endowments are not perpetual, because Rockefeller did not believe in perpetuity. "Perpetuity is a pretty long time," he used to say. All the Rockefeller Trusts are allowed to spend the income as well as the capital.

In fact, some of the trusts were liquidated, or amalgamated with general funds after it was found

that the motive for which these trusts were created no longer existed.

"Do not legislate for infinity."

This idea of Mr Rockefeller's has had great influence in shaping the policies of the boards which he established. The temptation to visualize the future in terms of the present —to think of the needs and methods of to-day as having a sure claim to immortality—is one which confronts trustees as well as founders of philanthropic foundations. For example, to establish under a permanent endowment in some university or research centre a department or chair of psychiatry or organic chemistry may seem, with such light as we have at the moment, a rational and socially desirable step. But what wisdom have we to-day to determine that a century or more hence psychiatry and organic chemistry will represent the pressing needs or the practicable techniques of that time? In endowing what they thought was of permanent importance, earlier generations made wrong guesses which embarrass us to-day. How can we assume that our guesses have any greater validity or are made with any clearer foresight?

This principle gave wide latitude to the Trustees of the Fund in the expenditure of the income as well as the capital. The general policy is laid down in the following notifications

(1) Ten years after the date of the gift, the income from it may be used in whole or in part for some purpose other than that for which the gift was made, such purpose to be as reasonably related to the original purpose as may be found practicable at the time, having regard to intervening changing conditions.

(2) Beginning five years after the date of the gift, 5 per cent of the principal of the fund may be used each year for any purpose for which income may then be used.

(3) After the expiration of twenty-five years, any part or the whole of the principal may be used for some other purpose, the new purpose—as in point one—to be as reasonably related to the original purpose as may be found practicable at the time, having regard to intervening changing conditio--

A full account is given of the total amount spent in 1937. This amounted to the huge total of nearly 10 million dollars, nearly three crores of rupees, besides recurring expenditures. The amount spent was distributed over 88 countries from Norway to Peru, the major part, of course going to the United States, and for medical and biological purposes. In fact, for some time past, it has been the policy of the Rockefeller Foundation to patronize medicine and biology to the exclusion of Chemical and Physical Sciences, so that the votaries of these latter subjects must find out some biological theme if they wish to get money from Rockefeller for their researches. We, for our part, do not consider that this is a sound policy.

Besides the U.S.A, the largest beneficiary has been China (nearly half a million dollars) where the Foundation gives grants to universities, medical colleges, for research and development. Rockefellers have a soft corner for China in their heart. In the review for 1936, the following sentence appeared:

"China to-day stands on the threshold of a renaissance. The Chinese National Government, together with many provincial and county authorities and private organisations, are attempting to make over a medieval society in terms of modern knowledge."

This proud ambition, in which the Foundation was participating, has been virtually destroyed by the events of the last six months. The programme was primarily a programme of rural reconstruction and public health. It was rooted in promising Chinese institutions like Nankai University and the National Agricultural Research Bureau, both in Nanking. It was promoting studies in subjects like animal husbandry and agriculture; it was carrying on broadly based field experimentations; and it was training men and women for administrative posts in rural and public health work.

Nankai University was completely destroyed last July. The universities and institutions in Nanking, where they are not too badly damaged, are serving to-day as army barracks. The field units in mass education and public health are so completely scattered that it is practically impossible to locate them. The work, the devotion, the resources, the strategic plans of Chinese leaders for a better China, have disappeared in an almost unprecedented cataclysm of violence.

At the moment there is nothing further to report. The Foundation still maintains its office in Shanghai. Whether

there will be an opportunity to pick up the pieces of this broken programme at some later date, no one can foretell.

We express our genuine sympathy with China which as far as industry and science are concerned, is in very much same condition as India. We regret very much that the sincere attempts of the Chinese leaders at a Renaissance should be so rudely disturbed by the aggressive action of a neighbouring imperialist power. We can only hope that out of her present struggle will emerge a new and reborn China which will again carry forward the torch of a higher civilization. It may not be out of the way to mention here that medieval China gave to the world the three great discoveries which made modern Europe great. These discoveries are: paper and printing machine, magnetic compass, and gunpowder, but alas! China herself never made any largescale use of these. The Academy Sinica, and other Chinese Scientific Institutions, which were doing splendid scientific work now lie in ruins, as a result of the sanguinary conflict and still we call the modern age "An enlightened one!" Contrast with this the work of Kublai Khan, grandson of Chenghiz Khan, who conquered China in 1265, and instead of razing the monuments of previous times to the ground to celebrate his victory, raised China by his wise administration to a pitch of prosperity which it had not since witnessed (*vide* pages of Marco Polo). Who were the greater barbarian, the nomad Mongol, or the enlightened modern nations who carry forward civilization with howitzers, poison gas, and aeroplane's dropping bombs, and in times of peace with tariff barriers and discriminating legislations!

Rockefeller's Charities do not extend to India

Almost every European nation has been the recipient of Rockefeller Charities, even such ones as are piling up armaments for offence and defence, France for the University of Paris (The grateful French adorned J. D. Rockfeller Jun. with a Legion d'honnour), Germany for the Physics Department of the Kaiser Wilhelm Institute; England for her Medical Research Council, and Library of the University of Cambridge. Italy has been left out —the Abyssinian venture gave her too bad a name. We have grave doubts whether the Spirit of the Donor looks with approval upon such large endowments to countries which have surplus enough to manufacture armaments for the destruction of mankind. However, it is for the present administrators of the Foundation to satisfy their conscience. To us, The policy appears to illustrate, apart from anything else, the wellknown adage of "Carrying coal to New castle." The endowments will be justified if the recipients are men who are carrying on useful work, but probably, owing to their views, may not be in favour with their respective Governments.

In the long and impressive list of the endowments we are sorry to note that "*India occurs nowhere.*" We may be permitted to observe in this connection that neglect of India does not appear to be consistent with the motto of the foundation "*to promote the well-being of mankind throughout the world,*" when onefifth of the human race—inheritors of the most ancient civilization of the world—are left out altogether from the operation of the Great Charity especially when considerable scientific investigation is being carried on in this country under very discouraging circumstances. So far as India is concerned, the Rockefeller Foundation gave money for the construction of the All-India Institute of Hygiene at Calcutta, and have given a number of foreign scholarships to Indian graduates. But these grants are quite insignificant compared to those given to much smaller countries.

NOTES AND NEWS

Mount Kanobili Observatory

We have received two numbers of the *Bulletin* of the Abastumani Astrophysical observatory, Mount Kanobili, Georgia, U.S.S.R, of which E.K. Kharadse is the director. The observatory is situated in 41°.53′ North Latitude, 42° 45′ East Longitude from Greenwich, at a height of 1500^{m} above the sea level. It is a well-known mountain resort in the Caucasus, well known for its climatotherapeutic properties. The mean temperature varies between −5°C in January, to 17·5°C in July, the maximum rising to 31·5°C in July, and the minimum going down to −19°C in January. The cloudiness amounts to 51% in the year. The number of absolutely clear nights is 90, and partially clear nights 182. The transparency of the air is stated to be ·88 on the Pickering scale. These figures are the averages for 35 years. The site was chosen as the result of a scientific expedition sent by the Moscow Government in 1932. By the twentieth anniversary of the October Revolution (1937), the observatory became ready for work. It contains at present a 16-inch refractor, a 13-inch reflector, spectro-helioscope, auxilliary mechanisms, and a power-house. The instruments were all manufactured at the Leningrad Optical Institute. The observatory is maintained by the Government, and has five scientific workers, besides the director, and other staff.

Within the short period of its existence the observatory has turned out a large amount of astrophysical work, which is published in the two numbers of bulletins. The publication is in Georgian, Russian and English, and obstracts are sometimes given in English.

Though compared to the Great American observatories, the Mount Kanobili Observatory has started with modest equipments, we hope that it will develop into a great institution and will have many years of useful work before it.

Findings of the Bombay Advisory Committee on Education

The findings of the Committee appointed to advise the Government of Bombay on the question of vocational training for boys and girls in primary and secondary schools which made a survey of the present position of education in the Province can be summarized as follows:

"Over two-thirds of the population of the province live on agriculture. Our primary schools which are to cater mostly for the children in the rural area (*i.e.* for children of agriculturists and artisans who form the main bulk of the population) fail to appeal to an average villager. The reason is not far to seek. The village child is made to sit still for long periods at a time in the school room. The result of several years' schooling of this kind often is that the child grows into a weakling that is unable to stand the sun and the rain and is thus not of much use for hard work in the field. What little book-knowledge the child acquires does not appeal to a vast majority of the villagers, who, though generally illiterate, possess a strong common sense. Brought up on books and nothing but books, the village child looks down upon manual work. Conditions in urban areas are much the same."

What is needed is reorientation of educational ideals. Education must be made thoroughly practical, both in the primary as well as secondary stages, with a view to bringing our schools into intimate touch with the life, needs and traditions of the people.

This Committee was called upon to consider two important Reports on Education, whose authors give helpful suggestions as to how education could be made more realistic and practical. Messrs. Abbott and Wood have shown how it is possible to provide diverse courses

on definite practical lines at the secondary stage. This Committee have duly considered the proposals of these two specialists while making recommendations for diversified courses at the secondary stage. The Zakir Hussain Committee present a comprehensive scheme of primary education through suitable form of productive work.

After careful consideration, the Committee come to the conclusion that the principle of 'educating children through purposeful creative activities leading on to productive work' is sound; its adoption is best calculated to remedy the main weaknesses obtaining in the present system of education.

The Committee stress the fact that education to-day suffers from an excessive amount of book-work. The child sits couped up in the class room from day to day and from year to year, conning his books and filling his notebooks, reading, writing, reciting, listening to the monotonous drone of the teacher's voice, and having his head crammed with as many scraps of knowledge as possible. Instruction within the class-room is altogether divorced from the world without, and the child remains out of touch with the practical realities of life, the shadows of which he so assiduously or listlessly pursues in his books. The dull monotony of desk-work seldom rouses the living interest or the intellectual curiosity of the child. Sedentary work, continued over a long period of time, has a disastrous effect on his physique, and passive absorption of knowledge, needing little active effort on his part, kills all originality and spontaneity and cripples him, mind and soul.

"To remedy this state of affairs, the Zakir Hussain Committee's recommendation is that some "Basic craft" be selected around which all school work could be centred. This would be possible to some extent with "crafts" that are really "basic," broad and fundamental, "rich in educational possibilities" and touching the life of the child and the community at all points.

"We are of opinion that among others the following should be chosen as basic crafts in the reorganized primary schools:—

Rural and Urban.

(1) Agriculture including subsidiary occupations—Rural Area.
(2) Fruit and Vegetable Gardening.
(3) Spinning and Weaving.
(4) Wood-Work.
(5) Clay-Work.
(6) Home-Craft.

"We are of opinion that at the primary stage not more than half the school-day should ordinarily be devoted to formal instruction in the class room."

The Committee make numerous other recommendations regarding primary and secondary education and allied matters. These may be briefly summarised as follows:—

The Cimmittee consider that Central Schools should essentially be schools of general education. They should be labelled neither vocational nor pre-vocational.

The articles that are produced by School Children under the new Scheme of education should have as far as possible useable and/or marketable value.

In view of the fact that Hindusthani is fast becoming the national language of India, it is desirable that people in the non-Hindusthani Provinces should have a working knowledge of every-day spoken Hindusthani. Suitable provision should be made for the teaching of Hindusthani in the upper primary standards.

Special impetus should be given to the spread of education among girls and that in every scheme of compulsory education preference should be given to girls.

In view of the present schools being examination-ridden, external examinations should be abolished. Heads of Schools should hold their own examinations and make promotions after taking into account the record of the pupil's attendance, work in the class-room, farm and workshop and in general extra school activities, as also his performance in school examinations.

Provision should be made at suitable centres for continuation courses for the benefit of children who may leave school before completing the full primary course.

Early provision should be made for more training institutions and for an increase in the number of places in the existing women's training institutions with a view to securing more trained women teachers for lower classes of primary schools.

For the success of the scheme of Basic Education, it is essential that provision for a four years' normal

course (on a par with the Secondary School Course) for the training of teachers of basic schools should be made and that at least one such normal school should be maintained for each district.

Special training institutions for the training of teachers of Central Schools and Supervisors should be organised in all Educational Divisions and arrangements should be made in these institutions for vacation or refresher courses for tecahers already in service and also for the systematic use of the Cinema, Radio, Museums, etc., as definite aids to work in schools.

Supervisors of Primary Schools should be specially trained for their work and that each such supervisor should ordinarily be in charge of about 50-60 schools with headquarters near about the centre of his beat.

Secondary Education

As regards the problem of Secondary Education the Committee suggest that the Secondary School Course should begin at the end of the seven years' course of Primary Education.

Managements of High Schools wishing to maintain Standards V to VII of the Primary Course should be encouraged to maintain classes for the full seven years' primary course.

The duration of the Secondary School Course should be four years, the Standards being numbered VIII, IX, X, XI in continuation of the Primary Standards I—VII.

It is proposed that the Secondary School Course should be divided into two groups:—(1) General; and (2) Science.

The four years' course should be divided into two stages:—(1) Standards VIII and IX; and (2) Standards X and XI.

For standards VIII and IX, the course should be common to all, with the exception of practical work.

Further a special committee should be constituted to draw up detailed syllabuses.

To start with, teachers of requisite qualifications for Vocational work should be selected so far as possible from among teachers who have worked or are working in Vocational Institutions of good standing and established reputation, in consultation with a Board of experts.

In Secondary Schools the mother-tongue should be the medium of instruction in all subjects except English and Hindusthani.

The Committee think that English should not ordinarily be introduced before the first year of the Secondary School Course, *i.e.*, before the commencement of the work of Standard VIII. If in any locality, there is an effective demand for the teaching of English in the higher primary stage and if thoroughly satisfactory arrangements by the appointment of a qualified teacher or teachers for instruction could be made, instruction in the language may be permitted as an optional subject from that stage without any financial obligations on Government.

The aim of teaching English should be essentially practical. Since the whole system of Secondary Education is examination-ridden, the Committee recommend that with a view to removing the tyranny of the Matriculation Examination, Heads of Secondary Schools should be permitted to hold their own examinations and issue Secondary School Leaving Certificates on the basis of full four years' record of pupils' work in the class-room, on the play-field, in the workshop, in the social and general activities of the school, as also his performance in the school examinations.

The University be moved to have the present Matriculation Examination replaced by special tests or examinations for entrance to Colleges affiliated to the University with a view to securing right type of students for University courses, none but those holding the requisite Secondary School Leaving Certificates being considered eligible for admission to the entrance tests of Colleges.

Till such time as the University decides to abolish the Matriculation Examination, it should be moved to take steps to improve the Matriculation Examination by providing alternative courses of studies and by modernising the Examination generally.

English-teaching Schools that are permitted to teach English from the initial stage (as the mother-tongue of the pupil is not one of the recognized languages of the Province) may continue to do so as at present provided that the schools arrange for regular instruction in one of the recognised languages of the Province and/or in Hindusthani.

The Department of Education should arrange for the periodical inspection of Vocational work in Secondary Schools in consultation with a Board of Experts.

General

The Committee recommend that the curricula sanctioned by Government should be regarded as standard in which alterations or modifications not inconsistent with the principles and spirit of the sanctioned Course may be made to suit local or special conditions after intimation in writing to the Department of Education before the commencement of the school year.

An Advisory Board of Education composed of official experts in the different branches of education and non-officials eminent in educational, vocational, business, or social activities, should be constituted. Its function should be:—

(1) To advise Government on matters of educational policy and practice.

(2) To collect information about educational activities and experiments in other parts of India as also in foreign countries.

(3) To issue bulletins disseminating modern ideas in education.

(4) To suggest ways and means for securing the co-operation of State utility services as also of commercial and industrial firms, particularly in the matter of pre-vocational training.

(5) To suggest arrangements for vocational guidance to pupils in Secondary Schools.

The Advisory Board should appoint sub-committees for (1) general education and (2) pre-vocational training with powers to co-opt experts.

The Committee are convinced that for the success of the new scheme it is essential that a Special Publication Bureau should be constituted for the preparation of books and appliances for the use of teachers as also for village libraries, school children and literate adults.

The emoluments of teachers in primary and secondary schools should be in accordance with the standard scales of pay that may be laid down for other public servants of similar attainments and responsibilities.

The scale of grants to aided schools should be revised to enable them to employ qualified teachers on adequate scales of pay with reasonable fixity of tenure and provision for old age, and also to enable them to meet the extra cost involved by the provision of practical work in primary and secondary schools.

The Committee stress the need of libraries specially meant for the benefit of children who cannot continue their school course beyond Standard IV and suggest that Government should publish pamphlets giving information about careers for pupils and also about the preliminary education needed for such careers.

Part-time classes for continuation or vocational education of those who cannot avail themselves of education in day or full-time schools should be organised as suggested in the Abbott-Wood Report, wherever there is a demand for them.

In view of the fact that this Committee has put forward a Scheme of Primary and Secondary Education with substantial practical instruction, it is essential to provide an adequate number of specialised vocational, industrial, trade and technical institutions. Government should take steps for the establishment of such institutions.

Transitional Arrangements

The Committee suggest measures for transitional arrangements and propose that a Special Officer not lower in rank than a Divisional Educational Inspector be appointed immediately to organise all work in connection with the initiation and development of the scheme of Basic Education, that he should act in consultation with a small Advisory Committee specially constituted for the purpose and that he be given the help of necessary assistants.

Compact areas providing necessary facilities be selected in each district to try the experiment of "Basic Education". So far as possible, all schools in such areas should be transformed into schools of the new type, the full Primary Schools within the areas being organised as Central Schools, *i.e.*, schools teaching the full seven years' basic course with arrangements for instruction in two or more productive crafts.

The above experiment be tried in the first instance during 1938-39, that if the results are assuring enough to scope of the experiment be extended during 1939-40, that the position be reviewed fully before the end of 1939-40 and that in the light of experience gained, arrangements for the complete reorganisation of Primary Education be made within five years.

The Committee are convinced that for the success of the Scheme of Basic Education it is essential that immediate arrangements for the special training of select trained teachers preferably with aptitude for productive or manual work of some kind should be made separately for each Educational Division. The emergency course of training at the start should be of about six months and the instruction should include among other things—

(1) Training in at least two basic crafts.
(2) Formulation and working of simple projects and schemes of correlated studies.
(3) Inculcation of idealogy of education through productive work, *viz.*, method of learning by doing, relating education to actual life, scope of initiative, sense of social responsibility, spirit of social service for national co-operative community.
(4) A Special Course in Physical Training, Drawing and Music.
(5) A short course in Physiology, Hygiene, Sanitation, Dietetics, Social studies and Hindusthani.
(6) Teaching of at least 25 lessons in the practising school under proper supervision.

These training schools should be residential institutions where the individual teachers under training have opportunities of receiving training to live a vigorous social life in an atmosphere of perfect co-operation.

Finally it is suggested that the supervisors for the experimental schools should be select men and women who should be specially trained to enable them to supervise and guide the work in the reorganised schools in their charge.

1851 Exhibition Scholarships

It is well known that India has been sadly neglected in her claims for the award of scholarships to her deserving sons. We have several times commented on this in these columns, and the matter has also received considerable attention from other sources. Recently the Registrar of the Lucknow University referred to it in a letter addressed to the Secretary to the Government of India, Department of Education, in which he asked him to represent to the Secretary of State for India, on behalf of the Indian Universities, "that the funds at the disposal of the Commissioners for the Exhibition of 1851, be in future allotted more equitably to India, in promoting the knowledge of science and art and their applications in productive industry, in extension of their accepted policy applied to other parts of the Empire.

The letter goes on to say—

"It is understood that after winding up the affairs of the Great Exhibition of 1851, the Commissioners were left with surplus funds from which a great educational centre has been built up at South Kensington. The Commissioners still possess an estate of the value of £500,000 and an available income of over £20,000 per annum.

"On an average they have awarded about 17 scholarships annually, each scholarship being of the value of £150/- p.a. The Universities of Great Britain, Canada, Australia, New Zealand and South Africa were invited to recommend candidates for these scholarships, but Indian Universities were left out of consideration.

"Since 1922 the Commissioners have awarded 5 senior studentships of the value of £450-500 each p.a. for which the British Universities and educational institutions are invited to make recommendations. There are 8 Dominion scholarships of the value of £280-300 p.a. for which the Universities in the Dominions are invited to make recommendations. Further, three scholarships are alloted to Australia, two to Canada, one to South Africa and one to the Irish Free State (since 1923). From all these privileges India was excluded.

"Will you be so good as to urge upon the Commissioners the desirability and necessity of fair treatment to Indian Universties, on the ground that the contribution of India towards the funds of the Exhibition was very substantial indeed, as the accounts of the Exhibition will disclose.The Commissioners in their 9th report in 1935 state that "it is probable that any additional funds placed at our disposal could more advantageously be applied in extending the scope of the overseas scheme to include the more recently developed countries of the empire, and in particular India, where the growth of University education, within recent years, has been most rapid." Even the Commissioners admit that India has been neglected. It is for us to press for equitable treatment being extended to capable research workers from India.

"His Majesty's Government have recently released the Commissioners from an obligation of £65,000 towards the cost of the Science Museum, the interest on this sum alone amounts to £2,000 p.a. This amount will cover the cost of two scolarships of the value of £250-300 p.a., tenable for two to three years. Recently one such scholarship has been offered to India since 1937. This is entirely inadequate from the point of view of our contributions to the funds of the Exhibition, as also from the point of view of innumerable research workers, for whom additional facilities abroad will be greatly beneficial, and whose contribution to the national wealth of India is expected to be of great value.

The letter clearly states the facts leading to the establishment of the scholarships (also vide Sc. & Cul., *1*, 480-82, 1936), and makes a strong case for the need of an equitable award of Exhibition scholarships to deserving Indians, and justice being done to this country.

Hydro-Electricity in Hyderabad States

Of the progressive Indian States though Hyderabad (Deccan) occupies a very high place, it has not paid attention to the possibilities of power development to to the extent as that of Mysore. Now the State has investigated its hydro-electric possibilities and the extent of electric power that can be developed from the two rivers namely the Godavari and the Kistna, which flow through the state has been ascertained to be about 145,000 K.W. continuous and there are possibilities of generating another 70,000 K.W., from their tributaries. Three projects have been put forward but the one of immediate importance is the construction of a joint reservoir at Mallapuram across the Tungabhadra river which would be capable of developing 42,000 H.P. The power generated would serve a nitrogen fixation plant, metal industries and rural electrification.

A comprehensive scheme has been worked out in which hydro-electric and irrigation projects are combined and the state would have a complete grid system. The total cost of all the projects for the development of the power possibilities would be about 65 crores and the capital expenditure would be spread over half a century and the scheme anticipates an estimated average return of about 8%.

Visit of Sir Leonard de Woolley to India

A press *communique* from Simla says that Sir Leonard de Woolley, the eminent British archaeologist has been invited by the Government of India to visit India in October and give the benefit of his experience in the work of archaeological excavations to the Government of India. The *Communique* says:—

"Extensive excavations, carried out by the Archaeological Survey of India at Mohenjodaro, Harappa and other places, have revealed the existence in these regions of a widespread ancient civilization similar in many respects to the Sumerian civilization of the Near East with which it had established contacts. In order to provide for fruitful co-operation in this particular field of exploration between the archaeologists in India and the archaeologists working in the Near East, it appeared desirable to the Government of India that the Archaeological Survey of India should have the benefit of the services of some eminent archaeologist who had worked on the Sumerian exploration in Iraq and other countries in the Near East. They have, accordingly, invited Sir Leonard Woolley to spend the next winter in India.

"Sir Leonard, who has accepted the invitation, will arrive in India by the end of October and stay in the country until the middle of January. During this period he will visit Mohenjodaro and Harappa, Chanhudaro and Amri, Taxila and Sarnath, Nalanda and Paharpur and other centres of archaeological activity in Northern and Southern India. This will enable the officers of the Archaeological Survey of India to exchange views with him as regards the technique of exploration. Advantage will also be taken of Sir Leonard's visit to utilize his vast experience of exploration for the purpose of suggesting sites which promise the best results from intensive exploration. In a country of the size and archaeological wealth of India, selective exploration is essential to derive the maximum benefit from the limited funds that are likely to be available for expenditure of this kind.

Sir L. de Woolley is best known as the excavator of Ur of the Chaldees, the city from which according to the Bible (Genesis) Abraham went away to the deserts westwards to escape from the cult of polytheism. Recently many of the stories recorded in the Bible are finding corroboration as a result of excavations carried out in the Near East, but probably no excavation of recent years has been more striking in its results than that of Ur by Woolley. This place is now a railway station on the Busrah-Baghdad railway, about four hours' railway journey from Busrah, and is marked

by a large mound. Excavations were carried out previously, and these showed that Ur was a flourishing Sumerian city from nearly 3000 B.C, to about 2000 B. C, and at times claimed hegemony over all the cities of Sumer. Though now about 400 miles from the sea-coast, it was, in the days of its prosperity, a seaport. Its decline was due to the rise of Babylon about 2000 B.C. as the ruling city of Mesopotamia.

Sir L. de Wooley's excavations which were carried out between 1923, and 1930, and are described in a popular way in *Ur of the Chaldees* has brought to light layers belonging to the times of the earliest Mesopotamian Kings Mes-anni-pa-da, as well as the funerary deposits in the tomb of Queen Shubad. But the most startling of his work seems to be that which is supposed to confirm the story of Noah's deluge. By sinking a vertical shaft, he came at a depth of 40 feet to a layer which was not virgin soil, but simply a bed of clay about 8 feet in thickness. Driving the shaft still further, he found remains of human habitation in the lower layers up to a great depth. It is supposed that the clay deposit was the result of a great river flood which overwhelmed the city, and laid it over with silt to a depth of 8 to 10ft. The next dwellers simply built over the old city-site.

Visitors to Ur are also pointed to a supposed residence of Abraham, who if he was a historical personage, might have been Wazir to a Sumerian King. There is also the impressive Ziggurat due to the Sumerian king Ur Nammee (2400 B.C.)

We hope that Sir L. de Woolley's visit to India will be fruitful, and we may invite the attention of the public to an editorial article in SCIENCE AND CULTURE of January 1936 about the ideals of archaeological research, and about the vast work lying before Indian archaeologists. It is also necessary that young Indian archaeologists should be sent abroad, and be allowed, by mutual understanding to participate in the excavation work done in Egypt, Syria, Palestine, Irak, Persia and Crete. This will widen their angle of vision, and enable them to learn the latest techniques of excavation, observation and preservation of antiquities.

Duration of the life of Fossil Man

It is usual to say that the longevity of man is constantly increasing with the betterment of the conditions of life, with abundance of nutrition, with the progress of hygiene, medicine and surgery. In France the mean duration of life was 38 years about 1835, but it now exceed 54 years. What was the condition in ancient and pre-historic times?

M. Vallois has collected all the relevant data regarding fossil man which he has presented to the 10th International Congress of Pre-historic Science held at Oslo, and he is going to publish a fuller account in the Journal, '*L' Anthropology*'.

By examining the degree of attachment of the long bone to the skeleton or by noting the stage of eruption of the teeth it is possible to determine within a year or two the age of the infant or the adolescent; amongst adults the estimation is less precise because it depends upon the degree of the use of the teeth and above all upon the degree of attachment of the bone to the vault of the cranium. Both appear to be more premature amongst fossil men than amongst the modern.

M. Vallois has examined from diverse point of view 187 subjects of which 20 belong to the Neanderthal race, 102 to the upper-palcolithic, and 65 to the mesolithic age. For the neolithic age there were not sufficient data but there were 273 observations by Franz and Winkler and 141 by Spiegelberz and Pearson upon the Egyptians of Roman times.

All these facts have been collected and put together by M. Vallois within the following table.

	Age of death in years.				
	0—14	14—20	20—40	41—60	More than 60.
Neandarthal ..	40	15	40	5	0
Upper-paleolithic ..	24.5	9.8	53.9	11.8	0
Mesolithic ..	30.8	6.2	58.5	3	1.5
Bronze-age ..	7.9	17.2	39.9	28.6	7.3
Egyptian of Roman Times.	17	17	39.7	16.3	13.4
Austria 1829 ..	50.7	3.3	12.2	12.8	21
Austria 1927 ..	15.4	2.7	11.9	22.6	47.4
France 1896-1905 ..	25.3	2.6	11.5	17.3	43.3

The discrepancy relative to children appears to be due to the fact that they were often buried outside the burial ground.

In spite of that, the table shows clearly that the duration of human life has been increasing constantly.

Old men were unknown till mesolithic times begin to count from the age of Bronze, but it is really during the last century that their proportion became considerable.

M. Vallois concludes, contrary to what Metchnikoff thinks and what many of the biologists write, that it is probable that the premature mortality which we have verified amongst our ancestors is the one which corresponds to the normal state of man. The length of life observed in our day may be regarded as a secondary phenomenon due to the very new conditions of life created by civilization. Thanks to these conditions the modern man can live up to a period where the enfeeblement of his physical forces and the reduction of his activity will have rendered him incapable of living within a primitive society (*La Nature*, Feb. 15, 1938).

Crisis due to Overpopulation in Poland and its Economic Condition

Under the title; 'the drama of an overpopulated country,' M. Debeauplan tries to show the great effort made by Poland in course of the last 20 years for shooting up to the level of a great modern nation. The creation of the port of Gdynia (at present the first port of the Baltic Sea), the construction of 2,000 K.m. of rail road, 2,000 K.m. of roadway, show it abundantly. But Poland already with 34 millions of inhabitants is going to increase its population each year by 400,000. This population is 60% rural, and very dense for a territory having an area of 388600 K.m. square. If one admits that for 100 hectares (247 acres) of cultivable land, there should be a maximum of 30 agricultural workers, we find that this figure reaches in Poland the value nearly 50 (exact figure is 48). The figures in other countries are as follows:—

France, ...	23;
Belgium, ...	33;
Holland, ...	27;
Germany, ...	30;
Italy, ...	44;
Denmark, ...	15;
(India, ...	52?).

Now considering the fact that there are 20 millions of peasants in Poland we find that if Polish peasants were to live up to the standards of other European countries, 10 milions of the these individuals should have some other occupation than agriculture. In Poland the salary of the agricultural workers varies from 35-120 francs per week (Rs. 2½ to Rs. 8). But this salary is only on paper; to find out the actual buying power this salary ought to be divided nearly by half. It is therefore not strange that a Polish citizen consumes 8 times more potato than a British citizen, but 5 times less sugar. We have very often remarked that the industry of a nation depends on the prosperity of its agriculture, therefore we are not surprised to find that there is an underproduction in the Polish factories, which is becoming more and more accentuated (In 1929 there were '84 million factory workers, in 1936 it has fallen down to '6 millions; the number of working hours has decreased from 1'6 billion hours to 1'12 billion hours. The number of unemployed has nearly quadrupled within the same period and the general index of salary has fallen from 100 to 53 in 1936. In order to improve these conditions certain notables in Poland advocate that the frontier should be extended at the expense of Czecoslovakia and Russia (frontier of 1772). This is a menace for the Ukraine, but such an idea find happily very few partisans. The Warsaw Government wants to organize emigration on the other side of the Atlantic and the project is before the League of Nations. But all the projects have so far been theoretical, practically one does not see how Poland where the misery among the labouring classes has been very intense can find out remedy for the consequences of overbirth. We have very often commented how overpopulation has caused (in course of historical times vast migration of people from the over-populated and relatively poor countries to the territories of other nations. If Poland suffers from a rate of increase in the number of inhabitants which is the highest in Europe, France suffers from the continued crisis of under birth, because, according to the census of 1938, the total population is only 42 millions of which 3 millions are foreigners settled in France.

—*La Science et la Vie*

Travancore Scheme for Conservation of Ancient Monuments

As a step in the systematic conservation of ancient monuments in Travancore, a survey by the State Archæological department of monuments having a historical, archæological or artistic interest in the State is now in progress. The result of this survey, so far available, show that among the most ancient of these

monuments are Hindu temples, some of which date as far back as the 8th century A.D. A passing phase of Pallava influence is evident from some of them, as is shown by the close resemblances of the cave temples at Kaviyur and Tirunandikara to Pallava work outside the State. Specimens of both early and later Chola architecture, as well as of the Vijayanagar period, are also to be found, while the Kerala style, which is more common, is distinguished by gabled roofs, wood carvings and absence of spires. Besides, specimen, of *vimanas, gopurams and mandapams*, characteristic of the early Chola, later Chola and Vijayanagar periods respectively are found in a good state of preservation, and a study of their architecture is engaging the attention of the Archæological department.

The Government of Travancore have, in this connexion taken steps for the preservation of such of the ancient rest houses (*vazhiambalams*) as have an artistic architectural or historical importance, and have sanctioned an annual grant for the purpose. There are over 125 such rest houses, in the State, some of which have ornamented and sculptured pillars of great artistic excellence. A few of them date from the 10th century A.D., as is shown from the evidence of inscriptions.

Triennial Review of Irrigation in India

The *Triennial Review of Irrigation in India* for 1933-36 which has recently been released for publication is a helpful guide to know what the state of irrigation in India is at present, and what schemes relating to it have materialised.

With a steady increase in yield and acreage crops worth over Rs 100 crores were raised from areas receiving State irrigation alone during the year 1935-36. From about 10½ million acres in 1878-79, the area annually irrigated by State works alone has now risen to about 31 million acres—nearly ⅛th of the total cultivated area in British India.

The total capital outlay, direct or indirect, on irrigation and navigation works amounted, at the end of 1935-36, to over Rs 153 crores, the gross revenue for the year to about Rs 14 crores and the working expenses to about Rs 5 crores, thus yielding a net return on capital of about 5·7 per cent.

There are near about 300 irrigation schemes in operation in British India alone, of which 70 are of a major description. Of the 300, a third are classified as productive and the rest as unproductive, *i.e.*, as works constructed primarily with a view to the protection of tracts with precarious rainfall and to guard against the necessity for periodical expenditure on relief in times of famine. Of the provinces in India with extensive irrigation works, the Punjab is easily the first with an irrigated area of over 11 million acres. Madras comes second with nearly 7½ million acres, followed by Sind and the United Provinces with over 4 million acres each. The next is Bihar and Orissa with over 9,00,000 acres. In the percentage of area irrgated to the total area sown, Sind leads with a proportion as high as nearly 90 per cent. followed by Punjab with 35 per cent, Madras with 21 per cent and the North-West Frontier Province with 20 per cent. Bengal is the only province where the area irrigated is less than 1 per cent of the total area sown.

The total average area irrigated in British India during the triennium was nearly 31 million acres, as against 30 million acres in the previous triennium, Sind and Bengal contributing largely to the increase due respectively to the functioning of the Lloyd Barrage cannals since 1932-33 and the extension of irrigation in the area commanded by the Damodar Canal. There has been an increase also in the United Provinces attributable mainly to the construction of the State tube-wells and the development of the sugar industry. The only decrease of any importance in the area irrigated was in the Central Provinces, where it was due to the character of the seasons and the economic situation. As in previous years, during 1935-36 also the Punjab showed the largest return on capital invested in productive works, namely, 14·2 per cent, followed by the North-West Frontier Province with 8·4 per cent, Madras with 7·4 per cent, Bihar and Orissa 6·7 per cent. Of the irrigation works of any importance completed during the triennium, by far the largest is the Llyod (Sukkur) Barrage and Canals construction scheme. With its 6,600 miles of channels and 48,000 miles of water-courses capable of drawing 46,000 cubic feet of water a second from the river, it is by far the largest canal system in India—possibly in the world. Its largest canal is the broadest ever excavated and exceeds the Panama Canal in width at bed level. The scheme commands a gross area of 7½ million acres—an area roughly equivalent to a quarter of England and more than the entire area irrigated in Japan. About 6½ million acres, or as much as is actually irrigated in Egypt, are cultivable; and it is estimated that about 5½ million acres or an area

about the size of Wales, will actually be irrigated annually when the project has been fully developed. With the completion of the system of canals, its cost went over Rs 20 crores, and it is expected to yield a net return of 7·39 per cent ten years after completion, that is, in 1942-43.

The other great engineering work, completed during the period under review, is the Cauvery Mettur project. Framed with two objects in view, the first, to improve the existing fluctuating water supplies for the Cauvery delta area of over a million acres, and secondly to extend irrigation to a new area of over 300,000 acres, the project involved the construction of a large dam on the Cauvery at Mettur and of an irrigation canal (the Grand Anicut canal) taking off on the right bank of the Cauvery, and the improvement and extension of the existing Vadavar canal. Easily the first among those in the British Empire and believed to be the second or third dam in the world, the dam at Mettur is over a mile long and impounds a 60 square-mile lake with a shoreline of 180 miles and a maximum effective capacity of about 94,000 million cubic feet of water. Estimated to cost about Rs 662 lakhs for all works, including hundreds of miles of canals and distributaries, the project is expected to yield a net revenue of over Rs. 50 lakhs. Details are also given in the Review of the other important schemes, including irrigation projects navigation channels and embankment works, now under consideration in the different provinces. Of these mention may be made of the Haveli Project now under construction in the Punjab. Estimated to cost about Rs 535 lakhs, the project is expected to yield a net revenue of over Rs 48 lakhs, or a return of about 8 per cent on the expenditure involved. The primary object of its construction is to irrigate the land lying along the banks of the Chenab, below the junction of the Chenab and Jhelum, and to improve the water supply of the Sidhani Canal and of the Chenab inundation canals in the Multan and Muzaffargarh districts. The project consists of three distinct but inseparable parts, namely, the construction of a barrage below the junction of the Chenab and the Jhelum, the construction of a link between the Lower Bari Doab Canal near Montgomery and the Pakpattan perennial canal, and the provision of a winter water supply to the Burala branch extension of the Lower Chenab Canal. It is estimated that the project will provide a probable perennial irrigation for over 555,000 acres and a probable non-perennial irrigation for over 450,000 acres in the Haveli Canals tract and will, in addition, irrigate 128,000 acres on the Montgomery Pakpattan link and over 88,000 acres on the Burala Branch Extension.

In Madras a large project for impounding the waters of the Tungabhadra river has been under consideration for a long time. Technical and financial difficulties and the problem of reconciling rival claims to share in the waters of the river have stood so long in the way of the execution of the project. The general question of the allocation of the waters of the Tungabhadra is now under examination by the Governments concerned. Another large project under consideration is the Lower Bhawani project. Drill borings along the line of the proposed dam were completed, and experiments on the duty of water for dry crops irrigated by flow were conducted in certain areas under the project conditions. Observations were also made on transmission losses in certain channels. The Government of Madras have undertaken to spend a sum of Rs. 50 lakhs spread over three years on a widespread scheme of improvements to the minor irrgation works, as a measure of economic relief and to reduce rural unemployment in Madras, and good progress has generally been made. In Bengal, the work in connexion with the detailed survey and investigation of the Darakeswar Reservoir project, which is intended to irrigate 1,80,000 acres, was in progress during the period under review. Discharge observations have been made during the monsoon seasons to ascertain the supply available in the river. A contour survey of far-reaching importance in parts of Central and Western Bengal was commenced in February 1936, with a view to determining the possibilities of extending irrigation and improving the drainage and sanitary conditions of the tracts by large schemes, such as the More Reservoir scheme and the Darakeswar Reservoir scheme, and therby of developing that area.

In the Lower Kumar river, a navigation channel of considerable improtance, locks and sluices have been put in with the object of controlling silting in the river, at a cost of about Rs. 7½ lakhs. The locks and sluices can be so operated as to control the flow in the Lower Kumar river, but the silting troubles, though reduced, still continue and a final solution has yet to be found. Owing to financial stringency the dredging programme in the Lower Kumar river was of a restricted character. As a result the river was navigable to large steamers from May to November each year, and to shallow drafted steamers and boats during the remaining months.

NOTES AND NEWS

Another navigation channel of considerable importance, in Bengal is the Attrabanks river, which forms a cross country connexion between the Rupta and the Madhumati rivers. Unusually tortuous from its junction with the Bhairab river near Alaipur to the river Madhumati at Asthail, it is becoming badly shoaled. The depth of river is so reduced in winter that the shoals are not navigable without extensive dredging. During 1934-35 and 1935-36 the condition of certain shoals became so bad that steamer traffic through this river had to be closed and diverted along the Madhumati river and the Attya Halifax Cut Route. In this diversion route, too the Mangalpore and the Haridaspur shoals in the Madhumati river had to be dredged in the years 1934 and 1935. A policy of gradually abandoning certain protective embankments, which with experience have been found to be of harmful effect because of the obstruction caused to river spill, was continued in Bengal during the period. In the United Provinces, the proposals for the Nindeh reservoir for the extension of irrigation on the Garai canal system in the Mirzapur district are being reviewed with a view to utilizing the scheme for development of electric power. Investigations were also made during the period for extending urban electricity and irrigation by means of electrically driven tube-wells, and canals fed by water pumped by electric power from rivers, into certain tracts of eastern Oudh not commanded by the Sarda Canal. Projects for three canals taking off from the Gogra, Kalyani and Gumati river were proposed.

As a preliminary step, a small scheme has been sanctioned for pumping 160 cusecs from the Gogra River and the erection of a power house at Sohawal Railway Station to supply energy for working the pumps and electrifying Fyzabad town. The canal is designed to irrigate over 43,000 acres annually. The expansion of similar power irrigation in Eastern Oudh will depend on the results of this experiment. An important work in progress in Baluchistan was the Quetta storm water drainage and embankment project at an estimated cost of Rs 2 lakhs. The project is designed to protect Quetta from the periodical damage caused by flood water. The existing drainage channels passing through the town are being improved so as to increase their discharging capacity and the vents of the bridges are being widened with a view to facilitating the passage of flood water through the town without causing any damage. The expenditure on the project up to the end of the year 1935-36 was about Rs 2 lakhs. The irrigation projects in Bombay now under consideration are the Kelegaon Tank project and the Waldevi Tank project. The first is intended to supplement the storage in the Ekruk tank at Sholapur, with a view to meeting fully the irrigation requirements of the tract under command and also the non-agricultural needs of Sholapur town with its cotton mills. The object of the Waldevi tank project is to provide Nasik town, Deolali Cantonment, the Great Indian Peninsula Railway and the Government Central Jail with an adequate supply of water. In the North-West Frontier Province, projects for lift irrigation of the area near Risalpur, and for the control of the Tank Zam and the Gumal River, are being considered.

Thyratrons for Grid-Controlled Rectifier Service

It is common knowledge that the output voltage of a rectifier fluctuates with changes in load current and supply line voltage. Frequently these fluctuations are so large that means must be used to correct them. This is particularly true when the rectifier feeds a load having a high back electromotive force and a small resistance, such as a storage battery. The facility with which the output voltage may be controlled by the use of thyratrons as the rectifying element has encouraged the design of tubes especially suited to this purpose. There is available a variety of circuits such that the output voltage of a rectifier may be made to obey any desired law. The successful application of these circuits depends upon the degree of reliability of the thyratron tubes used in them. To be most successful the tubes must possess certain characteristics. This paper (G. H. Rockwood, *Trans. the Electro-chemical Soc.*, 72, pp. 213-224, 1937) gives a brief review of the operation of grid-controlled rectifier circuits impose on the tube characteristics, and describes a particular type of thyratron with mercury-plus-argon filling which has proved especially useful in such rectifiers (Abstract from *Bell Sys. Tech. Jour.*)

Air-Conditioning in Indian Railway

Speaking at a meeting of the Calcutta Rotary Club on July 5, 1938 on the advantages of air conditioned travel on Indian railways, Mr L. P. Misra, Divisional Superintendent, East Indian Railway, Howrah, first stressed the fact that the amenities provided in first class carriages on Indian railways compared favourably with those on railways in any other country. Nevertheless, the fact remained that upperclass travel had not met with that response from the public in this country that it deserved. The climatic conditions, the extremes of temperature, the dust and the noise so inseparable from travel in tropical countries added to the discomforts of journeying and tended to keep passengers away. The railways in India had, therefore, to devise methods for overcoming these discomforts, and one means they had adopted was airconditioning. In America, which was the pioneer country in the adoption of air-conditioning, several systems were in vogue. Conditions obtaining in India, however, made it impracticable to adopt a number of these systems. The system now generally in use in India was the electro mechanical system.

After explaining the technical aspect of air-conditioning, Mr Misra said that it had been discovered that if 25 per cent of the total volume of air that was passed through the coach was fresh, it would be ideal for the human body. The air that was supplied inside the coach, was first filtered, the moisture reduced and then it was passed through ducts. Under the electro-mechanical system it would be easy to heat the carriages in winter. What would have to be done was to put out of action the cooling coils, and set up a contrivance for heating the air. Mr Misra said that on the B.B. & C.I. Railway air-conditioning was brought about by a system known as the ice-activated system. Ice was placed in the underframe, over which the air was made to pass. The air became cool in the process. Both systems—electro-mechanical and ice-activated—were on trial, and the Railway Board were not committed to either of them. But the electromagnetic system had this advantage, that it was more scientific, and by it, the temperature could be regulated with much more accuracy than was possible under the other system. Mr Misra said in conclusion that people who had travelled in air-conditioned coaches spoke highly of the advantages of the system, and in his opinion the prospects of the general introduction of air-conditioned coaches on Indian railways were very bright.

We should in this connexion invite the attention of our readers to the following article on "Air-conditioning for Comfort" by Professor P. N. Ghosh. The article deals with in short the different aspects of air conditioning, and gives in some detail how the temperature of a room, house, etc., can be controlled according to our liking.

Air-Conditioning for Comfort

P. N. Ghosh

Ghose Professor of Applied Physics, Calcutta University.

There has been recently a move all over the world for controlling the weather inside dwelling houses. Though, to the ordinary mind, the idea may appear to be a high-priced luxury, yet, when one takes account of the realities, it forms an expectation that may within recent years be fulfilled for moderate dwellings. Human beings have developed the sense of comfort with the growing amenities of life supplied by mechanical developments of the last century, and one of the most noticeable is that of controlling the physical properties of the atmosphere so rarely found to our liking.

Within the last decade there has been very large progress in this direction, and it is now possible to maintain the air within an enclosure at a satisfactory standard of purity and with a combination of temperature and water-vapour content suited to the health requirement of persons exposed to it. It should be necessary to point out that the condition so created shall be automatically controlled without the need of human element for adjustment.

Beginning of Air-Conditioning

The term "Air-Conditioning" which is being more and more common nowadays was first coined in U. S. A. in 1907. In 1911, W. H. Carrier read a paper before

the Society of Mechanical Engineers on "Rational Psychrometric Formulae," their relation to the problems of meteorology and air conditioning and the basic principle enunciated in that paper forms the background on which the modern methods of "air-conditioning" are based.

Even in the States with its extremes of climate and with people always ready to give any new idea a trial, it was only for industrial application that the practice of air-conditioning found favour. This, however, had its advantage as the practical feasibility, the success and failure of the application were under the direct observation of trained men. Modifications were soon introduced, improvements made, and the commercial possibility of equipments from the basic knowledge of the natural laws affecting the design soon sufficiently advanced to get a successful start.

Contrary to usual practice, experiments were done in large installations treating a whole building to the equipment. Thus in Rio de Janerio in Brazil, the first public theatre was air-conditioned at a cost of £50,000 in 1911 through the efforts of German engineers. In the States large number of hotels and public places soon took up the idea, and comfort of air conditioning in big installations, where cost actually was of no consideration, became a reality. It has now spread all over the world in many public institutions and public undertakings.

Essentials of an Air-Conditioning Plant

The first essential of any air-conditioning plant is that it must be capable of controlling accurately the temperature, humidity, purity and circulation of air within a given enclosure irrespective of the state and variation of outside atmosphere, thereby regulating the effects of such air on materials and on people exposed to it.

The combination of temperature and relative humidity that ensures comfort has been found from a very large number of trials in America as well as in the Continent of Europe, and it has been found that in winter a temperature range of 60° to 70° F and in summer of 70° F and 75° F with 45 to 60% of relative humidity ensures the comfort condition. There is another point of importace namely the control of air movement, as the human body is particularly sensitive to draughts, and proper air-conditioning should ensure the absence of these draughts.

Starting from outside air one has to abstract heat and ensure adequate dilution of deleterious gases, smoke, odours, so that pure and fresh air may be admitted into the enclosure. It is well known that the total heat content of air in any given state is the sum of sensible and latent heats due to the presence of water vapour in the atmosphere and the regulation of the absolute moisture content of the air has to be secured with the help of a device which should be capable of very close automatic regulation. If the natural moisture content is greater than that necessary, the excess is precipitated with the help of finely atomized spray of chilled water which has to be constantly recirculated and passed through the evaporator or a mechanical refrigerating plant. In places where air-heating is required in winter, there is the need also of a spray-chamber to add the desired humidity to the air in question. Successful air distribution calls for even diffusion without draught and the present tendency is to use high velocity outlets up to about 2,000 ft. per minute with an entering air temperature of 20° F below that of the conditioned space.

The field of refrigeration in air-conditioning is entirely different from those of ice-making and general low temperature work. The refrigerant shall be non-toxic thermo-dynamically efficient, compact and reliable.

The air-conditioning apparatus can be divided into three classes—

(*a*) Winter conditioners, with means of heating and humidifying;

(*b*) Summer conditioners, with means of cooling and dehumidifying;

(*c*) Year-round conditioners, which would have means to serve all the purposes.

Air-Conditioning in U. S. A.

It would be interesting in this connection to have a review of the conditions prevailing in the United States of America within the last few years.

"By the summer of 1936 the man who worked all day in an air-conditioned office, who travelled in air-conditioned trains, who lunched in air-conditioned restaurants, was beginning to demand at least summer cooling and dehumidification in his own home; and so to guide him to his expected ideal, in 1937 the manufacturing and supplying sides of the electrical industry developed suitable units for year-round air-conditioning as a standard equipment for new demonstration homes. In 1938 standardized unit conditioners ranging in size from 5 ton to 3/4 tons cooling capacity are coming into prominence as suitable units for residential blocks and cottages. The manufacturer foresees the time when air-conditioning small units are going to be as popular as gas and electric cooking ranges and home refrigerators. It is expected by the electrical concerns that in 1938 this factor would come up to 250,000 units."

The Equipment

The most common type of equipment is the central fan plant to draw in and treat the fresh air required in the building at one point and then distribute the air by means of several ducts to the different portions of the building and a separate system to bring back the air for re-treatment and re-circulation. Instead of one central plant and number of ducts, sometimes number of unit conditioners are fixed as independent units. The conditioner comes from the factory already assembled, and on installation site requires only fresh air, electricity and water connections to work the cooling coils and the surface heaters and precipitators. For summer conditioners, as no heating arrangement is required, but refrigerating and dehumidifying form the essential components, the system in a sense becomes less complicated.

Air-washer and Dust Eliminators

The spray-type air-washer of humidifier is actually a low pressure boiler adding water vapour to the air first passing through it, *e.g.*, with wet and dry bulb temperatures of 100°F and 65°F corresponding to a rather hot dry day, the air-washer installation has to increase the water vapour content from 66·9 to 96·3 grains per lb. Tables have been constructed by which it is possible now to get a fair regulation of the humidity factor and cleaning factor of the air within the close approximation.

It is interesting to note that within the past few months a number of dust-extractors of the electrostatic filter type have been put on the market in small sizes for home, shop and office use; the dust-laden air is drawn round ionizing wires charged to 12,000 volts and then passed through a series of alternately spaced high potential and grounded plates. The dust particles after being negatively charged adhere to the positive plates which are charged to about 6,000 volts and have a thin coating of oil to assist adhesion of the dust particles.

The important factor in filters is not simply the removal of certain percentage of dust by weight but rather the effectiveness for removing certain objectionable constituents of the air which may be the finest particles present or the coarser ones within a certain range. For instance pollen grains and types of dust, producing asthma or hay fever generally fall to within 15 to 50 μ range and most filters now used in air-conditioning plants are capable of removing 98% in number of these particles.

It can easily be imagined that the atmosphere prevailing in enclosed spaces require considerable amount of water-spray to render the air free from impurities and an arrangement for dust-free air would require fairly large quantity of water for its proper conditioning. For large establishments evaporative condensers have been adopted in which the condensing coils are placed directly underneath the water-spray system and a pump lifts this condensed water for the purpose of make-up. Outside air is drawn up through water-covered coils, then through eliminator plates to remove excess moisture and finally forced up by a number of fans suitably placed on the top of the unit.

In mechanical cooling systems though ammonia was most generally used, within the last two or three years *Freon* is the most popular refrigerant. It is a dichloro-difluora-methane refrigerant. It is favoured for air-conditioning plants, because it is said to be non-toxic in concentrations up to 20% by volume for a period of 2 hrs.

Dehumidification

The most commonly used system for dehumidification is by cold surfaces, the temperature of the surface being kept low by refrigeration. Where cold water is available water circulation is resorted to. For quick evaporation and absorption silica-gel is used along with suction pumps and are found much more effective than the old calcium chlroide absorbers. Following the experience gained in oil and gas industries in America, lithium chloride and activated aluminium show great promise in this line. The general practice of drying up

the absorbents is that of electric heating which liberates the absorbed water fairly quickly and is coming more and more into prominence in America. Regarding the sizes of dehumidifiers one finds for the silica-gel units at present four sizes namely six hundred, fourteen hundred, two thousand seven hundred and five thousand cubic feet of air per minute.

Humidity control is now being closely maintained automatically; and the temperature is arranged on a sliding differential between the inside and outside conditions to avoid risks of shocks to persons coming into or going out from the conditioned spaces. A number of thermo-stats, hydro-stats with their control valves are worked either by compressed air or by electrical relay units.

Air-Conditioning in England

In England there is no scope for any spectacular summer cooling and the majority of plants are arranged for year-round use. This year there had been an attempt to secure data regarding air-conditioned plants. A questionnaire was sent out in January 1938 to two hundred and thirty electric supply concerns of Great Britain up to the end of February 1938, 130 replies were received.

Ten authorities reported on twenty one industrial installations totalling 4746 H.P.

Five authorities reported on nine comfort installations in restaurants and cinemas totalling 1818 H.P.

Seventy two authorities reported on partial air conditioning systems in cinemas and public buildings, the installations consisting mainly of dust washers and heaters with plenum ventilation requiring motors, fans, and pumps totalling 2508 H.P., *i.e.*, with an average of 20 H.P. per installation.

It is estimated that the total load for air conditioning in Great Britain at the end of 1937 amounts to roughly about 70,000 H.P.

Installation and Maintenance Costs

Regarding the actual cost calculated on the basis of experience for the cinemas and public places one can broadly state that for a 2,000—seat cinema the annual cost for heating and plenum ventilation would be £4,500 and for complete air-conditioning £15,000 per year *i.e.*, an additional cost of £11,000 per year or a monthly expense of £900. The cinema people can well afford to bear this additional cost to attract sufficient number of visitors to pay for their own cost for comfort in the cinema.

Advantages and Uses of Air-Conditioning

In considering the desirability and the usefulness of air-conditioned residential quarter and office establishments it is well worth pointing out that more hours of ill-health were caused by the common cold with its sneezing and coughing than by any other ailment. The first three days of cold are those when there is a great risk of infecting other people. Considerable amount of experimental work in America and in England and the continent had been conducted and as a result it has been found out that when persons suffering from a cold were shut up in a room with others in normal health, (*a*) if the room not air-conditioned the cold infection spread to more than 60% of the people in sound health, (*b*) if the room air was conditioned the infection did not spread more than 5%. Many large and small air-conditioned offices in America kept records of time lost mainly through illness and the reduction in absentees is as high as 40% compared with the period before the equipment was installed. Moreover invigorating atmosphere led also to higher efficiencies in the office.

Of Benefit in Asthma and other Diseases

Patients suffering from asthma and hay fever being put into air-conditioned rooms reported relief and this lasted (from hours up to days) after they left the rooms. If recovery had been made in an air-conditioned hospital ward it could be maintained provided the patient is kept in an air-conditioned bed-room. In the treatment of circulatory diseases constant and favourable degree of temperature and humidity beneficial to the patient could be maintained. As a result of recent experiment there is promising evidence that air-conditioning could be effectively applied to the cure of tuberculosis in its early stages even under trying weather conditions such as prevail in the tropics. It is expected that within three or four years experimental evidences would convince the medical profession the value of air-conditioning plants for their patients.

Other Uses

From experiences in America it has been found that for very small residential installations air-conditioning prevents wooden furnitures and fixtures in a house from over drying and resultant shrinkage and warping in dry

winters. In damp weather it prevents walls and windows from weeping, growth of mould is discouraged, carpets, curtains fabrics and specially library books keep much better due to free from dust and absorption of moisture.

Within the last five years the introduction of air-conditioning storages in America have shown less chance of wastage and a considerable saving in the value of food stuffs otherwise lost. The wider adoption of the idea is being retarded on the part of the customer due to (1) reluctance to pay more first cost (2) lack of confidence in estimated annual savings (3) lack of understanding of the proper tariff schedule by the electricity concerns. But these factors have now been investigated by the recent National Development Committee.

In 1937 a number of small sized household air-conditioning units have been marketed in America and the inside view of the summer-self-contained air-conditioner of Fair bank Morse & Co. of U. S. A. is given in the next column.

Within recent years attempts have been made in U. S. A. to have a small sized dwelling house to have its own air-conditioned arrangement and units are now available for such dwelling houses at a cost ranging from 1,000 to 2,000 dollars and even there are smaller units for single rooms which are commercially available even at Calcutta within the limited price of Rs 1,200 to Rs 1,500/-. There is indeed a great future for a comprehensive study of this problem for our country-men and it deserves the attention of the university authorities and other educational institutions to arrange

for proper training and research suitable to our local conditions.

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MEDICINE AND PUBLIC HEALTH

The work of Tuberculosis Association of Bengal in 1937

The work of the Association is directed in many lines, chief amongst them are—Dispensary work, Publicity, raising of funds and training of medical men and Home Visitors.

A great stride has been made in the dispensary work. The total amount of diagnosed cases of pulmonary tuberculosis has been 3,757, a rise in number by 594 over the previous year. Besides, 173 cases of non-pulmonary tuberculosis were diagnosed. It is a great pity that 46·5% of all cases came to the clinic in very advanced and 33·5% in moderately advanced stages. About 30% of the diagnosed cases were unemployed persons and consequently neither could afford to pay the minimum cost of Rs. 3/- or 4/- for an X-Ray nor could they have good food and well ventilated houses. The results of treatment, with all these handicaps, had proved to be very satisfactory. Of all the cases treated by collapse therapy 63% improved and 61% were rendered noninfectious. If the association could have more beds at its control, it is confident of showing still better results.

It is rather disconcerting to note from thee report that majority of these cases belong to the age group of 20-30 and the incidence of the disease is increasing amongst the menials. These two show that the disease is sapping the youth and is increasing in people who are the best media for propagation of infection.

The Home Visitor's work had been notable for the year. 33,765 Home Visits were made—a rise in number by 10,098 over the previous year. 4,378 contact cases were traced. Many home visits could not be done and contacts could not be traced as the Association is not yet solvent enough to engage more Home Visitors, though they need them very much.

There has been also a great increase in publicity work this year. 300 lectures were given in schools, colleges, exibitions etc. Besides, the Association had participated in 18 Exhibitions in Calcutta and 8 Exhibitions in Mofussil.

The Association is in urgent need of money. Though this year they have secured a grant of Rs 10,000 from the Government and other collections are greater than the previous year yet there is a deficit in the Budget. They have inaugurated a "Building Fund," a "Feeding Fund" (to supply extra food for the needy) and "Kalyani X-Ray Fund" (to help the X Ray Examination of those who cannot pay for it,) by collections specially made for these purposes. All these are very much needed and the Association needs more money for these funds to work them to a success.

The Association is the pioneer and the only organization in India which trains Home Visitors. It is turning out a number of them every year. It is also training Medical and Public Health Officers. Since 1935 four such courses were held by the Association.

The Association had done very well in introducing the "new" case cards which permitted of statistical analysis. This will standardise the work and case taking of all the dispensaries and will help a thorough analysis of the rich material the Association possesses. A few years hence, by the help of these "case cards" very important statistical findings could be worked out. We need them very much as without the help of such findings no well directed campaign against tuberculosis is possible.

The Third International Congress for Microbiology

The Third International Congress for Microbiology will be held at the Waldorf-Astoria Hotel, New York City, from the 2nd to 9th September, 1938, under the auspices of the International Association of Microbiologists.

The Congress will be composed of the following 9 sections:—

(1) General Biology: Variation and Taxonomy Convener: C. E. A. Winslow.

(2) General Biology: Microbiological Chemistry and Physiology. Convener: Stuart Mudd.

(3) Viruses and Viral Diseases. Convener: W. A. Sawyer.

(4) Rickettsiae and Ricksettsial Diseases. Convener: Hans Zinsser.

(5) Protozoology and Parasitology. Convener: H. W. Stunkard.

(6) Fungi and Fungous Diseasees. Convener: B. O. Dodge.

(7) Medical and Veterinary Bacteriology. Convener: F. P. Gay.

(8) Agricultural and Industrial Microbiology. Convener: S. A. Waksman.

(9) Immunology. Convener: M. Heidelberger.

The following are the names and addresses of the office-bearers:—

T. M. Rivers, M.D. President, Rockfeller Institute for Medical Research, York Avenue and 66th Street, New York City.

M. H. Dawson, M.D., General Secretary, College of Physicians and Surgeons, 620 West 168th Street, New York City.

Kenneth Goodner, Ph.D., General Treasurer, Rockefeller Institute for Medical Research, York Avenue and 66th Street, New York City.

The Registration fee is 5 dollars which will not include the cost of a banquet ticket or a copy of the *Proceedings* of the Congress.

A World's Fair will be held in New York City during the summer of 1939. Consequently, those who wish to attend the Congress for Microbiology should make plans promptly. The American Express Company, the official travel agency for the Congress, will be glad to assist in such plans.

Scientific workers who wish to register their names as delegates or as contributors of scientific papers are requested to communicate with Dr A. C. Ukil, Secretary, Indian Committee, International Society for Microbiology, All India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta.

The effect of antithyrotropic serum on the action of human thyrotropic hormone

The thyrotropic hormone of the anterior lobe of the pituitary gland stimulates the thyroid gland. Injection of this hormone leads to symptoms of hyperthyroidism. In Grave's disease it is suggested that this hormone is secreted in enormous quantity. Collip and Anderson (*Lancet*, April 16, 1938) have shown that if injection of thyrotropic hormone into an animal be continued for several weeks a state of resistance is gradually developed and the thyroid gland is no longer influenced by the hormone. If serum from such an animal be injected to a normal animal the latter acquires a passive immunity to the thyrotropic hormone. The serum of the resistant animal possesses strongly antithyrotropic properties. This antithyrotropic serum is species-specific. Antithyrotropic serum derived from ox pituitaries is found to have no therapeutic value in the human subject. It is very difficult to collect human pituitaries for the preparation of antithyrotropic serum.

—*S. Banerjee.*

Hyper-adrenalism and Buerger's Disease

In Buerger's disease there is hyperplasia and degeneration of the middle coat of small arteries together with much proliferation and desquamation of the innercoat. Similar changes are also seen in veins but they are not occluded. It is suggested by Oppel (*Arch. Ital. clin.*, 1937, *47*, 5, 481,) that hyperadrenalism is a possible cause of Buerger's disease as better results are obtained by the excision of suprarenal of one side. Similar changes in the vessels are obtained by transplants of suprarenal tissue in males but less easily in females. Castration in males has no effect but if it is followed by implantations of ovary the arterial changes following the suprarenal grafting are insignificant or absent. This indicates the value of ovarian extracts in the treatment of Buerger's disease.

—*S. Banerjee.*

Vitamin B_1 and Nicotinic Acid in Pellagra

Spies and Aring (*Jour. Amer Med. Ass.*, 1938, April 2, p. 1081) have treated cases of classic pellagra with peripheral neuritis by the administration of vitamin B_1. The neuritic pain is promptly relieved by the intravenous injection of vitamin B_1. Glossitis and stomatities are however not cured by vitamin B_1. Nicotinic acid cures these conditions. Pellagra is

therefore the result of more than one factor, a conclusion also arrived at by Guha in 1931 (*Brit. Med. Jour.*, 1931, (ii), 53).

—*S. Banerjee.*

Vitamin B_1 in Herpetic Keratitis

According to J. Nitsulescu and E. Triandaf (*Brit. J. Ophthal*, Dec. 1937, 654.) Vitamin B_1 was found to be very useful in two cases of herpetic keratitis. The pain is relieved, progress arrested and cure hastened. There is however no evidence of aritaminosis.

—*S. Banerjee.*

Vitamin C and Blood Sugar Level

G. Izar and G. Cairrone have shown (*Med. Jour.* 8, 1938, p. 5) that subcutaneous injections and per oral administration of vitamin C are found to cause a fall in the blood sugar level in normal as well as in diabetic subjects. The fall reaches its maximum about an hour after the injection and is followed by a progressive rise up to the original level in the next three hours.

—*S. Banerjee.*

Public Telephone

Independent bacteriologists and employees of Post Office, Medical Departments in England and United States have examined all public telephones. They say that the risk of tuberculosis infection from the use of the telephone is negligible.

Our Medical Article for August

The following article on 'Tuberculosis and Industry' has been contributed by Dr. P. K. Sen of the Department of Tuberculosis Research, All India Institute of Hygiene and Public Health, Calcutta for our 'Medicine and Public Health Section' of the present issue of the journal.

Industry and Tuberculosis

P. K. Sen

Department of Tuberculosis Research, All India Institute of Hygiene and Public Health, Calcutta.

Tuberculosis has been present among human beings for a very long time. But never before has the disease been so active and wide spread as in this industrial age. We all know tuberculosis spreads by contact, specially from one person to another. Any factor which increases the chances of contact also increases the possibility of more people being affected by this disease. Industry is one of the most potent factors in this direction.

Formerly, people used to be of more rural habits, They lived in villages, there was no congestion; the houses being wide apart, they came in contact with fewer persons. They, in short, lived in a manner which afforded a much better protection from infection from others. With the advent of industrialisation, people from different parts of the country were drawn to areas where factories were located, so that soon there was over-crowding. Besides, being aggregated in small areas, they came to more intimate contact with one another both in the workshops and private lives. The housing problems of the workers, though becoming increasingly important as days passed, were neglected at the beginning. There was no plan for ventilation, no plan to avoid overcrowding. The workers gathered as close as was possible to their working areas. This made the housing and living conditions of the workers extremely poor and insanitary. We are conducting an investigation amongst the workers of a jutemill near Calcutta. The crowding, living conditions and sanitation of the houses where workers live are very unsatisfactory. Most of the workers come for work from the villages. Though poor in their homes the conditions of living are quite different. They are just the people who do not acquire much specific resistance against tuberculosis—as the incidence of the disease is much less in rural areas. They are, in the words of Prof. Cummins, "Virgin Soil".

In the cities where the chances of contact are greater, people are generally infected at a young age. If the infection is not overwhelming, which in most cases is the case, the disease is not established but the person acquires a specific resistance which can cope with, to a large extent, the subsequent infections to produce disease. These village people are generally not infected, that is, they are like "Virgin Soil". When they come for work in the industrial areas, they fall into this deep mine of insanitary conditions. The insecurity of position, unhealthy social habits, and mental disturbances arising out of this new environment sap out their vitality. Added to these is the greater chance of infection due to over-crowding both at the working places and in houses. A person who was not infected before, if infected with massive dose of bacilli, facilitated by the above conditions, he gets the disease quickly and in a more fulminating form. They die like flies and infect others rapidly and surely because of their ignorance and peculiar living conditions. Borrel, the great French pathologist, first detected this peculiar behaviour of the disease in such uninfected men. The African recruits in the Great War, the Senegalese, came to France. They were farthest away from civilization and tuberculosis amongst them in their native country was rare. They were, therefore, "Virgin Soil". When they arrived in France, they fell into an atmosphere where moderately heavy infection was possible. The French men are used to this and they do not get the disease. But the Senegalese, as they had no previous infection and consequently acquired resistance. Fell a prey to the disease and they died like flies. Though India and her village people are not in the same category of "Virgin Soil" as the Senegalese, yet certainly they are not as resistant as the Europeans or the town dwellers of India. So, when they come for search of work and have to live in the crowded environment where opportunities of massive infection are more frequently present, it is very likely that many of them get the disease and behave somewhat like the Senegalese.

India is on the road to industrialization. If at this very beginning we take note of the havoc that has been played by tuberculosis in other countries we can minimize much of the sufferings and can save many lives. We must try to improve the housing conditions, give protection by various methods to those who are not infected and remove the diseased persons from amongst the crowds. We do not need the building of expensive houses for workmen. We cannot afford it in the present financial conditions of our country. With the advance of industries we hope to be richer. Then only can we undertake to build houses for workmen as is being done now in Germany and at places in Great Britain. What we want now is good planning for even the *Bustee* or *Katcha* houses. Much could be achieved by simple planning to minimize crowding and to increase ventilation. To my mind, this should be one of the greatest obligations on the part of the authorities to look after the living conditions of the labourers. This should be done with the inception of the industry in a certain area. Planning from the beginning is important as it is very hard to demolish already built areas and to rebuild them. Besides, once the workers are used to insanitary living, it is very hard to change the ways even if they are housed under better sanitary conditions, later on. But, if they are educated and disciplined in the ways of the living from the very entry in the industrial life they have a much better chance to acquire healthy habits and to live accordingly.

The dangers mentioned above are the general effects of industrialization in a population who are not used to it. But there are some special industries which make the workers particularly susceptible to tuberculosis. All the industries evolving silica dust in their process are dangerous. The chief amongst them are pottery, sandstone, granite, metal grinding, sandblasting, manufacture of scouring powders, gold mining and coal mining. In all the above industries, silica dust is given up in very minute particles. They are inhaled by the workers during the whole period of their work. The inhalation of this dust may cause a disease of the lungs which is known as silicosis or miner's phthisis.

The production of silicosis depends on the nature of dust—its chemical composition, concentration in the working atmosphere and size of the particles and also on the presence of any previous lung-disease of the worker.

Quite an amount of work has been done on the chemical composition of silicious dust to find out the most potent composition in the causation of silicosis. From the result of all the investigations it seems that "free silica" is the most dangerous form of dust to cause silicosis. Silicates are less dangerous though at one time sericite or silicate of aluminium and potassium (K_2SAlO_3 6 SiO_2 $2H_2O$) was thought to be more dangerous than any other form.

Silica dusts are inhaled in the deeper parts of respiratory tract. They are then engulfed by certain

cells coming into the terminal portions of air-passages and carried to the nearest lymphatic. There they lodge and get dissolved in tissue fluid. Silica is an extremely insoluble mineral but investigations of King and Mellor show that it gets dissolved in tissue fluid very slowly. As silica is a tissue poison it causes necrosis of the area where it gets dissolved and there is a surrounding reaction of fibrosis. It is why in silicosis the lungs become beset with nodules of fibrosis. The last International Silicosis Conference came to the conclusion that silicosis is due to "solution" of the silica in tissue fluid. If that is so, it probably is right to say that the form of silica, combined or free, which is most soluble in the tissue fluid is the most dangerous form of dust.

In order to produce silicosis the dust must be present in the atmosphere at a certain concentration. If the dust is diluted with air or by any other medium to a certain extent body can dispose of the dusts and no harmful effect occurs. Cummings thinks that a normal man may work in an atmosphere unimpaired in health if the silica dust does not exceed 5,000,000 particles per cubic foot of air. This is almost the threshold " number of silica dust to produce disease. Any concentration above this forbodes danger and the more the concentration the more is the likelihood to develop the disease and to develop it rapidly.

The size of the particles also plays a great role in the production of the disease. The smaller the particle is, the longer will it float in the air, the easier will it enter into the deeper parts of respiratory tract and the sooner will it get dissolved, as smaller particles expose a greater total surface area of the dust to the action of the plasma. It is generally believed that particles of 5 micron and under in diameter are dangerous. This is known as " Effective size range." Any particle above this range is probably not dangerous enough to be taken into account. In fact most of the particles from the diameter of 10 micron and above cannot even enter the deeper parts of the respiratory tract. They are caught by the cilia of the mucous membrane of the upper air passages and are thrown out. Thus they have no effect.

Once a worker gets silicosis he is almost certain to die of tuberculosis in later years. No definite reason could be given for this susceptibility of the silicotic to tuberculosis. But it has been found to be true. Many authors believe that tuberculosis and silicosis are inseperable conditions, that is, when silicosis is present there is every likelihood of tuberculosis being present too. In my own investigation among the South Wales silicotic-coal-miners, no element of tuberculosis in some of them could be detected even by the most laborious search by clinical and *postmortem* examinations. We may, therefore, believe that though silicosis makes the person very susceptible to tuberculosis, tuberculosis is not universally present amongst the silicotics. But this cannot mitigate the dangers to which workers in all silica industries are exposed.

It will be realized from the names of the industries mentioned that many hundred thousands of workers are working in an atmosphere laden with silica dust. In Europe, America and South Africa a great amount of work has been done on preventive measures. The factories or the mines must be well ventilated, water sprays are used to bring down the dust particles and masks are used. There are many devices for all these preventive measures which are suitable to particular conditions. By these measures they have brought down the number of silicotics. This is a gain not only for the workers but for the capitalists also. For each case of silicosis, by the Compensation Act, the authorities have to pay quite a large sum of money as compensation.

It is unfortunate that almost no work has been done on the 'dusty industries' in India. We have many industries where silica dust is given out in clouds and it is likely that many of the workers are falling a prey to this disease and later to tuberculosis. It is urgent that we should conduct investigations amongst these industries and find out the incidence-rate of this disease and of tuberculosis. If required all the preventive measures must be adopted. The sooner it is done, the better.

The Tuberculosis Enquiry under the Indian Research Fund Association has begun an investigation amongst the Jute workers in a Jute mill in the neighbourhood of Calcutta. Most of the labourers there are recruited from villages. We shall be able to see the effect of this industrialization on the rural people. Besides, jute is a dusty industry and we may be able to find out whether or not there is any dust hazard in this important industry which is a monopoly of Bengal.

RESEARCH NOTES

New Types of Vitamin-D (D_3 & D_4)

That ergosterol is not the only pro-vitamin D, has definitely been established in recent years (Windaus, Lettre and Schenck. Ann, *520*, 28, 1935; Windaus, Schenck and Werder, *Z. Physiol. Chem. 241*, 100,1936). It has been found that irradiatcn of 7—dehydro cholesterol prepared from cholesteryl acetate, gives rise to a substance of high antirachitic activity (24,000 international units per mg. as compared with 40,000 units for vitamin D_2 which is obtained from ergosterol). This variety has been known as vitamin D_3.

A very recent observation by Windaus and Trautumann (*Z. Physiol. Chem., 247*, 185, 1937) has given further proof of the above view. It has been shown that irradiation of 22-dihydro erogosterol yields a substance (m.p. 107-8°, $(\alpha)D^{18}$—89·3) having a high anti-ricket potency and showing an absorption maximum at 265 m μ as shown by vitamin D_2 and D_3. This new variety of ricket-preventing substance has been termed as vitamin D_4.

This development in the line of chemistry of sterols and vitamin D, that sterols irrespective of the molecular weight can be made to possess antirachitic property, will add much towards the progress of science as well as towards the alleviation of human sufferings.

—*M. C. Nath.*

Influence of Heavy Water upon Amylase Formation

Germination of many seeds is associated with marked increase in their amylase activity. This increase is often due to the formation of several starch-splitting enzymes. Malted barley has been found to contain at least two distant amylases in proportions which depend upon the treatment of the grain. As water is an important factor in these changes and is also essential to the action of the amylases after they are formed, it is of special interest, therefore, to study the influence of heavy as compared with ordinary water upon the generation of amylase activity during the sprouting of barely.

Caldwell and Doebbeling (*J. Biol. Chem, 123*, 479, 1938) have performed experiments to compare the amylase activities of barely grains before germination with those of grains which had been allowed to germinate in water and in different concentrations of heavy water. The comparisons were made at definite intervals during the course of germination and also at what appeared to be the same stages of germination of the grains. The concentrations of heavy water studied were 1, 10, 50, 100%.

The authors conclude that heavy water is not appreciably unfavourable to the metabolism of this grain even when present in concentrations many times higher than those which are probably normally encountered in nature.

Hundred per cent heavy water, however, had a markedly unfavourable influence upon the rate and extent of the sprouting of the barley and upon the generation of the amylase activities which is affected in the same direction as the germination of the grain. Moreover, the unfavourable ininfluence of the higher concentrations of heavy water was much more pronounced with the starch splitting (a-amylase) than with the sugar forming (B-amylase) activity.

—*H. N. B.*

University and Academy News

Royal Asiatic Society of Bengal

An Ordinary Monthly Meeting of the Royal Asiatic Society of Bengal was held on Monday the 4th July, 1938, at 5-30 p.m.

The following candidates were balloted for as Ordinary Members:—

(1) Andrew McLaren Carstairs, M.A., Bengal Chamber of Commerce, Calcutta.

(2) Suprabhat Mozumdar, M.A. (Cal.), Master, Rajkumar College, Raipur, C.P.

The following papers were read:—

(1) Chintaharan Chakravarty.—Kāśīnātha Bhaṭṭa and his works.

A fairly large number of small treatises, principally on Purāna or Tantra topics, ascribed to one Kāśīnātha Bhaṭṭa Bhaḍa of Benares, *alias* Śivānandanātha, are available in manuscripts in different parts of India. But very few of these works have been brought to the notice of scholars either through descriptive notes or through print. Little again is known about the author. So an attempt has been made to collect an account of these works as well as of the author so far as could be gathered from a survey of them, mainly on the basis of the manuscripts of a large number of Kāśīnātha's little-known works, belonging to the Royal Asiatic Society of Bengal.

(2) R. Grace Lewison.—Folk-Lore of the Assamese.

A collection of 39 Folk stories, in English translation, collected during the author's ten years' residence in Assam. Narrator's name given in each case. The stories are classified as historical, moral and amusing.

The following exhibits were shown and commented upon:—

(1) M. Mahfuz-ul Haq.—A note on a Persian Manuscript of Sahā'if-i-Sharā'if of Muhammad 'Askari-al-Husaini' of Bilgrām.

The manuscript, which comprises the biographical sketches of the Persian prose-writers of India and Irān, has recently been acquired by the Royal Asiatic Society of Bengal.

The manuscript is apparently unique as no other copy is known to exist in any well-known library. A feature of the manuscript is that it is the author's autograph copy.

The author, Saiyyid Muhammad 'Askari bin Saiyyid Khurshid 'Ali, was born at Bilgrām. He was a talented Persian scholar and poet of his age. He composed the Sahā'if in 1213 A.H. (1815-16 A.D.). It contains valuable data regarding the Persian prose-writers in general and the contemporary Indian writers in particular. There are several interesting specimens of the compositions of the Mughal kings, princes and princesses.

(2) Chintaharan Chakravarty.—Manuscript of a hitherto-unknown work of the *Pārānanda* School.

The only work so far known expounding the doctrines and practices of the little-known but cosmopolitan Pārānanda School of Tantric worship, which puts a taboo on ritualistic details as also on animal sacrifice, which apparently is an essential feature of Sakti-worship, appears to be the *Pārānanda Sūtra*, published in the Gaekwad's Oriental Series (Volume LVI, Baroda, 1931). The Royal Asiatic Society of Bengal possesses a fragmentary manuscript of a small work, called the *Pārāmānandamatasamgraha*. It gives a brief account of the school. While the printed text, which is diffuse, is at times obscure, the present work, though of small extent, is clear and systematic.

(3) Baini Prashad.—Habitat group of the goggle-eyed fish or mud-skipper *Periophthalmodon schlosseri* (Pallas).

Gobies of the genera *Periophthalmodon* and Periopthalmus represent, in their habits, two of the most terrestrial types among fishes. They frequent the sea shores and estuarine mud-flats of the Indo-Pacific Region, and are sometimes found considerably above the water level, on aerial roots of plants and other objects that may be present in their habitat.

The mud-skippers breathe atmospheric air direct, and their skin is especially modified for conserving moisture. Their eyes are well adapted for a sharp aerial vision, and they use their highly muscular pectoral fins for locomotion on land. They feed on small animals that are left stranded on the mud-flats by the receding tides.

The exhibit shows a portion of the foreshore of Matlah at Port Canning. The dwarf Sundari shrubs (Avicennia officinalis L.) with their aerial roots form a characteristic feature of the habitat. The other noteworthy inhabitants of the mud-flats or of the associated saline pools are the Crabs, *Varuna litterata* (Fabricius and *Gelasimus annulipes* Latreille and *molluscs* of the family Cerithiidæ.

National Institute of Sciences of India

An Ordinary General Meeting of the National Institute of Sciences of India was held in the Library Hall of the India Meteorological Department, Poona, and 3 p.m. to 5 p.m. on both the days.

A Symposium on "Weather Prediction" was held, in which the (Abstracts of papers to be read enclosed herein) programme was as follows:

Dr C. W. B. Normand.—Opening remarks.

Long Range Forecast—

Dr S. R. Savur.—Seasonal forecasting in India.

Medium Range Forecasts—

Mr S. Basu.—Franz Baur's forecasts for 10 day periods.

Daily Forecasts—

(1) Air mass analysis and short period weather forecasts—

Dr S. N. Sen.—Air mass analysis and short period weather forecasts.

Dr S. K. Pramanik.—Application of air mass analysis to the problem of forecasting of nor' westers in Bengal.

(2) Upper Air Data and Weather Forecasts—

Dr K. R. Ramanathan.—Upper air data and weather forecasts.

Dr N. K. Sur.—Latent instability in the atmosphere and its consequences.

Mr S. P. Venkiteswaran.—Rainfall due to winter disturbances and the associated upper air temperatures over Agra.

Dr S. K. Pramanik.—Upper air data and weather forecasts.

(3) Forecasting for aviators—

Mr P. R. Krishna Rao.—Weather forecasting for aviation with special reference to local forecasts.

(4) Kinematical Methods in Weather Forecasting—

Dr S. K. Banerji.—Kinematical methods in weather forecasting.

BOOK REVIEW

THE METALLURGIST'S MANUAL, (*Cheap Edition with supplement*) *by T. G. Bamford, M.Sc., and H. Harris, M.Sc., published by Chapman and Hall, Ltd., London, Price 7s-6d.*

This book is intended for the use of metallurigists, metallurgical students at universities and technical schools of engineers and of others interested in metals. In accordance with the object, emphasis has been laid more on the practical aspect of the subject than on the theoretical background. In fact the book is one of the few publications on the essentials of metallurgy. The book is divided into seven chapters; each chapter gives a fairly clear account of the subject included in it. Chapter I deals with sampling and assaying of ores of copper, iron, manganese, gold, silver, platinum and other important metals—their qualitative and quantitative examinations. Chapetr II provides sound methods for the complete analysis of both ferrous and non-ferrous alloys of every day use. Chapter III is devoted entirely to the complete examination of fuels and refractories. Chapter IV shows in a very precise way how to calculate furnace charges—an information which is of fundamental importance to the beginners and workers in the metallurgy. Chapter V gives a clear and complete account of the methods available for the measurement of high temperature and the procedures actually adopted. Chapter VI deals with the practical sides of metallography and industrial alloys, which are very well treated. Chapter VII contains a summary of the manufacture of non-ferrous castings.

The tables appended at the end of the book serve a variety of purposes and are seldom found together in any single text book on metallurgy.

The book can be recommended to metallurgists, students of metallurgy and to others interested in metals.

—H. N. D. G.

TELEVISION—THEORY AND PRACTICE—*by J. H. Reyner, B.Sc., A.C.G.I., A.M.I.E.E., Second and Revised Edition.* Chapman and Hall Ltd., London 1937.

We welcome this new edition of the well-known publication by Mr Reyner. The old edition has undergone extensive changes and a large portion of the new edition has practically been re-written. The book is divided into two parts, the first dealing with the receiving technique and the second with the transmitting technique. As stated by the author more stress has been laid on the fundamental principles of the subject—and these have been very lucidly explained—than on the detailed descriptions of actual methods and systems. The serious student of Television going to take up the study of the subject will find the book extremely helpful. An excellent survey of the principles of both transmission and reception, particularly of the modern systems, is given. The treatment is logical and non-mathematical and the author has been able to bring home to the reader that Television to-day has passed the amateurish stage and has attained a sort of stability based on strict scientific principles. Inspite of the opinion expressed by the author that in an art like Television, which is changing so rapidly, detailed description of an actual working apparatus may soon become out of date we would have liked to see such discussion and description of some of the actual modern transmitting and receiving apparatus which are in more or less common use to-day. We hope it may be possible to include this in future editions of the book.

—H. K. R.

BOOK REVIEW

INTERMEDIATE PRACTICAL CHEMISTRY, *by Prof. P. B. Sarkar, D.Sc., Published by H. Chatterjee & Co., 19, Shamacharan De Street, Calcutta. Price 1/4- First Edition, 1938.*

This book is intended to meet the requirements of the Intermediate Students in practical chemistry. It fully covers the syllabus of the Calcutta University and Dacca Intermediate Board. The experiments have been very carefully drawn up and the description is very lucid and clear. The book seems fairly thorough and systematic, and the subject-matter has been well-arranged. The Intermediate students in science will have to appear at the practical examination from this session; and it is quite in the fitness of things that the author produced a really good book for the students. His book has been a distinct improvement upon the existing ones on the same subject and the students are sure to be benefited by this timely publication.

Besides the practical details, the book contains a world of useful information put in a popular way. This will go a long way to create a taste for chemistry for the beginner. The book is well bound but the printing leaves much to be desired.

—P. K. D.

LAC CULTIVATION IN INDIA, *by P. M. Glover, B.Sc., Indian Lac Research Institute, Namkum, Ranchi, Bihar, India, 1937. Price Rs. 2/-.*

This is a practical manual of lac cultivation which is one of India's present day monopoly trades. This book deals with the entomological study of lac insects with their geographical distributions in various parts of the world. A statistical report is given about the increased production of lac grown in India, Burma, Bangkok and Singapore. Detailed methods which have been worked out at Namkum to combat lac pests, which are the chief destroyers of lac insects, are discussed. The different soil treatments with manures and fertilizers for the improved growth of lac hosts thus causing increased production of lac are described. This book is intended to give the necessary information regarding lac cultivation in India and is likely to be much valued by educated lac cultivators and owners for the improvement of lac production. This book may be recommended to all concerned.

Baidyanath Ghosh.

ANNUAL REVIEW OF BIOCHEMICAL AND ALLIED RESEARCH IN INDIA, *Vol. VIII. Published by the Society of Biological Chemists, India, Bangalore. Price Rs. 3 or sh. 6.*

The latest volume of the series has come to be regarded as a stock-taking of the progress of biochemistry and allied researches in India during the year 1937. This review deals in a nut-shell with all the contributions which workers in India and Indian research workers abroad have made to the advancement of biochemical knowledge during the last year. The different chapters include—Vitamins, Proteins, Enzymes, Pharmacology, Human physiology, Pathology and Bacteriology, Food and Nutrition, Microbiology and Fermentation, Plant Physiology, Chemistry of plant products, Phytopathology-Mycology, Phytopathology-Entomology, Soils, Fertilizers and Manures, Animal Nutrition and Dairy Science, Veterinary Science—which are written by specialists in their respective fields.

This Review can be confidently recommended to all, who wish to have a connected impression of the biochemical contributors by Indian workers. The presentation and printing are excellent and the book is remarkably free errors. There is a full bibliography with each chapter.

Baidyanath Ghosh.

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the letters.]

Epidemic Dropsy and the Contact Infection Theory

In the investigations of Lal, Ray and Ghosal[1] on epidemic dropsy it has been stated that "as the number of rooms per person increases, the incidence (of epidemic dropsy) also rises, a finding which goes against the contagion theory," (p. 209). As this statement appeared to be *prima facie* very peculiar it was considered worth while to go into the statistical analysis employed which could lead to such a conclusion. It is difficult to imagihe a disease whose incidence will increase with the decrease in congestion.

A scrutiny of the statistical analysis indicates that it is based on faulty methods. The analysis suffers from the following two errors:—

(1) The partial correlation, the interpretation of which leads to the above conclusion, has been calculated according to a wrong method.

(2) No test has been applied to judge the significance of the partial correlation, which alone could have justified the above statement.

In working out a partial correlation same number of observations must be taken for all the variables and the same set of values for each variable must be used throughout. Neither of these conditions is fulfilled in the above analysis. The variables are—incidence, rooms per person and size of the family, the last variable being the one to be eliminated. The number of pairs of observation is 30 in one case and 16 in the other two cases. Moreover, the values of two of the variables, namely, incidence and rooms per person, have been found by one method in the first case and by an entirely different method in the other two cases. Thus the value obtained for the partial correlation is not a valid estimate nor does it enable us to apply any test of significance.

The correct value of the partial correlation, which can be obtained from the two tables containing 16 pairs of observations each, works out to be +0·3983 which is practically the same as obtained by the authors themselves, namely, +0·3976. This is merely a coincidence and should not be taken as a justification of the faulty method. Only 13 degrees of freedom are available for the correct value and Fisher's table[2] gives the expected 5% value as 0·5139, which shows that the partial correlation is not significant. Hence the statement quoted above is not justified. All we can say is that the evidence in hand does not contradict the hypothesis that for a family of a given size the incidence of epidemic dropsy is independent of the rooms per person.

12-B, Bakul Bagan Row, Bhowanipore, Calcutta.
20-6-1938.

B. Chatterjee.

[1] Lal, Roy and Ghosal, *Ind. Jour. Med. Res.*, *15*, 1, 163-259, 1937.

[2] Fisher, *Statistical Methods for Research Workers*, 4th ed., 188, 1932.

Efficiency of the "Entoray" Mosquito-Catching Machine

The inventor of the "Entoray" machine claims that if the machine is installed in a place it will catch most of the mosquitoes of the place and thereby reduce the incidence of mosquitoes in the surrounding areas within a specified radius. Senior White[1] *et al* have tested the efficiency of the machine and one of their conclusions is that "it is not capable of making any statistically significant difference in mosquito incidence even within a few feet of its point of operation," (p. 629).

A scrutiny of the data and the statistical analysis thereof shows that the experiment was not designed properly and the methods employed in the analysis suffer from serious defects. The following table gives the total hand catches of male mosquitoes for five consecutive years in experiment III (A).

Experimental Area		*Control Area*	
1-22 wks.	23-30 wks.	1-22 wks.	23-30 wks.
346	271	326	269
105	193	92	64
99	99	41	45
82	163	55	80
67	82	81	46

If we compare the figures of 1-22 weeks for the two areas, when no machine was working in either area, it will be seen that while the incidence of mosquitoes was steadily falling in the experimental area, in the control area the incidence was rising since the fourth year. Moreover, in the fifth year the total catch in the control area rose for 1-22 weeks and fell for 23-30 weeks. This shows that some unknown cause has been operating in the control area which was probably absent in the experimental area. As the actual experiment with "Entoray" was carried out in the fifth year, the value of the second area as a control is extremely doubtful.

Figures for 30 weeks for each of the five years were used in the statistical analysis which was carried out separately for the male and the female mosquitoes. Expected weekly values for the fifth year were obtained by extrapolating from straight lines fitted to four figures for each week. Deviations of the expected from the observed values in the fifth year were worked out. The mean of these deviations for the first period, namely, 1-22 weeks when the machine was not working, was compared with the mean for the second period, namely, 23-30 weeks when the machine was working. Fisher's *t* test[2] was applied to test the significance of the difference between the means of the two periods. The results of this test could not bring out any significant difference caused by the machine.

The above method of analysis is faulty for the following reason:—

No test has been applied in order to judge the significance of the straight line regressions. As a matter of fact, excepting a very few, the regressions are all insignificant even at the 5% level. Hence there is no justification for working out the expected values from the straight lines.

As anti-larval measures over a wide area were started only from the second year, the best procedure under the circumstances is to take the mean of the values of the second, third and fourth years as the expected value for the fifth year. As the incidence of mosquito during the earlier weeks is rather small, it is better to leave out the figures for first few weeks. This will ensure homogeneity of the figures for each period. In the following table the non-machine period has been taken both as 1-22 weeks and 16 to 22 weeks (the figure 16 has been taken arbitrarily).

	Male.			Female.		
	1-22 wks.	16-22 wks.	23-30 wks.	1-22 wks.	16-22 wks.	23-30 wks.
Mean dev. (Exp.-Ob.)	1·3	2·8	8·7	2·7	9·7	17·2
Difference	7·4	5·9		14·5	7·5	
Standard error	1·41	2·36		2·88	3·86	
Degrees of freedom	28	13		28	13	
t	5·23	2·50		5·03	1·94	

Comparing these observed values of *t* with those expected by chance alone, as given by Fisher,[2] we find that the results are highly significant for both males and females, if 1-22 weeks be taken as the non-machine period. If, however, we take 16-22 weeks as the non-machine period, moderately significant result is obtained in the case of males and no significance is brought out in the case of females. Hence, on the whole it will be safe to say that the machine has reduced the incidence of male mosquitoes, while its effect on the female mosquitoes is doubtful.

In the analysis of figures of experiment III (B) also a faulty method has been adopted. In obtaining the values of χ^2 mean frequencies have been used which is fundamentally wrong. Only total frequencies should be used in χ^2 test. The correct values of χ^2 are highly significant with a positive correlation in the case of males and a negative correlation in the case of females. Thus in the case of males the machine appears to increase the incidence and in the case of females the machine decreases the incidence. The second result is definitely in favour of the machine but the first seems to be somewhat improbable. The figures for the males suggest that the control area is under some unknown influence which probably is absent in the experimental area. Thus the figures for the control area do not provide us with good control figures for the males at least.

We are, therefore, led to the following conclusions:—

(1) The experiments were not properly planned;

(2) Defective statistical methods were applied in analysing the data which led to some positive statement against the machine.

(3) A proper analysis of the data establishes the efficiency of the machine at least in some cases.

12-B, Bakul Bagan Row, Bhowanipore, Calcutta.
20-6-1938.

B. Chatterjee.

[1] Senior White, Lal, Adhikari, Swaroop—*Rec. Mal. Surv. Ind.*, *6*, 595-629, 1936.

[2] Fisher, *Statistical Methods for Research Workers*, 4th ed., 151, 1932.

Resistivity of Thin films: Caesium

In the last issue of this journal[1] an expression for the dependence of electrical resistivity on the thickness of metallic films was derived on the assumption that electrons colliding with either boundary suffer random scattering, and the formula obtained, *e.g.*,

$$\rho_t = \frac{\rho_\infty}{1 - f(t/\lambda)} \qquad \ldots \quad (1)$$

where ρ_t is the resistivity for thickness t,
ρ_∞ " " " " bulk material
λ " electronic mean free path in bulk material

and $$f(t/\lambda) = \int_0^1 \left(\frac{t}{\lambda z}\right) e^{-} dz$$

was applied to Lovell's[2] measurements of Rb films. It is proposed to apply the same to Lovell and Appleyards'[2] measurements on Cs films. The following table presents the observed, as well as the calculated values of ρ_t.

$T = 64°K.$, $\lambda = 1450Å$

t in A	5	10	15	20	30	40	50	75	100	200	300	400	500	∞
$\rho_t \times 10^6\Omega$ (expt.)	246·9	140·7	87·9	46·9	24·7	17·3	15·0	13·8	11·8	10·8	9·9	9·9	9·4	4·0
$\rho_t \times 10^6\Omega$ (Lovell's formula)	172·8	98·7	69·1	54·3	39·5	32·1	27·1	18·7	15·8	8·8	6·9	5·9	5·9	..
$\rho_t \times 10^6\Omega$ (formula 1)	210·0	105·3	76·3	60·6	44·7	36·0	30·3	22·6	18·6	11·7	9·2	7·8	7·1	..

It would appear from the table that ρ_t tends to remain constant beyond 300 A, but actually it decreases very slowly and an accurate estimate of its value after 300 A was not possible from the graph in Lovell and Appleyards' paper. It will be observed that formula (1) fits in with the observed data rather well except for the intermediate region 20 to 100 A where the discrepancy between the observed and calculated values is quite as pronounced as rather more so than, in case of Lovell's formula. It is of particular interest to note in this connection that recently Fuchs[4] has worked out an elaborate expression to account for the increased resistivity of films. He has considered cases of random scattering as well as those of partially elastic scattering with different reflection coefficients. Comparing his results for random scattering with ours, we find that according to him also, for values of $t \lesssim 15$ or 20 A, the assumption of random scattering suffices to bring about satisfactory agreement with the observed data. As thicknesses exceed some 200 A°, Fuchs concludes that surfaces again increasingly favour random scattering. For the intermediate region 20 to 200 A° choosing suitable values of reflection coefficients i.e., different degrees of elastic scattering, he obtains as close agreement with observation as desired, though it must be remarked that it is somewhat peculiar that colliding electrons at the surface will behave one way when the film is either very thin or thick and another way for intermediate regions.

Further details will be published elsewhere.

Indian Association for the Cultivation
of Science,
210, Bowbazar Street, B. Mukhopadhyay.
Calcutta.
10·7·38.

[1] *Science and Culture*, May 1938, p. 626.
[2] A. C. B. Lovell, *Proc. Roy. Soc.* A 157, p. 311.
[3] Appleyard, E. T. S., and Lovell, A. C. B., *Proc. Roy. Soc.* A Vol. 158, p. 718.
[4] Fuchs, K., *Proc. Camb. Phil. Soc.*, 34, p. 100, 1938.

The Structure of Sulphur Particles in Colloidal Suspension in Water

It has been reported[1] previously that the spontaneous solid deposits of colloidal sulphur, formed as a result of a very slow process of sedimentation, as well as the electrolytic deposit obtained on addition of a requisite quantity of NH_4OH of proper concentration to the colloidal solution are crystalline and their structures are exactly similar to that of orthorhombic sulphur or S_α.

In order to arrive at a definite conclusion about the real nature of the colloidal sulphur particles in the state of suspension several attempts were made also to study the solution by X-ray diffraction method,[2] but they were all unsuccessful.[3]

Recently we have been able to come to a very definite conclusion as regards the nature of colloidal sulphur particles suspended in water. A totally new method of studying less volatile liquids by the X-ray diffraction method has been developed, which involves in exposing the liquid in small drops to the incident radiation. With the arrangements made, it was possible to control the size of drops, which in our experiment was of the order of a millimeter. We found that in the case of colloidal solution of sulphur, a drop of the above mentioned size remained, on an average, undisturbed and practically unchanged for more than half an hour inspite of the mechanical disturbances due to the constant working of the pumps and other sources.

It is also worth mentioning here that no change in the quality of the solution was noticed and we have also not been able to observe any trace of congulation of sulphur particles and the consequent quick deposition of sediments in the colloidal solution under the influence of X-rays. To test this point a set of preliminary experiments were necessary. For, if the deposition of sulphur takes place in this condition, any crystalline pattern obtained may be due to these deposits and no definite conclusion regarding the nature of the suspended sulphur particle may be arrived at.

A quantity of the solution was enclosed in a thin-walled glass tube of about 1·5 mm. bore. The tube was sealed at both ends and exposed to the X-rays (5m. amp at 35 K.V) for about 10 hours. No sign of sedimentation or any other change could be detected.

The photographs obtained with colloidal sulphur drops exhibited a crystalline pattern but the back ground was very diffuse owing to the scattering of X-rays by the water molecules in the solution. Measurements of the sharp rings and the visual estimation of the relative intensities definitely show that the colloidal particles in the state of suspension are also crystalline like ordinary S_α. The detailed description of the method and the result will be published in the *Indian Journal of Physics*.

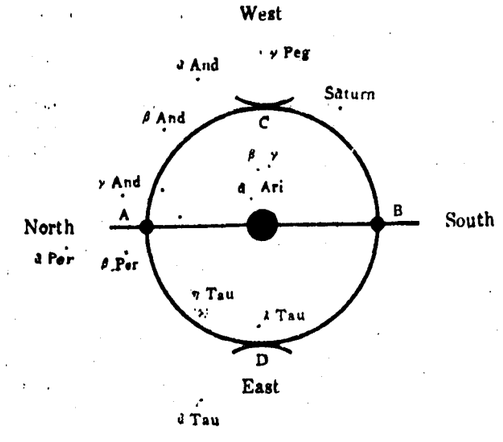
Khaira Laboratory of Physics, S. R. Das.
University College of Science, K. Ghosh.
Calcutta.
20·6·38.

[1] *Ind. Jour. Phys.*, July. 1938.

A Lunar Halo with Partial Parhelic Circle and 'Horizontal' Arcs seen at Hyderabad

At about 4 A.M. of 24th June 1938, I witnessed what was undoubtedly an incomplete system of lunar halos, with parhelic circle and so-called 'horizontal' arcs—a phenomenon visible generally in very high latitudes. A rough sketch of the apparition giving the position of the moon in the eastern sky is enclosed herewith.

The first inner halo circle of *white* colour and about 22½° radius was complete; the parhelic circle passing through the moon and the points A, B, extended a couple of degrees beyond its points of intersection with the halo. Its portion inside the halo was faint, and at the points A, B, it presented the appearance of somewhat roundish bright patches.



There was *no* second halo circle of 45° radius, nor was there any semblance of the so-called 'vertical' line passing through the moon, at right angles to the parhelic circle. But at C—the topmost point of the halo, there was a short bright (the so-called 'horizontal') tangential arc, concave upwards, towards the west.

By 4·30 A.M. the lower (eastern) part of the halo was well above the horizon. At D its lowest point, a short, fairly bright (the so-called 'horizontal') arc, slightly concave downwards (towards the east), was discernible.

All the time the sky was covered with a uniform, thin veil of haze. After 4.30 A.M., the southern part of the haze thickened into clouds, the bright spot at B disappeared and the whole system vanished not long afterwards.

On the evening of the 22nd June, there was a good downpour of rain and the night of the 23rd was cold and chilly. The haze on the morning of the 24th was presumably due to minute snow crystals in the upper atmosphere, which gave rise to the unusual halo.

Begumpet, a suburb of Hyderabad, Deccan, has latitude 17° 25′ 54″ North and altitude 554 metres.

Begumpet, Mohd. A. R. Khan.
Deccan, N. S. R.
10·7·38.

The Separation of Neurotoxin from the Crude Cobra (Naja Naja) Venom

Starting with a sample of crude cobra venom the m.l.d. of which for pigeons (300 g) was 0·3 mg. it has been shown by us[1] that the neurotoxin could be concentrated in a protein fraction which constitutes only 5·2 per cent of the protein content of the crude venom, or 1 mg. of the purified product contained 59·6 m.l.d.

Recently we have obtained a sample of cobra (Naja Naja) venom which is three times more active than the venom which we used previously. Experiments were therefore undertaken to separate the neurotoxin from this active sample.

A one per cent venom solution is first precipitated at 22 per cent sodium sulphate concentration as mentioned previously (*loc.cit*). The filtrate then precipitated at 29 per cent sodium sulphate concentration by the addition of more 44 per cent sodium sulphate solution. The mixture is filtered and the filtrate is treated with more solid sodium sulphate, so as to bring the concentration of the salt to 36 per cent. The precipitate formed is separated by filtration. The active principle in the filtrate is precipitated by sodium-tungstate and sulphuric acid and eluted as described in a previous paper by Ghosh and De.[2] In this way a sample was obtained in which 1 mg. of protein was associated with 106 m.l.d. When, to 8·5 mg. of this product, dissolved in 4 c.c. of ice-cold water, adjusted to *p*H 2·8, 8 c.c. of ice-cold methyl alcohol is added a precipitate is formed.

This precipitate containing the active principle is separated by centrifuging and then washed with cold 66 per cent methyl alcohol. It is found that 124 m.l.d. are associated with one mg. of protein of this precipitate. The purified neurotoxin sample which we obtained previously starting with a crude venom sample (m.l.d. 0·3 mg.) contained only

5·96 m.l.d. per mg. of protein. Therefore our new preparation is 2·06 times more active than the one reported previously.

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8-7-38.

B. N. Ghosh.
S. S. De.
N. L. Kundu.

[1] *Science and Culture*, 2, 585, 1937.
[2] *Ind. Jour. Med. Res.*, 25, 3, 1938.

Note on the use of Mercury volume-meter for the determination of Specific Gravity of Timbers

The methods usually employed in determining the volume of a small specimen of timber are

(1) by measuring dimensions of the specimen and then calculating its cubic content;

(2) by displacement of water;

(3) by displacement of mercury;

(4) by displacement of any other liquid of known specific gravity.

Of these the first method is very simple and direct; and a number of measurements are needed for accurate results. The second method is widely used, but it must be emphasized that the timber specimen in this case is always associated with a certain amount of moisture absorption, and a consequent discrepancy in the results. The method is particularly useless at different stages of progressive drying. The practice of coating specimens with paraffin involves further error in more than one way.

Of instruments depending on the use of mercury, the Breuil mercury volume-meter is very popular. The instrument is so designed that it records the volume in cubic centimeters, and the specific gravity is computed from

$\frac{W}{V \times d}$, where W=weight of the specimen in air,

V=volume recorded by volume-meter,
d=density of water at the temperature of the experiment.

This method apparently looks very simple. But the trouble with this method is that it is not at all easy to recover all the mercury that penetrates into the timber pores. There is always left some amount of mercury inside the specimen, a matter which should not be overlooked. Besides, as a result of some mercury filling pores, the reading recorded by the volume-meter cannot give a correct value for the amount of mercury displaced. Consequently, a correction must be made to the above formula in order to arrive at a true value of the specific gravity of the specimen under examination, and the following formula was found to be best suited for the purpose—

$$\text{Specific gravity} = \frac{W_1}{V+(W_2-W_1)}$$

W_1 = weight of specimen in air
V = volume recorded by volume-meter
W_2 = weight of specimen in air after mercury displacement
density of mercury at the temp. of exp.
density of water at the temp. of exp.

where W_1=weight of specimen in air,

V =volume recorded by volume-meter,

W_2=weight of specimen in air after mercury displacement.

The Robertson-Brown displacement bottle also makes use of mercury, but was found to be not so accurate as the Breuil volume-meter when worked out as above.

Very little work has been done to determine the specific gravity of timbers by the displacement of some other liquid of known density. The results are likely to be affected because of the absorption of liquid by the wood, or the solvent action of the liquid on the ingredients of the timber, or both.

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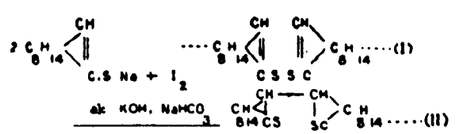
14-4-38.

B. N. Mitra.

On a New Rearrangement in the Thiocamphor Series

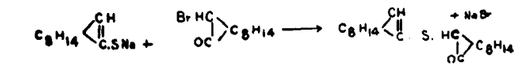
By the action of iodine on sodiothiocamphor in benzene, two products are obtained,—an unsaturated disulphide (I) b.p. 160°/10 m.m., and an 1:4 dithioketone, bisthiocamphor (II) m.p. 180°. The compound (I) is obtained if the reaction is allowed to take place at 0°, and the product is isolated at once from the reaction mixture. But if iodine is added to sodiothiocamphor in boiling benzene, and the product isolated after 15-16 hours, bisthiocamphor (II) results.

The disulphide (I) does not react with hydroxylamine, but gives tests of unsaturation, whereas the dithioketone (II) gives a dioxime and an azine, thus confirming the presence of two—C:S—groups. The disulphide (I) when kept in cold for 2-3 days in contact with alcoholic potash (20%) is changed into the dithioketone (II). The same rearrangement is also effected by heating the disulphide with a saturated solution of sodium bicarbonate or even with a saturated solution of sodium thiosulphate for 5-6 hours. The reaction of iodine on sodiothiocamphor can therefore be represented as follows:—

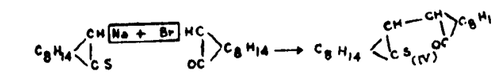


That sodiothiocamphor reacts in the thiolic phase during the formation of bisthiocamphor is also corroborated by the

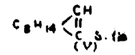
isolation of a sulphide, (III) by the interaction of α-Bromocamphor and sodiothiocamphor according to the following reaction:



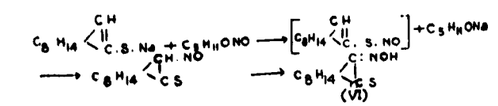
Had sodiothiocamphor reacted in the thioketo phase then thioketone (IV) would have been expected.



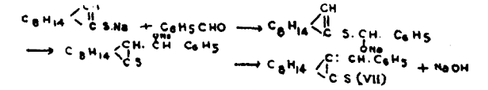
While the paper on bisthiocamphor was published[1] the author explained the reaction by the assumption of a C-Na-thiocamphor analogous to C-Na-Camphor. But the above observation leaves no doubt as regards the constitution of sodiothiocamphor as well as the mechanism involved in the formation of bisthiocamphor. Attempts were also made to isolate C-alkyl-and C-acyl derivatives of thiocamphor, but it has been observed that S-alkyl and S-acyl derivatives are exclusively formed by the action of alkyl iodides and acyl chlorides respectively on sodiothiocamphor. It has also been observed that α-halogenated esters, *e.g.* Bromoacetic ester, α-Brom propionic ester, Bromo malonic ester etc., give rise to S-substituted derivatives with sodiothiocamphor. It is therefore definitely established that sodiothiocamphor unlike sodiocamphor behaves only in one phase and its constitution can be represented by (V).



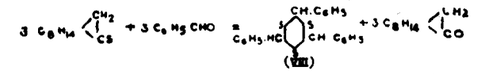
According to this assumption, the formation of all the C-substituted derivatives of thiocamphor can be ascribed to a rearrangement of radicals from sulphur to carbon through the unstable intermediates which could not be isolated. The formation of iso-Nitroso thiocamphor[2] (VI) accordingly, is now represented as follows:—



The formation of Benzylidene derivatives[3] (VII) of thiocamphor by the action of benzaldehyde on sodiothiocamphor can be interpreted as follows:—



Alkali appears to be responsible for the above type of rearrangement, for if the condensation of aldehydes and thiocamphor be allowed to take place in presence of alcoholic hydrochloric acid, the reaction takes a different course with exchange of radicals, camphor and trithio benzaldehyde (VIII) m.p. 226° being the products of reaction:



The exchange of oxygen for sulphur in benzaldehyde is nothing unusual and has also been observed by Mitra,[4] in the case of thioacetoacetic ester.

My sincere thanks are due to Dr P. K. Bose for his kind interest in this investigation and also for the facilities of his laboratory.

The details of these results will be published in due course in the *Journal of the Indian Chemical Society*.

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[1] Sen, *J. Ind. Chem. Soc.*, *14*, 213, 1937.
[2] *Ibid.*, *12*, 751, 1935.
[3] *Ibid.*, *13*, 523, 1936.
[4] Mitra, *J. Ind. Chem. Soc.*, *9*, 633, 1932.

ON A NATIONAL SCHEME OF EDUCATION

Even an ardent admirer and follower of the Mahatma like Prof. Banerji finds it difficult to support him in his denunciation of the machine, and of the machine age; if we apply the test of the Chinese philosopher, the system of education advocated by the Committee will not make Indians fit for the present age.

To us, scientists, it appears that the Mahatma's system lacks in progressive vision, *i.e.*, it does not say how villages are to be linked to the cities, and how the industries which are indispensable for the Nation's life and for the body politic (those connected with transport, communication, power, essential chemicals etc.) are ever to be managed by Indians for the benefit of the Indian population. Apart from adopting a policy of *laissez faire* to these urgent problems, his whole attitude towards the machine and the modern city-civilisation is one of *defeatism*. He looks at its evils, but does not try to understand its mechanism of work and he starts with the inner conviction that the machine civilisation must be intrinsically evil. But may we submit that it is a wrong reading of history to say that the mechanisation of a vast continent like India would necessarily entail a bloody class war, or colossal expenditure, foreign experts, or foreign machinery.

It is true that the Industrial Revolution in Europe caused great social dislocation and political unrest, but this was due to that fact that the discoveries of science were first utilized by capitalists, for the sake of private gain, and statesmen and leaders of thought were slow to realize their repurcussion on society and at first adopted a policy of *laissez faire* towards them just as the Mahatmaji proposes to do now and expressed itself in class war and sometimes popular discontent. When the problems could no longer be avoided and they had to introduce beneficient but contentious legislation in order to achieve social welfare. But it is the test of statesmanship to learn from lessons of history: there is the example of Europe's apt pupil, Japan, which has introduced the Industrial Revolution *without the horrors of a class war* or without having to borrow foreign technicians or foreign capital.* What has been achieved by Japan can also be achieved in India povided the Nation *will* so. It would be a happy day for India if the Mahatma can overcome his attitude of defeatism towards the Machine, devote a little time to the mastery of the technique of modern civilisation, and then makes up his mind. We are quite sure that he will find that the machine, instead of being man's master can also be made his slave, and that it is possible to utilize the machine for promoting social welfare much more efficiently than with the system advocated by him. He can then lead the Nation to the right track with his usual energy of conviction and driving power. Otherwise we feel, that by diverting the attention of the Nation from the only path which holds out prospects of relief against the present problems of poverty, unemployment and defencelessness, he will be committing what we may describe by the oft-quoted phrase as a "Himalayan Blunder."

* Our appreciation of the achievements of Japan has nothing to do with her aggressive policy towards China which we unreservedly condemn.

A Review of the Wardha Scheme of Primary Education

Nripendra Chandra Banerji

THE proceedings of the Wardha Education Conference supplemented by the Zakir Husain Committee Report and the syllabus and prefaced by Mahatma Gandhi's articles in the *Harijan* on the basic principles of the New Education are very interesting reading.

In the words of Sj. Kishorilal Mashruwala, (one of the members of Zakir Husain Committee which have elaborated with a precision and assiduity worthy of all praise the details of this New Education) the Segaon Method (or the Wardha Method) is the application of the law of non-violence in the training of the child as a prospective citizen of the world; further, the centre of the Method lies in a productive industry; and yet further: the method may be shortly summed up in the phrase, "From the hand and senses to the brain and the heart, and from the school to the society and God." The sources of knowledge in this method are "work, observation, experience, experiment, service and love" and mere literacy (that is information on various matters through reading and writing) is not considered knowledge or even the medium of knowledge.

In the words of Sj. Mashruwala 'The Basic Course should include a good knowledge of the mother-tongue, a fair acquaintance with its literature, a working knowledge of the *national* language of India, a general knowledge of such subjects as mathematics, history, geography, physical and social sciences, drawing, music, drill, sports, gymnastics etc., as well as of a vocation to a degree which should enable an average student to start a modest career and a zealous and bright student, if he will, to take up a course of higher general or vocational training.' It should extend to not less than seven years.

The method has been worked out *mainly for the Basic Education through the Khadi industry,* which is the only industry in India in which the state could employ practically an unlimited number of workers without loss to itself and pay them the minimum wage necessary for healthy subsistance (not less than *one anna per hour* for work at the average speed); the schools under the system are expected to provide a major part of the running expenses by the sale of school products taken in hand by the state itself.

To quote Mahatma Gandhi himself:—"My *plan* to impart *Primary Education through the medium of village handicrafts* like spinning and carding, etc., is conceived as the *spear-head of a silent social revolution fraught with the most far-reaching consequences* (the italics are ours). It will provide a healthy and moral basis of relationship between the city and the village and thus go a long way towards eradicating some of the worst evils of the present social insecurity and poisoned relationship between the classes. It will check the progressive decay of our villages and lay the foundation of a juster social order in which there is no unnatural division between the 'haves' and the 'have-nots' and *everybody is assured of a living wage and the right to freedom* (the italics are again ours). And all this would be accomplished without the horrors of a bloody class war or a colossal capital expenditure such as would be involved in the mechanisation of a vast continent like India. Nor would it entail a helpless dependence on foreign imported machinery or technical skill. Lastly, by obviating the necessity for highly specialised talent, it would place the destiny of the masses, as it were, in their own hands."

To quote (with slight adaptations) from the body of the report itself:—

(*a*) Education should be imparted *through* some *craft* or *productive work which*

should provide the nucleus of all other instruction provided in the school.

(*b*) The aim is not superficial literacy but "the literacy of the whole personality—" "the important capacity of using hand and intelligence for some constructive purpose."

(*c*) Socially such education "will tend to break down the existing barriers of prejudice between manual and intellectual workers, harmful alike for both."

(*d*) Economically the scheme " will increase the productive capacity of our workers and will also enable them to utilise their leisure advantageously."

(*e*) From the strictly educational point of view, " knowledge will thus become related to life, and its various aspects will be correlated with one another."

(*f*) The object is *not* primarily the production of craftsmen able to practise some craft " mechanically " but rather the exploitation for educative purposes of the resources implicit in craft work.

(*g*) There is an ideal of citizenship inherent in the scheme—the provision of a minimum of education " for the intelligent exercise of the rights and duties of citizens " and for the production of 'workers' and members of "a co-operative community in which the motive of social service will dominate all the activities of children during the plastic years of childhood and youth."

(*h*) " There is an obvious danger that in the working of this scheme, which is expected to cover the major portion of its running expenses by the work of the pupils, the economic aspect may be stressed at the sacrifice of the cultural and educational objectives. Teachers may be tempted to devote most of their attention and energy to extracting the maximum amount of labour from children " while neglecting the intellectual, social and moral aspects of craft training.

The main outlines of the seven years' course of Basic Education are given in the Report as:—

(1) *The Basic Craft*:—(*a*) Spinning and weaving, (*b*) Carpentry, (*c*) Agriculture, (*d*) Fruit and vegetable gardening, (*e*) Leather work, and (*f*) other craft " regional in character " and suitable for constructive education.

(2) *Mother-tongue* (which will not only develop the capacity to write legibly, correctly and with speed, and to describe in writing every day happenings, reports of meetings in the village etc., to write personal and business letters, but insist on an acquaintance with and interest in the writings of standard authors).

(3) *Mathematics* (capacity to solve speedily the ordinary number and geometrical problems arising in connection with the craft and with home and community life; also a knowledge of business practice and book-keeping).

(4) *Social studies* (a course in history, geography, civics and current events: a simple outline of Indian history: the history of the Indian national awakening: celebrations of national festivals and of the 'National week' in the school, acquaintance with the public utility services, the working of the Panchayet and the Co-operative Society, the growth and significance of representative institutions, duties of public servants etc., a study of world geography in outline with a fuller knowledge of India and its relation with other lands).

(5) *General Science*: (*a*) Nature study; (*b*) Botany; (*c*) Zoology; (*d*) Physiology; (*e*) Hygiene; (*f*) Physical Culture (*g*) Chemistry " of air, water, acids, alkalis and salts ". (*h*) A knowledge of the stars " showing direction and time at night." (*i*) Stories of great scientists and explorers.

(6) *Drawing*.

(7) *Music* (special emphasis on group or choral singing, and

(8) *Hindusthani* (to ensure that all school children may have a reasonable acquaintance with a common 'lingua franca).'

And for the efficient working of the scheme there should be

(*a*) The proper *Training of Teachers*. They should have an understanding of the new educational and social ideology inspiring the scheme combined with an enthusiasm for working it out. The training should include a reasonable *thorough mastery of the processes and technique of certain basic crafts*. They should be trained to " link up life, learning and activity."

(*b*) *Supervision*: It should not be mere inspection, it should mean personal co-operation and help offered by men " able to play the role of leaders and guides in the educational experiment ".

(*c*) *Examinations*: There should be a Board of Education who should judge the efficiency of its schools by sample achievement tests, by the efficiency of the pupils in the basic handicraft and by the specific contributions made by teachers and pupils to the improvement of the general life of the community around, and lastly

(*d*) The formation of an *Independent Non-official Central Institute of Indian Education* to serve as an advisory body on and organise research on problems and policy and practice of education.

The above is a short summary of the theory and practice of the New Education which has come to be known as the Wardha Scheme of National Education (mostly in the words of the originators and of the fountain-source, Mahatma Gandhi).

Now the *sociological idea of a state based on absolute non-violence* where there is no need for even a defensive national army, navy and air-force, where internal order and international order will be kept by loving persuasion and kindly compromise, by the sanctions of moral force and the leverage of a cultured intelligence only is an entrancing idea; it is Gandhism at its apex. Intellectual India admires the Ideal but with very great mental reservations.

Also the *economic idea of socialisation by tackling India to a handicraft civilisation and keeping industrialisation at arm's length* to be shunned a something essentially unholy and ravenous i another of those ideas which is being increasingl rejected by Indian intellectuals, savants an scientists.

We hold to non-violence as a beautifull romantic and essentially practical technique o political struggle by an unarmed nation of slave against a fully armed police state; we do not con sider it as a feasible and practical basis for a full grown, independent state.

We believe in the necessity, nay the urgency of reviving and revitalizing, our old village indus tries, by new modes of harnessing of power an electricity in an increasing measure and whereve necessary. We have, however, no dread of th modern machine when it is used for social an constructive ends of production and distribution The machine is a human product and a human product becomes evil only when it is evilly used We do not believe India can ever become a first class state without planned and speedy creation an socialisation of key industries.

Inspite of these beliefs, we are definitely o opinion that the Wardha scheme of Education i a very useful, interesting and efficient scheme which if *properly* launched, after a *proper training* of a large body of intelligent, selfless and patriotic teachers, with *proper funds* supplied by the stat as well as by private agencies, will after a decad or two, give us an entirely novel country-side buzzing with hope, blazing with social service, fi up by co-operative constructive organisations. I will make the young children virile, alert an active; it will rebuild a new rural India. The edu cation will be an education for a modest living, fo citizen service, for moral and physical uplift. A honour to those who rally to this new revolutionar banner (it is revolutionary in the best sense of th term—for the idea and the method are strikingly new and adapted to the betterment of our sleepy inert, starved villages, which are 7 lacs in number

But at the same time, the needs of pure culture and training in the arts and sciences and industrie must not be forgotten: there must be another scheme equally revolutionary to link up the villag

A REVIEW OF THE WARDHA SCHEME OF PRIMARY EDUCATION

life with the city life, to link up handicrafts with key industries, to connect the thought, the research, the poetry, the philosophy, the science of India with the world as a whole—a scheme which will provide for skilled technicians, first-class scientists and thinkers and poets, able to pull their weight in the arts of offence and defence, in the sphere of Economics, Science and Letters. For it is a utopian dream to think of shunting India away from the highways of modern endeavour back to the ruts of the peaceful, contented village commune, producing its food and clothing and other simple needs and falling eventually a prey (as of old) to ravening Powers armed to the teeth with the death-dealing weapons of war, and equipped with the modern industrial and economic organisations helped by money-power and propaganda. With these reservations, we commend the Wardha scheme of Education to the general public.

Electric Power Supply in Japan 1887-1938

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Area and Population of Japan

THE total area of the Japanese Empire (excluding the recent acquisition in China, since july 1937) amounts to 681,274, Sq. Kms. and that of Japan proper amounts to 385,000 Sq. Kms. The total population of the Japanese Empire (excluding the recent Chinese conquest since July 1937) amounts to about 10 crores and that of Japan proper amounts to 7 crores, as on the 31st Dec. 1937. The figures, statistics and data given below are all concerning the cities and towns of Japan proper. The population of Japan proper is only 5% of the world population and the area of Japan proper is about 0.5% of the world's total land area!

The density of the population of Japan proper is 181 to the Sq. Kms. being only next to Belgium, Holland and England in the order of the congestion of population, although in point of total population, Japan stands fifth, the first four, being (in order of their population,) China, India, Soviet Russia and U. S. A. Only 17% of the land in Japan is arable. Thus Japan proper tops the list in point of congestion with 1170 souls per Sq. Km. of the total farmlands. The annual increase of the population of Japan is 10 lakhs which is, roughly speaking, twice as much as those of Great Britain, Germany and France, three Great Powers, all put together. Even such a vast and rich country as the U. S. A. shows an annual increase of population amounting to only 80% of the annual increase in Japan. All these facts serve to demonstrate the tremendous pressure on the Japanese soil and the need for expansion, (conquest!) elsewhere. Being a thickly populated country and being highly industrialized, the villages are gradually merging into towns and cities. Stretches of land extending to about 20 and 30 miles, as between Kobe and Osaka, Osaka and Kyoto, or Tokyo and Yokohama are practically like one continuous street, thanks to the network of electric tramways and railways. Out of the 11, 600 cities and towns of Japan, less than 250 villages i.e., less than 2% remain without electric transmission. Most of these are groups of small hamlets too far out of the way or located in some farway islets, in the inland sea.

Out of the 12, 500, 000 residential households and industrial buildings as many as 11, 4000, 000 are wired for electric purposes, apart from the innumerable advertisements of the neon lamps which even the ordinary barbers are using. This makes an average of 91% for the whole country. Even in an industrially advanced country like the United

ELECTRIC POWER SUPPLY IN JAPAN (1887-1938)

States only 75% of such buildings are wired. The number of electric bulbs used in Japan at the end of the year 1935 amounted to 42.5 millions, that is, an average of 61 bulbs per hundred of the population. It is interesting to note in this connection that the manufacture of electric bulbs has been a great industry in Japan and at the end of the year 1934, 26 million bulbs valued at 20 million yens were produced in Japan of which 16 million bulb were exported for the value of 7.6 millions, (i.e., the export rate was 2.1 dozs. per yen and 10 million dozs. were sold in the country for 12.4 millions, (i.e., the sale price in the country was 0.8 dozs. per Yen). This is an instance why the prices of articles in Japan are much higher than those that are sold outside.

Japanese houses being usually made of wood (and paper, grass and bamboo!) can be wired with very little cost and trouble. In addition to this the congestion of the inhabitants caused by the crowded localities within narrow areas has facilitated easy distribution of the current. In the United States, with its vast area, nearly 25% of the houses are not yet wired.

Development of the Electric Industry in Japan

The beginning of the electric industry in Japan is supposed to date from 1878, but from a commercial point of view, the foundation of the Tokyo Dento Kabushiki Kaisha (Tokyo Electric Light Co.,) in 1883, forms the first landmark in its history. Apart from the telegraph, the first use of electricity in Japan was in 1885 in which year a cotton mill in Osaka and the Bureau of the official gazette in

TABLE No. I

ELECTRIC LIGHTING IN JAPAN (1887-1935)

Year.	No. of wired homes in millions.	No. of lamps in millions.	No. of lamps per cent of population.	Candle-power in millions.
1887	....	only 75 lamps	....	....
1903	30,000 homes only	....	....	....
1910	....	1.95 millions	3.8%	....
1913	2.2 millions	5.6 „	....	52.0 millions
1914	....	6.99 „	12.9%	....
1919	....	14.2 „	....	....
1921	7.0 millions	18.1 „	....	.... „
1923	....	21.7 „	35.9%	334.1 millions
1926	10.2 millions	30.2 „	....	548.0 „
1931	11.4 „	37.4 „	....	782.3 „
1933	11.6 „	38.4 „	54.9%	810.0 „
1934	....	40.5 „	59.0%	....
1935	....	42.5 „	61.0%	....

ELECTRIC POWER SUPPLY IN JAPAN (1887-1938)

Tokyo adopted a small lighting system for their own use. In 1887, the Tokyo Electric Co., undertook to light commercially seventy five incandescent lamps using a home-made generator installed at the first commercial plant in Nihonbasti, Tokyo and capitalized at Y. 200,000. By the end of 1892, there were 11 electric power enterprises with a nominal capital of Y. 2,500,000, power generation being meant only for lighting purposes was from steam power alone.

The first hydro-electric plant in Japan was started in 1892 in connection with the Lake Biwa Canal works at Kyoto by the Kyoto Municipality. In 1895, Kyoto Electric Railway Co. was started for running electric railways. By 1898, this was increased to 2,000 H.P. by the same municipality. In 1898, the Nayoya Electric Railway Co. was started for running electric railways. In 1899, the first long-distance transmission concern was started by the Koriyama Kenshi Boseki Kaisha (Koriyama Silk Spinning Co., Ltd.) which succeeded in transmitting 10,000 volts over a distance of 15 miles. At the end of the Sino-Japanese War (1896), the number of companies increased to 47. The number of houses to which electric current was supplied in 1897 amounted to 30,000 only.

Before the Russo-Japanese War, electric power in Japan was chiefly generated from steam-plants though the water power was also used on a small scale. As the price of coal began to rise and the company's profits fell, hydro-electric power schemes were more and more taken up. Every war that Japan has fought is a landmark in its industrial development. In the year 1903, the total electric power installed was 44,000 kW. of which 31,000 was from coal and 13,000 kW. from water. Between the years 1904 to 1908, nearly 120 new companies were established. The number of lights used in 1908 was three times the number used in 1903 and the power used for electric motors increased fourfold in the meantime. The capital of the companies floated during that period of five or six years figured at Y. 227,542,000 in 1908, which was the largest sum invested in any single industry in Japan at that time. In 1907, the Tokyo Electric Light Co., constructed a long distance line from Katsuragawa and a power station of 22,500 H.P. (water volume 750 cu. ft. and height of waterfall 345 feet) at Komabashi a distance of 50 miles from Tokyo, and power was transmitted at a pressure of 50,000 volts. The electric light generated by water power was supplied 30-40% cheaper than steam electricity and on top of it was pointed out that, it was easy to make a profit 20-25% a year. This marked a new era for the Hydel scheme.

TABLE No. 2

LENGTH OF TRANSMISSION LINES

(In 1,000 Kilometres.)

	1907	1914	1928	1932
Low Voltage .	8	46	362	371
High Voltage.	9	69	406	412
Special High Voltage .	2	24	128	138
TOTAL .	19	139	896	921

N.B.—The system of *high tension* wires has spread like a spider's web in Central Japan. The highest voltage transmission in Japan at the present time is 154,000 volts and the longest distance is 150 miles of the Inawashire Hy. Elec. Coy.

After 1904, the temporary Investigation Bureau of Hydro-Electric Power was established under the direct supervision of the Minister of Communications and investigations regarding the available water power were made throughout the country. The office was abolished on the occasion of the administrative readjustment in 1913 but the work carried out up to that time is believed to have practically ascertained the water power resources workable. Out of the 1536 places judged to admit of being utilized, at first 850 were subjected to investigation. The horse-power available was ascertained to be 2,295,223 exclusive of projects already under sanction which represented 3,275,201 H.P. The exploration and investigation cost the Government Y. 700,000 (about 10 lakhs of rupees) out of the original estimate of Y. 15,000,000 spread over five years. The office which was abolished in 1913 was resusciated in 1918 to conduct further researches on the subject. By 1921, it was shown that nearly 7,850,000 H.P. or more could be generated. As a result of the investigation and encouragement from the Bureau, the hydro-electric power quickly developed and, in 1912, had increased to 233,000 kW.

TABLE No. 4

COMPANIES CLASSIFIED BY PERCENTAGE OF THEIR DIVIDENDS
(from 1912 to 1920)

Year.	Over 15%	Over 12%	Over 5%	Under 5%	No Dividends	Loss.	No. of Companies taken into account
1912 .	9	52	140	15	32	12	260
1913 .	7	75	172	20	45	20	338
1914 .	6	92	198	29	48	21	394
1915 .	11	106	197	33	60	18	425
1916 .	13	121	219	20	65	18	456
1917 .	33	118	237	9	46	20	463
1918 .	40	129	228	10	50	21	478
1919 .	58	130	230	9	47	26	500
1920 .	49	122	232	23	62	39	527

According to the statistics for 1933, the enormous sum of Y. 5,190,000,000 is invested in electrical enterprises including lighting, power, electric railways and allied industries. At the end of 1935, the paid-up capital of the "Big Five" stood at Y. 951,044,000 while fixed assets amounted to Y. 1,547,952,000.

The Tokyo Lighting Co. heads the list of power firms with a paid-up capital of Y 429,564,000 and fixed assets valued at Y 769,184,000.

A reference to the table showing the growth of electric power would show that the demand for electric power increased along with the economic expansion but it also indicates the rate of increase varied very widely according to business conditions. During the period from the Great War to 1928, the economic conditions in Japan were comparatively stabilized and this was clearly reflected in the amount of electric power consumed, the annual percentage increase ranging from 10 to 20%.

However, the percentage increase fell drastically following the temporary return to gold standard which brought a deflationary influence to bear on finances and depressed business in general. Power consumption showed an increase of 15.3% in 1929 but registered a trifling gain of only 1.4% in 1930, when the gold embargo was lifted. It was that year also in which all the electric power companies faced the problem of heavy surplus of generating capacity and resorted to reckless competition. As a consequence, in *1932, new legislation of control*

TABLE No. 5

REVENUE, EXPENDITURE AND PROFITS OF ELECTRIC INDUSTRY
(1887 to 1934)

Year.	Paid-up-capital (in million Yens).	Revenue (in million Yens).	Expenditure (in million Yens).	Profit (in million Yens).	Rate of profit per cent paid up capital.	Dividend of rate per cent.
1887 . . .	(only 200,000)	Beginning	..	..	..	..
1892 . . .	2.5	Nominal value	..	..	..	..
1908 . . .	..	22.0	12.0	10.0	9.2	7.5
1922 . . .	..	489.0	251.0	188.0	12.5	7.6
1926 . . .	2,454	..	..	280.0	11.0	..
1930 . . .	8,181	897.0	641.0	256.0	8.0	7.2
1933 . . .	3,494	921.0	738.0	183.0	5.2	3.2
1935 . . .	4,125	..	..	226.0	5.5	..

Out of the total income of Y. 921,00,000, on income of Y. 277 million was derived from the supply of current made for electric lights only.

TABLE No. 6

VOLUME OF POWER GENERATED AT GENERATING PLANTS

(in 1,000 kWH units)

Year.	Maximum average.	Annual percentage increase.
1923 . . .	1,152	21.2
1924 . . .	1,397	21.1
1925 . . .	1,580	13.1
1926 . . .	1,832	15.9
1927 . . .	2,090	14.1
1928 . . .	2,344	12.1
1929 . . .	2,513	7.2
1930 . . .	2,561	1.9*
1931 . . .	2,735	6.8
1932 . . .	3,078	12.4†
1933 . . .	3,324	8.1
1934 . . .	3,649	9.8

* Gold embargo was lifted.
† Suspension of the gold standard.

TABLE No. 7

TRENDS IN POWER CONSUMPTION

(in 1,000 kW units)

Year.	Consumption.	Annual percentage increase.
1924 . . .	6,572,286	32.1
1925 . . .	7,768,113	18.1
1926 . . .	9,326,390	20.1
1927 . . .	10,599,504	13.4
1928 . . .	11,914,646	12.4
1929 . . .	13,739,350	15.3
1930 . . .	13,936,188	1.4*
1931 . . .	14,144,930	1.5*
1932 . . .	15,651,210	10.6†
1933 . . .	17,408,526	11.3
1934 . . .	19,078,682	9.6

* Japan's return to the gold basis, and the acute economic distress of the nation. In 1931, there was an average surplus of 620,000 kw.
† Re-imposition of the gold export embargo.

under a competent minister was organized by the Goverenmet and the formation of the Electric Power Association by the Big Five under Government supervision stabilized all internal competition These conditions underwent a complete change after the second suspension of the gold standard and with the general business revival due to the depreciation of the Yen, power consumption increased substantially.

TABLE No. 8

POWER CONSUMPTION FOR LIGHTING AND POWER

(in 1,000 kW units)

	1914	1928	1930	1932*
Lighting . .	159	797	888	979 (20%)
Power . .	323	2,948	3,533	3,812 (80%)
	482	3,746	4,421	4,791*

* In 1932, only 80,000 kws. (*i.e.* 2%) of the electricity were used for Agricultural purposes.

In 1933, only 1000 kW.

Total consumption, 5,000,000 kW. of which Hydro-electric was 62.0% and oils and coal was 38%. The amount of coal used for the generation of electricity was about 5% of the domestic output of Coal in Japan.

In 1933, the total consumption amounted to 18,000,000,000, kWH. of which 4,000 million kWH. were used for lighting purposes and 11,700 million kWH. were used for industrial use. During the year there were 818 enterprises producing power in 7115 different plants. Amongst these were 114 municipalities in urban and rural districts producing power and managing and running their own tramways. The total income was Y. 921 millions, of which Y. 277 millions were obtained from supply of electricity for domestic purposes (lighting). The total installed power amounted to roughly 5 million kW. of which 62%, *i.e.*, 3.1 million kW. were generated by water power and 38%, *i.e.* 1.9 million kW. was generated by steam power. The total investment was about 4,000 million yens and the working staff amounted to 170,000 souls. In 1933, Japan occupied the third place in the world in respect of production, being only next to the U. S. A.

854,000 million kWH) and Germany (25,500 WH.). In the volume of electricity produced y water power, Japan is only surpassed by the J. S. A., Canada and Italy. Between 1912 and 1933, he development was so remarkable that the use f bulbs had increased seven-fold, the electric rail-ray mileage had gone up seven-fold, the production f electricity had reached 8.5 times as much and he capital invested had risen to 12 times as much.

TABLE No. 9

CURRENT OUTPUT OF THE LEADING COUNTRIES OF THE WORLD
in million Kilo-watts

Country.	1929	1933
Japan . .	16,812	18,160
U. S. A. . .	90,084	82,379
Germany .	16,891	14,650
England . .	10,401	18,886
France . .	14,319	14,905
Italy . .	9,815	11,181
Canada . .	17,963	17,339
Switzerland .	3,509	3,880
Belgium . .	1,768	1,861
Holland . .	1,604	2,088

TABLE No. 10

CURRENT OUTPUT BY COUNTRIES
(in milliards of kWH.)

Country.	1932	1933
Japan . .	12.56	16.96
U. S. A. . .	99.04	108.03
Germany .	28.46	25.50
Britain . .	18.71	20.30
Canada . .	15.86	17.55
France . .	13.70	14.85
Russia (U.S.S.R.)	13.39	15.86
Italy . .	10.23	11.29
Norway . .	9.15	..
Switzerland .	4.79	4.93
Sweden . .	4.90	5.35
Belgium . .	4.11	4.26

The *per capita* consumption of electricity has been as follows:—

172 kWH. in 1927.
268 kWH. in 1933.
310 kWH. in 1934.

In England, at the same period the *per capita* consumption was said to be 600 kWH. (all produced by thermal power) and in Norway, it was said to be 1700 kWH.

Rates charged for Electricity Supplied for various purposes

Many of the municipalities in Japan have adopted a special type of street lighting which deserves to be studied. The front light on the main door outside every house in several villages and cities is connected by a special wire line and the main connection of this line in not connected with any metre but is directly under the management of the municipality. The lamp (18 C.P.) is switched on and off from sunset to sunrise and a charge of about 50 Sen (Six annas and a half in Indian money) is made monthly and is to be paid by the owner of the house. The bulbs are also coloured to indicate the profession of the owner, *e.g.*, a red bulb in the case of doctors, nurses etc. This system saves an immense amount for the municipality in street lighting, besides being a source of regular income.

Cost of the Unit

For House lamps—(16 C.P.) per bulb per house Sen 50-60 per month.

In certain factories, for the labourers during the night, in the dormitories only Sen. 15 are charged per bulb (about two annas) per month.

For factory use generally, the price ranges per unit, between Sen 2 to Sen 6 per unit (one pice to three pice).

For very large electro-chemical industries the price ranges, for large scale consumption, between 0.6 Sen to 1.5 Sen per unit (¼ pice to ¾pice).

There are special lines for supply of current in small houses where only a few lamps are required and they are charged per bulb per month.

The supply is cut off automatically early in the morning and is resumed in the evening.

(*a*) Charges in Hanshin District (Kobe) *per lamp per month* are as follows:—

10 Watts or 6 Candle power (Roughly 1 pice=2 Sen).	55 Sen. at present.
20 Watts or 16 Candle power	63 Sen.
30 Watts or 24 „ „	73 Sen. (nine annas).
40 Watts or 32 „ „	90 Sen. (eleven annas).

(*b*) Charges in Osaka *per lamp per month* are as follows:—

8 Candle power	46 Sen.
16 „ „	50 Sen.
25 „ „	67 Sen.
40 „ „	90 Sen.
50 „ „	1.05 Sen. (1=100 Sen=As 13).
80 „ „	1.55 Sen.
100 Candle power	1.75 Sen.
150 „ „	2.45 Sen.
200 „ „	3.15 Sen.

For such house lighting, no charge is made for the meter as none are required. The voltage used for home lights is 100 A.C. in Osaka and 110 A.C. in Hanshin (Kobe area).

In distant areas, for home use, the price of the current goes up to 11 Sen per kW. of current consumed.

A voltage of 220 A.C. is considered dangerous, especially when the atmosphere is humid and is therefore utlized only for *power lines. The Alternating Current* 100 to 110 voltage has been adopted deliberately for domestic use in order to avoid accidents. It is found safe and suitable for lighting and other domestic purposes.

Electric power supplied by the electric power stations of the State Railways for the year 1933-34 amounted to 139,197,271 kWH. for which Y. 1,300,223 were spent. The net expenses per kWH. were a little more than 0.9 Sen (Y. 0,009) i.e., in Indian money ¼ a pice or one eighth of an anna.

ELECTRIC RAILWAYS AND TRAMWAYS IN JAPAN

ELECTRIC RAILWAYS:—	
1908	70 miles
1918	600 „
1931	over 3,625 „
ELECTRIC TRAMWAYS:—	
1934	over 1,600 miles

Total Power Capacity

The total hydro-electric power reserves in Japan amount to 14.5 million H.P. (Normal flow) of which only 5.4 million H.P. are already harnessed. This makes an average of 99 H.P. to the Sq. mile as against only 20 H.P. in the United States.

The total installed plant capacity of Japan is at present in the ratio of 6 of water-power to 4 of fuel. In practice, nearly 90% of the total current output is being generated by water power. Large scale enterprises, such as paper, caustic soda, etc., generally operate their own auxiliary thermal stations equipped on an extensive scale.

In the field of hydro-electricity, there still remains a good deal of undeveloped water power which will be exploited gradually. But, on the other hand, the steam turbine which has been greatly improved in Europe since the World War is playing an important role in generating electric power, steam-pressure, formerly in the neighbourhood of 120 pounds has gradually been raised and has recently reached 1200 pounds. Electricity can thus be generated to-day more economically at a steam-plant than in a Hydel plant. A paper mill, for example, which needs electric power for making paper pulp has to use steam for drying paper. If electricity is generated at a low cost by high-pressure steam, the steam left over can be used advantageously at low pressure for drying paper. Both steam and electricity are also required at plants where dye-stuffs and chemical fertilizers are made. The same is true for the manufacture of soda carbonate by the Ammonia Solvay Process. The Toyo Soda Kogyo, K.K. of Japan which manufactures both soda

carbonate and caustic soda claims that the cost of the electricity which it produces in its own power generating plant is one of the lowest in Japan. Electricity can to-day be generated at a low cost even when coal is high in price. As it becomes necessary to go deeper into the mountains for water-power, the construction of hydro-electric plants become more costly than before. Water-power at one time, used to be cheap and a coal-burning plant was only an auxiliary. But conditions have changed, and to-day electricity is generated at some places by coal at much less cost than water power.

In Japan, instead of throwing away surplus power available in hydro-electric schemes in the rainy season when the supply of power is the maximum available, it is customary to use this power for chemical industries which do not have to depend upon steady power. The latest practice is to operate a water-power plant at the full capacity when there is abundant supply of water and to have a steam plant as an auxiliary to operate in the low water season. This is one of the reasons why electrical enterprises have recently increased and have become profitable in Japan.

Regarding small industries and their success, the abundance of cheap electric power (as also cheap coal gas) enables small enterprises to obtain an adequate supply of motive power at low rates. Even large factories which formerly depended on steam power and later utilized the method of group drive by means of electro-motors have recently adopted individual drive extensively.

The electric industry in Japan was originally planned only for lighting purposes irrespective of the cost of production per unit. Its use was then extended to electric tramways many of which were taken up by municipalities like those of Kyoto and Nagoya. The municipalities also took the control of street-lighting in their own hands and did not leave it to foreign private companies to exploit the ready-made market. Power development for industries soon followed and the wars waged by Japan gave an impetus and opportunity to expand the industries which were being systematically subsidized and fostered by the state. The recent munition and electro-chemical industries, involving the production

TABLE No. 12

WATER POWER OF THE WORLD BY COUNTRIES IN 1932

(in 1,000 H.P. units)

	Total potential power during low water season.	Developed.
Japan Proper	6,400	4,100
U.S.A.	38,000	14,885
Canada	18,000	6,125
Italy	3,800 (5,857-during high water season)	4,840
France	5,400	2,300
Germany	2,000 (highest developed power)	2,000
Norway	9,5000	1,900
Sweden	9,000	1,675
Spain	4,000	1,000
Austria	1,660	700
Brazil	15,100	640
U.S.S.R.	16,425	496
Mexico	6,000	494
England	850	400
Others	311,865	2,545
TOTAL	446,000	46,400

of aluminium, ammonium sulphate, alkalies, iron and steel, etc. have given an enormous impetus to the Japanese trade, and with the depreciated yen which is worth half its pre-war value in foreign currencies, Japan hopes to *turn her electrical resources* (with Japanese raw materials whose prices have gone up only slightly) *into the form of finished merchandise*, and have a wide market abroad.

The typhoons and floods of September 1934 caused a heavy loss to the industrialists of Kyoto and Osaka. The heat power stations located within a small and limited area were one and all put out of action by the floods. None of these stations was in a position to operate for days together in place of the water-power stations which had been badly damaged. The present trend is to install Diesels within individual workshops to become self-supporting.

TABLE No. 13

POWER CONSUMPTION OF INDUSTRIES
(in kilowatts)

Industries	1933	1934	1935
1. Chemicals	562,361	773,000	825,000
2. Textiles	516,188	552,000	574,000
3. Mining	366,278	302,000	333,000
4. Food-stuffs	291,247	311,000	320,000
5. Metal Products	258,718	501,000	676,000
6. Ceramic Products	170,478	211,000	242,000
7. Engineering	147,944	203,000	229,000
8. Lumber and Wood Products	135,497	145,000	151,000
9. Printing, Bookbinding and Agriculture	..	..	..
10. Others	785,069	176,000 641,000	177,000 645,000
Total	3,255,785	3,818,000	4,178,000

Laws Relating to State Management of Electric Power Industry

Legislation on the electric power industry has its basis from the viewpoint of national defence and as motive power for industry in general. A previous Government drafted a bill to enforce strict official control of the generation and transmission equipment which would have reduced the existing private companies to mere distributing agencies as their principal plants were to be compulsorily taken over by a Government company. The plan was perhaps too drastic to be passed through the Diet without serious amendments.

The national emergency has again induced the present Government to come forward with a bill on the same problem. In view of the complicated and controversial character of the subject, a special committee was first formed to prepare the material for drawing up the bill. The ultimate plan was based on the majority opinion of the above committee, its characteristic being the exclusion of the already developed water power from compulsory investment, which according to the previous Tanon ji plan was included together with steam power and transmission systems. The fundamental idea of the bill was explained by the Minister as follows: "Because of the basic nature of the industry and its monopolistic character, exploitation of electric power resources should not be left to decisions based on mere profit-making or private economy".

In the Diet, the bill was subjected to poignant criticism, doubts being expressed concerning the efficacy of government-managed company and the constitutionality of compulsory investment. Difficulties were also encountered in the valuation and compensation problem of investments by private companies and how to dispose of bonds issued in foreign currencies. The bill was, however, finally passed with amendments agreed upon by joint conference of both Houses of Parliament.

Legislation comprises the following four Laws:

(1) Electric Power Control Law.

(2) Japan Electric Generation and Transmission Company Law.

(3) Debenture Disposal Law in Connection with State Management of Electricity.

(4) Amendment to Electric Power Enterprise Law.

Electric Power Control Law

The fundamental objectives of the national electric power policy is revealed at the commencement of this law: "The Government is authorized to manage the generation and transmission of electric power, in order to lower the cost of electricity, ensure an adequate supply of power and to promote a wider range of its use (Art. 1)". The practical management of the plants, however, is conferred upon the Japan Electric Generation

and Transmission company (Art. 2). A Bureau called "Electricity Bureau" will be newly established to supervise the new company, and under this bureau, practical plans for the erection of plants will be decided (Art. 3). An advisory council will be established to assist the above bureau in deciding power rates and other important problems (Art. 5).

Japan Electric Power Generation and Transmission Company Law

The Japan Electric Power Generation and Transmission Company will be established to take over all major new water and steam power equipment and all the main transmission systems. As a general principle, however, existing water-power equipment will be left as at present, but the power generated will be conveyed through the transmission system controlled by the new company.

As regards the valuation of the plants taken over, half of the total value of construction costs and profit will be considered as share of the private companies. Construction cost is defined as the cost actually paid out for construction, reduced by the amount for depreciation. The profit value will be decided in consideration of the average profit rate for the past ten years (Art. 9). The contributing companies will be paid in shares of the new power company (Art. 11). In case a contributing company cannot continue business with the plant left in its possession, it may request the new company to acquire the whole plant outright (Art. 14.).

The contributing companies may request the new company to exchange the shares given to them into cash or company bonds at face value (Art. 15).

The management of the new power company will be exercised by a President, Vice-President, five directors, and three auditors (Art. 18). The President and the Vice-President will be appointed by the Government among 10 candidates elected by the general meeting (Art. 20). Ex-officials who have been supervising the company cannot become directors for five years after their resignation from Government service (Art. 22).

The new company will be previleged to increase its capital even before calling up the un-paid capital, to the extent of three times its paid-up capital. The Government guarantees a minimum dividend of 4% for ten years after the establishment of the company (Art. 32).

Debenture Disposal Law in Connection with State Management of Electricity

With the enforcement of the above-mentioned laws, a difficult problem may arise as regards the debentures of private companies issued on the security of their assets. This is especially true in connection with funded foreign borrowings. The law accordingly regulates that equipment on the security of which bonds are issued, will remain unaffected, even after the equipment is handed over to the new company (Art. 1). To protect the bondholders' interests, the new company shall guarantee both the principal and interest, in case obligations are not met by the contributing companies (Art. 3). In case all or a larger part of the mortgaged equipment is taken over by the new company, the Government is authorised to transfer the burden of the debt to the new company (Art. 4). In such case, the company will reject repayment before maturity (Art. 7), whilst the Government will guarantee both the principal and interest (Art. 8).

Amendment to Electric Power Enterprise Law

Government control will also be strengthened as regards the retail service of electricity. Government supervision over the disposal of profits, depreciation and extension of service area is added to the original law (Art. 23). The Government is authorized to order private companies to take over or to exchange certain areas to permit lower charges (Art. 24, 26).

Bioluminescence

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By 'bioluminescence' is meant the production of light by living organisms, of which the fire-flies are the well-known examples. The production of light by these living organisms attracted the attention of people for a long time. It was also known to them that moisture is a necessary condition for the luminescence being visible. Though this subject of animal luminescence attracted the attention of chemists like Robert Boyle in the seventeenth century, nothing could be clearly stated about the mechanism of the production of light until 1885 when Dubois suggested the cause to be the enzymic oxidation which is occurring within the cells of these animals. In recent years Havery, Kunda and others made a systematic study of the subject. Thus to-day it is known that this light production is a peculiar phenomenon of enzymic oxidation in presence of a special substrate within the cell.

The phenomenon of luminescence has been observed among fire-flies, glow-worms, crustacea, mollusca, and among 40 different orders of animals as well as of numerous bacteria and fungi. Thus the phosphoresence of the sea, the ghostly appearance of rotten tree stumps and the glow of meat and fish in the dark are all due to one or another bioluminescent organisms undergoing oxidation.

The luminous material is almost universally manufactured by the living cells as granules which undergo oxidation within the cell. There are two different kinds of this oxidation (*a*) intra-cellular luminescence, as is the case with fire-flies, (*b*) extra-cellular luminescence, *i.e.*, where luminous slimes or secretions are extruded, chiefly among astrocod, crustacea, etc.

Whatever may the process of oxidation the actual mode of light production is due, as has already been stated, to enzymic oxidation. Thus, inside the cell there are both the enzyme and the substrate, in the form of granules; both are distinguishable under the microscope, one large and yellow and the other small and colourless. The enzyme is known as luciferase and the substrate as luciferin. The enzymes, luciferases, of different species of animals are different and different shades of luminesce are produced when they act on luciferin of closely allied forms. No light-production is possible if luciferin of different species are used.

Luciferase and luciferin can be prepared from living animals but the dried organisms serve as a better source. Drying the organisms quickly in a vacuum desiccator over calcium chloride is best, as the dried material retains its activity for 15 years producing light whenever moistened. Thus the dried material contains both luciferase and luciferin in an unharmed condition and the phenomenon of luminescence is not a 'vital' process in the same sense as nerve conduction or muscle contraction.

From the dried material luciferase can be separated by simple cold water extraction, since contact with water and oxygen of the atmosphere brings about complete oxidation of the substrate luciferin. The process of oxidation may be hastened either by aeration or by adding substances of the type chloroform. The substrate luciferin is likewise prepared by the destruction of the enzyme. Simple hot water treatment is quite sufficient to destroy the enzymic activity without allowing time to oxidize luciferin.

Luciferase is non-dialysable, and destroyed by trypsin. It is insoluble in alcohol and in all fat solvents. The enzyme can be precipitated by protein-precipitating reagents like—phosphotungstic acid, etc. chemically, luciferase behaves as an albumin, but its chemical nature is yet unknown. Luciferin behaves like protein and remains stable in absence of oxygen.

BIOLUMINESCENCE

The mechanism of luminescence has been the subject of much discussion, since oxygen, rather than moisture, is a necessary accompaniment of the enzymic oxidation. Oxidizing agents like potassium ferri-cyanide in absence of oxygen failed to produce luminescence. Therefore, luciferin, luciferase and free oxygen form a triod making up the bioluminescent system. The enzyme luciferase acting in a like manner as enzymes of the type oxiedases. The chemical process underlying the production of light in aqueous media may be represented as

$$\text{luciferin} + \text{luciferase} + \tfrac{1}{2}O_2 \longrightarrow \text{oxy-luciferin} + H_2O + \text{light}$$

Thus luciferin is oxidized to oxy-luciferin. This product seems to represent a very slight change in the molecule since it can be reduced to luciferin again provided oxygen is absent during the process of reduction. No luminescence accompanies reduction. Since nascent hydrogen is a good reducer and other methods of reduction (hydrogen and Pt. or Pd, H_2S, $Na_2S_2O_4$ etc.) involve the taking up of hydrogen, we may represent the change to occur in the following manner

$$\text{oxy-luciferin } (L) + H_2 \longrightarrow \text{luciferin } (LH_2)$$

Thus the process of oxidation can be represented as

$$LH_2 + \text{luciferase} + \tfrac{1}{2}O_2 \longrightarrow L + H_2O$$

Since bioluminescence is undoubtedly an example of chemiluminescence,—a luminescence produced by the direct result of the energy of a chemical reaction and quite distinct from fluorescence or phosphorescence, where the energy for light production comes from incident radiation. Chemical luminescence may be of two kinds corresponding to two varieties of photo-chemical reactions. (i) the direct photo-chemical process in which molecules absorbing radiation (excited molecules) undergo photo-chemical change and (ii) the sensitized photo-chemical reactions in which the photo-sensitizer absorbs the energy of radiation, later transfering it by collision to other molecules, which undergo photo-chemical change. Thus, in the first type of chemiluminescence, the energy of reaction remains with the reaction product and may be emitted as light whereas in the second type mentioned, the excited molecule resulting from the reaction transfer by collision their excess of energy to other molecules, exciting them to luminescence. Thus luciferin—oxyluciferin—luciferase system is the ideal case of the latter type of chemiluminescence. Thus luciferase is the source of luminescence, since the energy produced by the oxidation of luciferin to oxyluciferin excites luciferase molecules which luminesce on being returned to their normal state. Thus the reaction is represented as follows.

$$(1)\ \text{Luciferin} + O \xrightarrow[\text{[luciferase]}]{} \text{Oxyluciferin}' + H_2O$$

$$(2)\ \text{Oxyluciferin}' + \text{luciferase} \longrightarrow \text{Oxyluciferin} + \text{luciferase}'$$

$$(3)\ \text{Luciferase}' \longrightarrow \text{luciferase} + h\nu(^1)$$

The process of oxidative reaction is catalysed by the enzyme present and the product of oxidation carries a quantum of energy indicated in (1) by dash. This quantum of energy is transferred to the enzyme in (2). The enzyme luciferase loses its quantum of energy as a quantum of light ($h\nu$) producing the phenomenon of luminescence (3)*

*Read at the Calcutta University Chemical Club on April 12, 1938.

The Semi-Centenary of the Lick Observatory

THE Lick Observatory, California, celebrated last June its semi-centenary. At one time it ranked as the premier observatory in the world, but within comparatively recent times it has been eclipsed by other observatories, like the Mount Wilson and the Dominion Astrophysical Observatory, Victoria, Canada. But the Lick Observatory has got a splendid record of work to its credit.

The history of its foundation will prove interesting to readers of SCIENCE AND CULTURE. The founder, James Lick, was by profession a mechanic from Pennsylvania and of Dutch stock and had very little liberal education. He migrated to Peru as a maker of pianos and made some modest fortune there. Later he migrated to California and invested his savings in real estate. Though California was known to the world as the Eldorado, the land of gold, the actual discovery of gold was made in 1849 in a rather romantic way accounts of which can be read in '*Men and Metals*'. The story of the discovery of gold caused a large influx of adventurers from all parts of America and Europe to this part of the country, which was still then mostly uninhabited. People who had already settled there and invested in real estate suddenly found themselves possessed of huge fortunes and by 1875 James Lick, a fairly old man, found himself possessed of millions of dollars and did not know what to do with them. At one time he thought that he would invest his fortune in making a large bronze statue of himself and his wife, overlooking the Sanfrancisco Bay after the manner of the classical Colossus of Rhodes. But he had joined a club of learned men some of whom came to know of this project and wanted to dissuade him from it. But James Lick had a mind of his own and he changed his opinion only when somebody pointed out that the projected statue would be at a very exposed place and that the Russians might come some day and bombard it to atoms. Somehow he was persuaded to the idea that a large telescope would be the proper thing to invest his millions in. He got a number of advisors and formed a project which after a good deal of vicissitudes grew into the Lick Observatory. The total donation to the Observatory was about 700,000 dollars but the benefaction was not sufficient to leave a surplus for the running expenses. This is generously met by the University of California.

Edward Singleton Holden, then director of the Washburn Observatory of the University of Wisconsin, was appointed the first Director of the Lick Observatory, at the recommendation of Simon Newcomb, whose assistant he had been at the U. S. Nautical Almanac Office. He resigned in 1897, retiring to private life, and was succeeded by his pupil, James Edward Keeler. The next director of the Observatory was W. W. Campbell, best-known for his application of the spectrograph to the study of stellar motions, a field in which he was a pioneer. R. G. Aitken, well-known for his work on double stars, followed Aitken as director, retiring in 1935, when he was succeeded by Wright.

A word about the splendid scientific work carried out by the Lick Observatory. We all know that of the nine satellites of Jupiter four were known to Galileo; and four more were discovered here. The discovery of about 4,000 visual double stars and 400 spectroscopic binaries also goes to the credit of the Lick Observatory. Amongst its other achievements, we may mention the exact measurements of celestial spectra by Keeler, the epochal observations of double stars by Burnham, and the discovery of the dense companion to Procyon whose existence was suspected by Bessel some 75 years earlier, and of 33 comets. Besides, the members of the staff of the Lick Observatory have participated in many eclipse expeditions. A party was sent to India to observe the eclipse of January 22, 1898 and it was then that the moving-plate technique of Campbell was introduced.

A Geologist in Russia

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It is necessary to say that many of us went to the U.S.S.R. in connection with the International Geological Congress frankly sceptical of all the claims we read about the Russian Geologists, and some of us maintained a polite disbelief of these claims until they were demonstrated during actual field studies and other visits. The most convincing proof to me, after finding the Soviet geologists to be as thoroughly keen and efficient as the best among ourselves, was their complete self satisfaction. There was clearly close scrutiny among themselves of each other's work, and it was evident that no serious error of judgment or faulty deduction, on a fundamental matter, could escape notice. Their efficiency had gained for them the complete confidence of the Soviet Government, who have made great demands for supplies of mineral raw materials and had so far obtained their requirements by the usefulness of their Geological Survey.

As regards travel details, the Soviet frontier formalities are now well-known. Every bag and box is literally emptied, every handkerchief is shaken out, every book is scrutinized and newspapers usually confiscated, and then after this exhausting business they seem to forget to collect revenue on obviously dutiable articles as tobacco and brandy. By this stage the language difficulty has probably induced friendliness and you may be conducted to your train by a porter who will certainly refuse a clumsily tendered tip. It is true that it is not possible to buy, in the U.S.S.R., a first class railway ticket for travel on European railways outside the Soviet Union. This shows that there is some difference, but the Russian first class or tourist class is quite as comfortable as one desires in the conditions previling in the U.S.S.R. The same remarks apply to hotel accommodation except perhaps in the newest Moscow Hotel in the capital, which is very good. The greatest trial is the delay over meals in any hotel, until experience teaches the tourist to go to meals at off hours or to a table where the waiter values a tactfully placed tip—yes, even 50 kopeks which represent half a rouble. The present exchange is roughly 25 roubles to the £ or say a rouble equal to -/9/- annas, but in buying Russian beer at 3½ roubles or Russian cigarettes at 6 roubles for 50 we found the value of the rouble nearer 4*d*., and so, expensive.

According to the Soviet constitution every citizen is entitled to work and is paid according to ability, skill and responsibility. They have a Rest Day after every five days' work when they work roughly 8 hours a day. They are entitled to full pay leave, to free medical attendance, to free education for their children, and to old age pension besides other allowances. In the Hammer and Sickle Steel Works near Moscow where an annual output of 250,000 tons of steel products—sheets, bars, rods and wire—is maintained, the unskilled workmen get 200 to 400 roubles a month, the furnace foremen may earn 1,000 roubles a month, the metallurgical chemist as much as 3,000 roubles a month, and the general manager has a salary of 2,000 roubles plus a bonus on output. Women have equal rights with the men, which means of course that they have more. We saw women at work on rail-road ballasting and track work, as workers under-ground in coal mines, as tram conductors and drivers, operating machines in various types of works and invariably as clerks and accountants. All hotel and railway booking and enquiry offices are staffed with women, and almost without exception the guides and interpreters on sight-seeing tours are neatly dressed young ladies. When a particularly well-dressed lady was introduced to us we knew instinctively that we were about to be asked for our impression and opinions by the journalist of some important Soviet newspaper. Women of course take an active part in educational work and as investigators in scientific research, but

we were surprised to find several women on the Russian Geological Survey who carried out the arduous duties of field work and welcomed our scrutiny of their maps and deductions. Home life, as we know it, is fast disappearing as the tendency is to live in rooms or suites and have meals in restaurants and hotels. I was very astonished at the almost entire absence of dogs in Moscow and most of the cities we visited.

From a metallurgical point of view the new steel works at Magnitogorsk in the South Urals and Kuznetsk in Siberia have pride of place. They are over 1,000 miles apart and each is said to be more than twice as big as the Tata Works at Jamshedpur and to have been erected in a shorter period in wild and useless country. Instead of each work being a centre for the assembly of raw material—iron ore, coal and limestone—necessitating the return of empty wagons to the mines and quarries, these two great works are linked. Magnitogorsk has been erected near the iron ore mines while Kuznetsk is the coalfield so that the wagons taking coking coal to Magnitogorsk return to Kuznetsk with iron and thus haulage of empty wagons is avoided. Shortage of railway wagons and the extent of the Russian railway has made it essential for the Soviet Government to devise means of avoiding unnecessary rail haul. With this object in view it is becoming the practice in some colliery centres to convert large quantities of coal into gas and to pipe this gas to power stations which previously used coal. Thus large gas producers have been erected at Tula for the supply of gas for boiler firing and other purposes in Moscow nearly 100 miles away. There is thus not only a saving in the haulage of raw coal but in the avoidance of smoke in the city and the absence of any ash to handle in the power stations.

In the west Urals collieries have been opened at Kizel to work a coal not exceeding 12 feet thick, in strata tilted at a steep angle (30° to 40°), and averaging 21 per cent. ash with 5 per cent. sulphur. We would forget about such a coal almost anywhere in India, and yet it is being raised at 4,000 tons a day in a colliery which is equipped in a manner superior to anything seen in India. The coal is coked and the surplus gases used for boiler firing in a great central electrical station which supplies electricity to the colliery and the villages round and for the electrification of the railway for 400 miles. The high sulphur coke, which is useless for iron ore smelting, is utilized in an adjacent area for copper ore smelting.

The Soviet claim that reserves of copper ore estimated to contain 17 million tons of metallic copper, roughly 16 per cent. of the world total, have been established in Russia, is still considered as 'not proven' I was not able to visit the Kounrad deposits in Kazakhstan, but it is certain that the large copper smelting works on Lake Balkash are to be supplied with the Kounrad ores and the production of metallic copper at these smelters is estimated at 100,000 tons a year at full capacity. On looking into details, however, I was astonished to discover that the Kounrad ores averaged under 1.5 per cent. of copper, which is appreciably below the famous low grade copper ores of Chuquicamata in Chili which average over 2.0 per cent. copper and has the finest smelting works in South America. Our Indian copper ores of Singhbhum normally contain over 3.0 per cent. of copper although somewhat inferior ores are treated by the skill of the present management. I was given to understand that the Soviet metallurgists aimed at treating sulphide copper ores with as low as 0.75 per cent. copper.

A Russian claim which I am pleased to confirm was that of producing commercial quantities of oil from strata of Palaeozoic Age—a subject somewhat painful to those engaged in the search for oil in England. At the Sterlitamak-Ishimbaevo oilfield in Bashkiria the annual production of oil from numerous deep wells was of the order of a million tons, and there was no doubt at all that the oil was coming from rocks not younger than the Lower Permian equal in age to the Lower Gondwana Coal of India. Further, the geology of the trans-Volga region showed that the same rocks were present further north, and borings had proved two areas, east and west of Perm, in the Kama basin, which were potential oilfields.

The potash salt deposits, estimated at 15,000 million tons of potash, in the Solikamsk area was to my mind the best example of Soviet geological and mining enterprise. They claimed deposits of potash salt greater than those of Stassfurt in Germany and, backed by the Soviet Government,

were producing over 1,500,000 tons of potash a year. The equipment of these mines, which we descended, is absolutely up-to-date and includes an underground workshop for all repairs. The shaft is equipped with two winding engines one for hoisting skips and the other operating double-decked cages from a depth of 750 feet and raising 5,000 tons of potash salts daily.

There is to my mind no finer example of scientific skill, supported by State funds, than the development of the Russian aluminium industry. Aluminium ore had been found at Tikhvin in 1883 and re-discovered in 1916, but when carefully examined in 1925 this bauxite was considered unattractive for aluminium production. However, when the Volkhov hydro-electric station was opened in 1926 the Soviet chemists set to work to discover a means of utilizing the Tikhvin bauxite and devised a commercial process by 1929. Meanwhile the Soviet geologists had found rich alunite deposits in Azerbaijan in the Caucasus, and immense quantities of phonolite in the Khibin of the Kola Peninsula. Means were also devised for preparing alumina from these raw materials, and special success attended the recovery of alumina from the phonolite. The Soviet Government sanctioned an aluminium works at Volkhov in 1929 and when this was completed and produced 800 tons of aluminium in 1932, another large aluminium works was begun at Dneipropetrovsk near the huge hydro-electric station. Those who know the complicated details of bauxite purification and the metallurgy of aluminium will know what I mean when I say the Russian aluminium industry was based on abnormal lines and was consequently economically unsound. However the production of aluminium had risen to 4,000 tons in 1933 and the Soviet chemists had secured an enormous experience in establishing a domestic aluminium industry. Then suddenly in 1933 good bauxite was discovered in the Urals in sufficient quantities to be workable on a large scale. A new reduction works was immediately begun at Kamensk near Sverdlovsk and was to have been operating at the close of 1937. The production of aluminium from the two older works had meanwhile risen as follows:—14,000 tons in 1934, 24,000 tons in 1935, and 36,000 tons in 1936. It is estimated that 72,000 tons will be produced in 1938 when the Kamensk plant is working. A fourth plant is now under construction in the north and there is little doubt that the Russian aluminium industry will shortly lead the world.

It seemed wonderful that the present great Soviet organisation for geological surveys and mineral developement has grown from the old Russian Geological Survey, which in 1913 had a cadre of 30 geologists and a budget grant of about 4 lakhs of rupees and was considered as a sort of scientific luxury. It is not too much to say that the existing Geological Survey of the Soviet Government is by far the biggest organisation of its kind and holds an unique position among similar institutions in other countries. Elaborately staffed and equipped, abundantly furnished with means, and loaded with heavy responsibilities the Russian Geological Survey has the complete confidence of the Soviet Government. Its Central Geological Administration has been made responsible for all geological work—research and surveys, as well as prospecting, development and working of mineral deposits throughout the U.S.S.R. In addition to the normal duties of advising the Soviet engineers in regard to the selection of new railway routes, canals, building sites, proposed tunnels and the foundations of dams, the Soviet geologist is consulted on all problems of road and building stone, cement making materials, and brick clays. Questions of underground water and surface water supplies, both for town supplies and for irrigation purposes, are specially referred to him, as well as other irrigation problems relating to soils and silt. Unless the Soviet geologists had abundantly proved their usefulness to a Government, who seem bent on developing their mineral resources so as to dispense with imports of such materials, they could not have been expanded and financed as they have been. They have, to some extent, been fortunate in that the mineral production has been entirely under State control for State purposes, so that no commercial competition of a serious nature has existed. However, notwithstanding some uneconomical features, the geologist in Russia has proved that the successful Soviet industrialization, which we saw, could not have been carried out within so short a time as 20 years without a properly equipped Geological Survey.

Clove Industry in India

THE Zanzibar Government, in June 1934, passed a Clove (Purchase and Exportation) Decree and organised an association called the "Clove Growers' Association" with wide powers of interference with free trade in cloves. This Decree practically resulted in squeezing out indian merchants from lawful pursuits in the Zanzibar Protectorate, and it formed the subject of much comment and criticism both in India and in Zanzibar. Organised boycott of Zanzibar cloves was carried out in India on a wide scale. The Government of India took up a sympathetic attitude towards the cause of the Zanzibar Indians. The Zanzibar Government had ultimately to yield to the Indian clove traders in respect of about 50% of their demands. It appears however that the Zanzibar Administration is more anxious to protect the interest of the Clove Growers' Association than the legitimate interests of the trade and of the Indian traders. It is therefore, in the fitness of things that attempts should be made to grow this commodity on Indian soil not only to secure the proper recognition of the rights of the Indian traders in the world's clove market, but also to make this country independent of foreign supply.

In May 1937, the Imperial Council of Agricultural Research accordingly started an inquiry on the present state of clove cultivation in India. Mr. A. K. Yagna Narayan Aiyer, retired Director of Agriculture, Mysore, was appointed special investigating officer for this purpose for a period of six months. He inspected as many clove growing localities in Southern India and in Ceylon as possible with particular reference to the conditions of soil and climate and the general features of the cultivation, growth conditions, yields, diseases etc. Also, through the help of available published literature and from information gathered through correspondence, he collected considerable data on the conditions of cultivation in other clove-growing countries, notably in the Zanzibar Protectorate and in Madagascar. The report of this investigation has recently been published by the I. C. A. R. (*Miscellaneous Bulletin No. 20*). The report describes in detail the various factors which lead to a good yield of clove in different parts of the globe; and Mr Aiyer expresses the view that the growth of clove trees in Nilgris, Tinnevally and Travancore States have the same general characteristics as elsewhere.

Clove trees are found to flourish within the tropical zone between the Tropic of Cancer and the Tropic of Capricon. So far as India is concerned, the whole of Southern India falls well within this geographical belt. The most serious difficulty for the proper growth and fruiting of clove trees under Indian conditions seems to be that although the total annual rainfall in these tracts will more than satisfy the requirements of the trees, the monthly distribution is not by any means satisfactory. Mr Aiyer points out however that "with suitable shade and, if at all possible, with some arrangement for some hand-watering of the young seedlings, the first two years can be weathered successfully. Indeed with suitable methods of plantations, we may, without undue optimism, expect to bring into existence some five lakhs of trees in the course of the next fifteen years".

The clove industry suffers seriously from the handicap that very little is known regarding the striking differences which are often observed as regards the bearing capacity of trees. The ordinary yields of eight to ten pounds of dry cloves per tree are often largely exceeded. Yields of fifty or sixty pounds per tree are not rare, and there is even a record of the phenomenal yield of 250 lbs. per tree. An accurate scientific study of these high yielding varieties is immediately necessary. The soil and moisture conditions which favour such high yields need also careful investigation.

Then again, the quality of cloves is regulated by the traditional opinion of the trade where colour, shape and size are the deciding factors. Zanzibar

CLOVE INDUSTRY IN INDIA

quality with a clove-oil content of 17% sells at Rs. 8'17 per 25 lbs. while the first grade Penang quality with an oil content of 13.7% fetches a price of Rs. 20/- per 25 lbs. The oil content is therefore no indication of the quality as judged by the trade. If clove plantations were to be successfully extended in India, the planters should have accurate knowledge of the standards according to which the quality of their produce will be judged. The marketing section of the Imperial Council of Agricultural Research should be in a position to render necessary help in the matter.

Mr Aiyer has rightly laid stress on setting up of co-operative planting experiments to be located in Madras, Travancore and Mysore which may be carried out by the Directors of Agriculture of these places with the Imperial Council of Agriculture Research as the co-ordinating agency.

Clove has been known in India from ancient times as a spice and a medicinal article and its cultivation in many parts of southern India is even now not extinct. In competition with cofee and tea however, these plantations have been sadly neglected. Clove is in indespensable article of consumption in India and the home consumption is rapidly increasing. Every effort should therefore be made to extend its cultivation and to make India self-supporting so far as this article is concerned. The quantity of clove consumed in India amounted on an average, to 73,500 cwts. per year during the last ten years.

The number of bearing trees required to produce this amount can be reckoned at about 9½ lakhs. This number is not so large as it may look, because if we suppose that they are raised as pure plantations, only the thousand acres of suitable land will be necessary. How small, from the point of extent this is, can be realised when one looks into the acreages of the various plantation crops such as tea, coffee, and rubber. The question whether the clove can be grown in India on a profitable basis has been answered in this report in an emphatic affirmative; and it now remains for the public and the Departments of Agriculture in Southern India to bring the schemes of clove cultivation to fruition.

Riddle of Plant Growth Substances

Dr William C. Cooper of the United States Department of Agriculture reports a series of experiments which throw new light on the process of increased growth of plants treated with plant hormones. He indicates that the real root forming substances are already in the plant and not in the treatment.

Several chemicals are known to promote rooting. Cooper used indole-3-acetic acid, one of the first chemicals identified as a growth substance. He treated lemon cuttings—soaking the base of each cutting in a solution of the chemical—planted part of them, and got the anticipated response—more and stronger roots than from untreated cuttings. Part of his cuttings he did not plant. Instead he cut off the treated base sections and again treated the shortened cuttings. The second treatment did not stimulate nearly so much root formation as the first treatment.

Doctor Cooper says that the probable explanation of these conflicting results is that the chemical treatment causes the downward transport of naturally-occurring root-forming substances which are already in the plant and which are necessary for root formation. For convenience in the discussion of these substances, they have been named rhizocaline.

Cooper's experiments with various other plants indicate that plants which do not root readily when treated—delicious apple cuttings, for example—are lacking in rhizocaline. The chemical nature of rhizocaline has not been discovered.

—*Science Digest.*

NOTES AND NEWS

On the Script of Mohenjo-daro

In an article on the "Numeral Signs" of the Mohenjo-daro script published as a memoir of the Archaeological Survey of India, Prof. S. C. Ross, of the Leeds University, has made a study of the monograph of all the so-called numeral signs, which consist of a group of short and long strokes numbering from one to twelve. An analysis has been made by him also of the sign combinations. According to a newly accepted method for the analysis of sign combinations in undeciphered scripts, the so-called numerals, it is shown, may not have stood for actual numbers, but most probably indicated a syllable of the spoken numeral of the base language used at Mohenjo-daro. The suggestion is accordingly made that in the language of Mohenjo-daro, numbers were perhaps expressed somewhat in the same way as in English in that the decimal system was used and a simple compounded word for each of the numbers from "one" to "ten" as also a specific word for twelve (like dozen) existed. The general character and particularly the numerals of the alternative families of languages, such as the Dravidian, Munda or Burushaki, etc., have also been examined, and the conclusion is reached that the actual character of the signs in Mohenjo-daro agrees with the hypotheses that the language was an old form of the Indonesian family, which now includes Malay and Javanese, etc. The idea that script might have been Indoaryan is considered as entirely out of the question.

Recent Advances in South African Pre-history

Twenty years ago very little was known about African pre-history. The researches of the last two decades, however have revealed, to some extent, the story of man's past in this continent "though even to-day much of the continent is still unexplored. We have learnt enough to realize that this great land-mass has played an important part in the story of the human race, and indeed, has had its effects upon ancient Europe," writes Prof. A. J. H. Goodwin, of the University of Cape Town, who excavated the Oakhurst rock-shelter, near George, in Southernmost Africa, in an interesting article on "Recent Advances in South African Pre-history" in SCIENTIA 1-6-1938. Recently considerable advance has been made of in our knowledge of prehistoric Africa in all the three major periods, *i.e.*, the Earlier, the Middle and Later Stone Ages. First, both in importance and in tune, is the recent survey of the Vaal River gravels undertaken by the Bureau of Archaeology. Second, is the discovery of a Neanderthaloid skull at Florisbad in the centre of the Orange Free State, by Prof. T. F. Dreyer. Finally, there are the author's own excavations at the Oakhurst rock-shelter. These three factors constitute the major advancements in our knowledge of South African prehistory during the past few years. In his article two important material facts contrasting with European conditions, have been brought out. These are the absence of glacial phenomena, and the lack of flint over the greater part of Africa.

Practice of Pharmacy in India

Pharmacy is essentially a system of public service. The state of pharmacy, however, in India can only be described as chaotic. "If the present needs of the country in the matter of an efficient public health service are to be adequately met and if the tremendous undeveloped drug resources of the country are to be utilized, it is essential that the training of the pharmacists should be improved. Secondly, it is important that a correct conception of the nature of the profession and its functions and importance should be appreciated by the public. For this purpose an active educational propaganda has to be carried out." Thus observed Bt-Col. R. N. Chopra, I.M.S., presiding

over the third annual session of the Bengal Pharmaceutical Association at Calcutta. He next referred to the appointment of the Drugs Enquiry Committee which suggested in its report the enactment of a legislation to control both the adulteration of drugs and to organize and superintend the training of persons who practise pharmacy. In these directions the Bengal Pharmaceutical Association has been doing useful work since its foundation about three years ago. But it is regrettable that since April 1931, when the report by the Drugs Enquiry Committee was submitted, no progress as outlined by the Committee has been found to be possible by the Government of India excepting that an imperfect piece of legislation under the name of "Import of Drugs Bill" was introduced in the Central Legislative Assembly which went to the Select Committee stage in October last, 1937. This Select Committee was later adjourned *sine die* after expressing that the proposed bill be substituted by a more comprehensive legislation on the recommendation of the Drugs Enquiry Committee. The only work that stands to the credit of the Central Government in this direction is the establishment of a nucleus of a Central Drugs Control Laboratory in the creation of the Biochemical Standardization Laboratory at the All-India Institute of Hygiene and Public Health which also began its work so late as in 1937. But unless suitable legislation is in force the work at this laboratory will be of no practical use.

British Admiralty Research Ship

Under the superintendence of Sir Stanley Goodall, Director of Naval Construction, the Royal Research Ship *Research* is under construction for the admiralty by Messrs Philip & Son Limited at Sand Quay, Dartmouth. The ship is meant for investigations into terrestrial magnetism and atmospheric electricity in different ocean areas. This work was carried out till 1929 by the American Research Yacht *Carnegie* upto the time of her loss by fire.

The *Research* would be 142 ft. 6 in., in length on the water line, breadth 34 ft., maximum draught 13 ft. 2. in., and loaded displacement 770 tons. It will mainly work under sail. On account of the nature of work for which she has been designed and the delicate instruments which she will carry on board, the use of magnetic material has been avoided as far as possible. The hull of the ship is of teak plank on brass frame, copper sheathing is fitted throughout and 80 tons of lead has been used as ballast, anchors, cables, wire-rigging are of aluminium bronze and drinking water tanks are of teak-wood. The Diesel Engine which is to be used as the propelling machinery is practically designed to be made out of bronze alloy and the crank shaft is of non-magnetic steel. There would be dynamos, refrigerators, air compressor, fitted up for different purposes and each one is of special design. Even the ship's typewriter and the nails in the packing cases are non-magnetic. The ship would have a complement of 6 officers and 22 crews and staff of 4 scientific observers. The vessel is expected to be launched in February 1939. She will proceed first to the Carnegie Institute, Washington and then to South America and will make a circuit of the Indian Ocean and return back to home waters in 1940.

The ship is to demonstrate the essential truth of the aphorism that "science knows no frontiers" even by the British admiralty with her complement of dreadnaughts and submarines.

What should be your Radio Set?

It is sometimes believed by the radio subscriber that the value of a radio set depends on the number of valves in it. It is total sensitivity and quality of reproduction that matters not the valves. Mr F. C. Ramsell, speaking at the Calcutta Rotary Club on September 6, 1938, advised the radio set buyer with a limited sum of money to spend, to purchase a plain set, *i.e.*, one which had no subsidiary circuits and one which used its four or five valves solely for the purpose of signal amplification.

As for the person who had a fair amount of money to spend on a radio set, he advised him to make sure whether he considered high fidelity reproduction or long-distance reception of paramount importance. If it was high fidelity, the set should have a large loud speaker, and it should be fitted with a push-pull arrangement of output valves. If it was long-distance reception which was required, then the set should possess two stages of I. F. amplification, even if high fidelity circuits had to be sacrificed.

Proceeding, Mr Ramsell said that if the owner of a radio set wanted good reception—as free as possible from interference caused by fans, refrigerators,

motor-cars, trams, etc., it was imperative that the aerial should be erected at least 30 feet above all possible sources of radiation of the unwanted noises. It should also be at right angles to the chief source of interference, and, having once got the aerial reasonably clear of man-made statics, it was equally imperative that no unwanted impulses be picked up on the down-lead (which conveys the signal from the aerial to the set). This, he said, could only be accomplished by using a shielded wire, or the hoisted flex of Dipole aerial. Regarding interferences caused by nature, such as electrical storms, there was little which could be done to eliminate them. Many systems had been invented but none had been able to entirely eliminate these noises.

The New Vice-Chancellor of the Calcutta University

The Hon'ble Mr Azizul Haque, at present President of the Bengal Legislative Assembly, and formerly Education Minister, has been appointed Vice-Chancellor of the Calcutta University in place of Mr Syama Prosad Mookerjee, whose term expired on the 22nd August last. He possesses wide experience in educational matters of this Province, and, as such, is eminently fitted for his new responsibilities. We hope and trust that under his able guidance the University of Calcutta will continue to progress in every sphere of its activities as during the regime of his predecessor. It is quite in the fitness of things that the University has conferred on Mr Mookerjee the degree of Doctor of Literature *honoris causa* as a mark of the appreciation of the good work done by him during the four years of his administration.

The Death of Prof. J. R. Banerjee

The death occurred at Calcutta of Prof. J. R. Banerjee on September 6, 1938. He was a prominent figure in the educational circle of Calcutta and an educationist of note. He was the Principal of the Vidyasagar College, Calcutta, for 1924-34. Prof. Banerjee was intimately connected with the Calcutta University for over a quarter of a century, having been a member of its Senate and Syndicate from 1911 to February 1938. He was Dean of the Faculty of Arts for two years and connected with various boards of studies of the University.

The Study of Nutrition in India

The need for proper dietary surveys in the different parts of India has been stressed several times in these columns. Some surveys are under way, and details of diet surveys carried out by the Nutrition Advisory Committee in Mysore, Travancore and Kashmir States, Assam and several other parts of India where the work is still in progress are now available. We all know how important these investigations are for defining the problem of nutrition in this country, for they clearly demonstrate the deficiencies of typical Indian diets. The relation between signs of deficiency disease and certain indices based on body measurements has been extensively studied; such work is expected to lead to fundamental knowledge about changes in body structure resulting from malnutrition, and it is hoped to evolve a simple method of detecting malnutrition based on these body measurements, which can be used to study the incidence of malnutrition in groups of school children. The effect of skimmed milk in accelerating growth and improving the general condition having been demonstrated by experiments in boarding schools, similar investigations were extended to groups of poor day-school children.

Education and Administration

Mr John Sargent, Educational Commissioner designate to the Government of India, presided over the Educational Science section of the British Association meeting at Cambridge. He has been Director of Education at Essex and, has served for a long time with local administrative bodies. His presidential address bears testimony to his intimate knowledge of the complex relation between local self-governing bodies and educational organization in England. Mr Sargent apparently is in love with the British system. Though he will be confronted with a wider area with a far more complex relation between Central, Provincial and local adminstrative bodies on the one hand and different cadres of educational institutions on the other, we hope Mr Sargent will bring to bear on the educational problems of the country the catholicity and vision which inspires his address, extracts from which are given elsewhere in this issue.

Indian Science Congress Association, Silver Jubilee Session

The report by the local Secretaries and the audited accounts of the last Silver Jubilee Session of the Indian

Science Congress Association present a very bright picture of the co-operation in various ways, particularly in the form of donations and of the hospitality offered to the delegates, received from the citizens of Calcutta and public bodies including a large number of commercial and industrial organizations. Their assistance contributed to the splendid success of this important session. The total grant of the Calcutta University in connection with the celebrations is Rs 15,000/- including Rs 2,500/- to the local reception committee. Besides this, the various educational institutions of the city largely helped in one way or other in attending to the various details of the programme. The total expenditure was Rs. 25,376 and odd. It is interesting to note that the number of members registered in the Association was 2,458 of which more than 2,200 attended; whereas only 739 were present at the 22nd Session at Calcutta in 1935.

Royal Institute of Science, Bombay

The Royal Institute of Science of Bombay has issued its third report for the period 1934-1937. It may be recalled that the Institute commenced teaching work in 1920 for undergraduate and post-graduate classes. But from June, 1937 the undergraduate classes have been removed to Elphinstone College where languages are also taught. The cost of education per head was on the average per year Rs. 680 of which Rs. 260 were met by the Government of Bombay. The annual expenditure per year was near about Rs. 1,95,000. The staff of the Institute has 159 notes and papers to its credit for the period under review, chemistry leading with 102 papers. The abstract of these are appended in the report. A very interesting chart is included which shows that 36·4% of the alumni are college teachers and 21·8% are in science posts in industries. Those employed in Research Institute and the research scholars make a total of 5·4%. It is significant that pure research work is being done by 0·6% and those studying abroad (the majority of whom aspire for covetable easy jobs) amount to 6·7%. These figures are made from a total of 165 students who were in the post-graduate departments during 1925-37. The report rightly points out that quality of research work is suffering because the batch of research workers mentioned above are either preparing or waiting for jobs to not-very-suitable grade of which they surrender and if necessary may also refund the money. We may add such a situation prevails all over this country.

Are the Jews Unproductive?

Man is defined as 'a rational animal', his distinctive characteristic being rationality. It is this quality that has made him the most powerful living being. He has conquered the forces of nature and harnessed them for his multifarious use. He has mastered science, which has given great power.

But man has also evolved a system of ethics. He has perhaps built it up for his own convenience and comfort, for he wants to keep up the Society in which he has constantly to move. He needs a well-ordered Society for the satisfaction of his primary instincts of sex, hunger, and group-associations.

But ethics itself has got to be rational and its study must at all costs tally with the dictates of reason. The ethical principles must be rational and stand the searching test of ordered reasoning. The result is that man has gradually cultivated a scientific outlook.

It is therefore sometimes highly puzzling to find men preaching and holding opinions apparently against reason. There are men obsessed so much with hatred that they are guided more by the dictates of the heart than by those of the head. Psychologists will perhaps explain this obsession as a 'complex'.

We do not know how the Jew-complex of Herr Hitler can be explained. Psychoanalysis will no doubt reveal it. But is not psychoanalysis the production of the brain of Freud who is a Jew, and is therefore, as declared by the Fuhrer at Nürenberg, unproductive? The opinion of the Nazi Leader cannot be loose talk, pronounced in the heat of a moment, but is the result of careful thinking and deliberation. But the literature describing the new Hitlerian theory have not given any cogent reasons to support so original a thesis. This gives rise to serious doubts about the validity of the proposition. For, let us consider Freud, Ehrlich, Einstein, Haber, Meyerhoff, Warburg, Wasserman, Hertz and a host of other famous names in their respective fields of knowledge. Are they, then, to be henceforth called unproductive, since Herr Hitler has declared them to be so? The declaration is preposterous and appears to be the outcome of a brain suffering from the Jewish complex.

SCIENCE IN INDUSTRY

India's Industrial Future

Though it is admitted on all hands that progressive industrialization will mean for this country a rising standard of living and afford enlarged opportunities to the people, doubts are often expressed as to the possibility of industrialization solving the unemployment problem. We agree fully with Mr N. R. Sarker, Finance Minister, Bengal (in his address on the prospects of industrialization in India, delivered at Gwalior) that the maximum amount of industrialization will not of itself solve the problem. It would no doubt relieve economic distress of the rural population as much by enlarging opportunities for employment as by stimulating demands for raw materials for the industries. Much also depends on the growth of population on the one hand and the development of national resources on the other. According to Mr Sarkar, therefore, "India's policy of industrialization should thus be determined on the basis of the requirements of her own economic order. In certain details, India may initiate and adopt with profit the industrial methods and technique of other countries. But the main objective of our policy should be a broad-based and remunerative agriculture succured by flourishing cottage industries and further sustained by the development of larger industries."

During the last twenty-five years, however, the world has witnessed with disbelief and suspicion the great economic drama enacted on the soil of Russia. In the days of the Czar, the conditions, material and social, were very much the same as we find in India to-day. Nobody could then believe that the problem of Russia's poverty and unemployment could be solved by industrialization alone. But to-day we find that the whole outlook has changed. A new era has been ushered into the land. Industrialization alone has completely eradicated unemployment. That is not because the rate of population has gone down since the days of the Czar—but because Soviet Russia has known how to adjust itself to the sudden increase in population. France, Germany, Italy, Japan, Great Britain, Holland—all these countries have each a greater a density of population than India. She is also far richer than any of these in the matter of her natural resources. She possesses, perhaps in excess, latent national wealth which if properly tapped and developed should meet the demands of her whole population and more besides. Efforts must therefore be made to utilize fully the resources of the land, to strengthen man power, and raise social, health and economic standards through the advancement and application of science. This is unlikely to achieve so long as capitalism continues in its present form at least.

Gold-Plated Glass

To the credit of Prof. Charles S. Gibson goes the discovery of what is described as a new and easy method of depositing film of pure gold on glass or other surfaces. The examples of his work were recently included among the exhibits in the South African Court of the Imperial Institute, South Kensington, England. According to Prof. Gibson, brilliant films, the heaviest of which is only 0·0004 mm. thick have been deposited chemically on suitably prepared surfaces. By reflected light they appear as massive gold, and by transmitted light show the beautiful greenish-blue colour characteristic of thin gold films. They are capable of being polished, but can be produced in such a manner as to render this unnecessary. The thickness can be varied by altering the condition of the reaction and the conditions of the reactants. Pure gold films are actually more easily produced than those silver, and chemically they are much more inert." The process discovered by Prof. Gibson is said to have considerable scientific value, besides the point of view of luxury.

Storing Eggs

The new vacuum-carbon dioxide oil treatment to keep eggs fresh in storage has been applied on a commercial scale and found to be much superior to other commercial methods of shell treatment. A carload of eggs was stored six months in New York City. Sixty-five per cent of the eggs oiled by the new vacuum-carbon dioxide method went into storage as U. S. Extras, and 68 per cent. came out still in the same grade. But of the eggs oiled by the ordinary dip method, 73 per cent went into storage as U. S. Extras and only 39 per cent came out in that grade of the untreated controls, 77 per cent went in and 10 per cent came out as U. S. Extras.

The eggs are placed in a Vacuum Chamber which draws the air out of them. Then they are dipped in a tasteless, odourless mineral oil in the chamber and placed in carbon dioxide. The eggs automatically pull some of the carbon dioxide saturated oil into the pores of their shells—*Science Digest.*

Industrial Article for October

'Power Alcohol' by Dr N. G. Chatterjee, D.Sc. of the Harcourt Butler Institute, forms the industrial article of this issue of our journal.

Power Alcohol

N. G. Chatterjee
Harcourt Butler Technological Institute, Cawnpore.

In this paper, I propose to confine myself to the possibilities in the United Provinces of generating power by the use of alcohol fuel.

In the absence of indigenous supplies of coal or petroleum within these provinces, it is but natural that greatest attention should be paid to ethyl alcohol, as it is the only alternative fuel, the supplies of which can be drawn from recurrent vegetable sources instead of the nature's fixed capital of mineral wealth. The rapid development of the internal combustion engine as generators of power in motor cars, tractors, and stationary engines of small and medium power, is leading to an ever-increasing demand for a volatile liquid fuel, which is at present being almost wholly met by imported petroleum, entailing huge drainage of national wealth. We have therefore to enquire, on the one hand, into the possibilities of finding prolific and cheap indigenous sources of alcohol, and on the other hand, into the suitability of alcohol as a motor fuel.

***Sources of Alcohol*—On account of the rapid growth of the sugar industry in these provinces, there is now a large surplus of molasses, the disposal of which is an acute problem. Molasses is an ideal raw material for the manufacture of alcohol, so that in it we have an abundant supply of cheap raw material, distributed all over the province. It is estimated that in the United Provinces, about 200,000 tons of surplus molasses would be available per annum, at a price not exceeding annas -/4/- per maund. Indeed our information is that the average price received by the sugar factories for molasses during last year was only about Rs. 0-1-2 per maund. Assuming that one ton of molasses would produce 60 gallons of alcohol, it would be seen that in surplus molasses we have a potential indigenous source of supply of about 12,000,000 gallons of alcohol.**

***Comparison of Alcohol and Petrol*—The main points in which alcohol differs from petrol as a fuel may be summarised as follows:—**

(1) The vapour pressure of alcohol at low temperatures is lower than that of petrol. In consequence of this the alcohol motor is more difficult to start. This can easily be remedied in different ways.

(2) Alcohol takes longer to burn to explosion than petrol; hence the alcohol-motor should have a higher compression and a longer stroke than the petrol engine.

(3) The mixture of alcohol vapour and air can safely be subjected to a pressure of 200 atmospheres, whereas the safety limit for petrol is 80 atmospheres.

(4) Mixtures of alcohol vapour and air have a wider explosive range than is the case with petrol. This permits of greater latitude in the air supply.

(5) Alcohol vapour requires less air for its combustion than petrol vapour; hence there results more thorough mixing in the case of alcohol and consequently the combustion is more complete.

(6) The heat of combustion of alcohol is much lower than that of petrol. But this disadvantage may to some extent be compensated by the higher latent of alcohol, and the larger increase in specific volume of the products of combustion, so that a mixed petrol-alcohol fuel in certain proportions may actually show a slightly better efficiency than straight petrol.

Alcohol Fuels—These may be divided into two classes:—

(1) Hydro-carbon fuels containing alcohol.

(2) Straight alcohol.

Of these, the first type has received most attention and large quantities of such mixed fuels are being used in almost every country in the world for driving motor cars in place of pure petrol. It is now established beyond dispute that a mixed fuel consisting of petrol containing absolute alcohol to the maximum extent of 25% is just as good a motor fuel as straight petrol. Indeed certain distinct advantages are also claimed for such types of petrol-alcohol mixed fuels.

This subject has of late been widely discussed in this country, so that it would suffice to say that such petrol-alcohol mixed fuels can be indiscriminately used with entire satisfaction in place of petrol in all kinds of motor cars, without feeling the necessity of making any alteration in the engine or even the carburettor.

The behaviour of petrol-alcohol mixed fuels in engines designed for petrol when the proportion of alcohol is increased is summarised below:—

(*i*) Mixtures containing 0 to 15% of alcohol behave practically the same as pure petrol and in use do not require any change in the carburettor. The consumption of the fuel is of the same order. A more smooth running of the motor is noticed.

(*ii*) When the quantity of alcohol in the mixture is increased it is found that at about 20-25 per cent alcohol the working of the motor is always very smooth and in actual practice, a slight diminution in fuel consumption may be observed.

(*iii*) When the proportion of alcohol is raised to about 30-35% the mixture falls down again so far as fuel consumption is concerned, to the standard of petrol, or perhaps a slight increase in consumption may be noticed. The flexibility of the motor continues to be perfect, but a regulation of the carburettor and spark control becomes almost a necessity.

(*iv*) When the alcohol proportion is still further increased, it becomes absolutely necessary to modify the carburettor and the control, while the fuel consumption increase rapidly.

Strength of Alcohol and Fuel characteristics—

"Spirit of all strengths down to about 50% can be used for working internal combustion engines, assuming of course, that the latter have been properly adjusted. The fuel consumption increases, for a given compression ratio and load, with the water content of the spirit. The change however, is very small—an increase in strength from 80 to 90 per cent spirit brings about only an insignificant increase in the power of the engine. With spirit of strength between 100 and 80 per cent, the consumption of fuel is directly proportional to the water content of the spirit. With 70% spirit it is difficult to keep the engine going. Spirit of 50% strength brings about the maximum decrease in power and the efficiency of the engine is very low. The maximum power is 72% more when using spirit of 94% strength. The presence

of water in spirit admits of an increase in the compression ratio without premature ignition."

Theoretical Aspects of Engine Performance with Petrol and Alcohol. (Lichty and Ziurys—*Ind. & Eng. Chemistry*, September 1926).

The results are summarised in the following table, for the four different sets of conditions:—

Condition I—Both fuels completely evaporated and at the same temperature, which requires much more heat input for the alcohol-air mixture.

Condition II—The gasoline completely evaporated and the alcohol 54 per cent evaporated, which requires the same heat inputs.

Condition III—Both fuels completely evaporated, but at the minimum mixture temperature in each case.

Condition IV—No evaporation or heating of either fuel-air mixture.

	Condition I.		Condition II.		Condition III.		Condition, IV.	
	Gasoline at 101°F	Alcohol at 101°F	Gasoline at 101°F	Alcohol at 55°F	Gasoline at 101°F	Alcohol at 71°F	Gasoline.	Alcohol.
(*a*) Heating value .	100.6	100.0	102.0	100.0	100.6	100.0	100.0	102.2
Relative charge density . .	..	..	..	12.3	..	5.6	..	..
Expansion of product .	..	0.8	..	0.8	..	0.8	..	0.8
Sp. Ht. of product .	2.2	..	2.2	..	2.2	..	2.2	..
(*b*) Result per cent.	102.8	100.8	104.2	113.2	102.8	106.4	102.2	103.0
Net increase per cent.	2.0	..	..	8.6	..	3.5	..	0.8
Heat supplied per cent.	100	284	100	100	100	234	None	None

(*a*) Per unit volume of correct mixture at any standard conditions, corrected for condition of fuel.
(*b*) Results are computed as follows:—
Column 1: (1.006×1.022) 100=102.8.
Column 4: (1.000×1.123×1.008) 100=113.2.

Practical Tests of Engines run on Alcohol.—The theoretical deductions mentioned above have been to a large extent fully confirmed by the results of the practical tests conducted from time to time by different investigators. The following may now be accepted as fully established:—

(1) Alcohol of strength 94-96%, may be used as fuel in ordinary engines designed for working on petrol, with minor changes in the carburettor and float. The consumption of fuel would be approximately 50% more than that with petrol.

(2) In engines specially designed for working with alcohol (increased compression). Higher power may be obtained, while the fuel consumption would be about 33% more than with petrol for the same power.

In general, therefore, it is seen that the petrol engine requires some modifications to suit it for alcohol fuel. It is important to observe that whereas the best condition of working with petrol as fuel are known very fully, the work on straight alcohol fuel is of a pioneer nature, and it is doubtful whether full justice has yet been done to alcohol.

Method of manufacture of alcohol.

Alcohol is manufactured by the rectification of the dilute solution obtained after the fermentation of sugar or starch bearing materials is complete. The usual strength of this fermented wash as it is generally called is about 6-8%. Due to certain peculiar properties of a solution of about 96 parts by volume of alcohol and

4 parts of water, this is the maximum strength of alcohol that can be obtained by straight rectification of the 'fermented wash.'

The manufacture of industrial alcohol is at present being carried out in all distilleries in India equipped with patent continuous stills. In fact, the alcohol as it comes out of these stills is what is known as 'rectified spirit' and the strength varies generally from 90% to 96% by volume. The subsequent manipulation of this spirit in warehouses by the addition of water, chemicals, or other substances, converts it into various froms of drinking spirit, 'methylated spirit,' or 'specially denatured spirit.'

Further dehydration of rectified spirit was till recently a matter of considerable difficulty, and the usual process of getting 'absolute alcohol' was by distillation with lime. This was a costly process and entailed considerable losses in working. But within the last fifteen years or so, at least two different processes have been developed and have met with considerable commercial success. These are commonly known as the azeotropic process and the salt dehydration process. The following table (*International Sugar Journal*, March 1938) gives the present annual production of absolute alcohol by these processes:—

World production of Absolute Alcohol (1937)

I. *Azeotropic process.*

	Hectrolitres
1 Hectrolitre=22 gallons	
(a) Melle system	5,250,000
(b) 'Drawinol' system	3,000,000
Total ..	8,250,000

II. *Salt-dehydration & other processes*

(a) Hiag system (alkali acetates)	3,975,000
(b) I. G. F. system (gypsum) ..	265,000
(c) Merck Pressure system (lime)	120,000
Total ..	4,360,000

Importance of Commercial dehydrated alcohol.—It may well be asked what was the necessity for the commercial manufacture of cheap dehydrated alcohol. The reason is that dehydrated alcohol has a much wider range of miscibility with petrol than rectified spirit, which was found to be unsuited for the preparation of alcohol-petrol mixtures, in the proportions in which the latter were found to be best as a motor-car fuel. Mixtures of rectified spirit with petrol tend to separate easily, and thus give rise to trouble. On the contrary, mixtures made with dehydrated alcohol and petrol have been found to be stable and perfectly satisfactory for all practical purposes.

It may be interesting to note that with the success achieved in the commercial manufacture of dehydrated alcohol, the world consumption of the latter for purposes of preparing mixed motor-car fuels has been rising rapidly as is shown by the following table for the two countries, France and Germany.

FRANCE.	GERMANY.
1931-32 .. 18,827,000 gals.	1931-32 .. 25,657,000 gals.
1932-33 .. 42,658,000 „	1932-33 .. 34,593,000 „
1933-34 .. 54,388,000 „	1933-34 .. 45,823,000 „
1934-35 .. 81,524,000 „	1934-35 .. 48,509,000 „
1935-36 .. 88,000,000 „ (probable figure)	

As dehydrated alcohol is now almost exclusively used for the generation of power and as recent researches have evolved processes so that now there is little difference between the cost of manufacture of dehydrated alcohol and rectified spirit, 'power alcohol' has now become almost synonymous with dehydrated alcohol. It seems, therefore, that for power purposes the use of denatured rectified spirit of about 96% strength is an anachronism and should be given up.

Cost of manufacture of power alcohol—A good deal of false cry seems to have been raised a few years ago on the question of cost of manufacture of power alcohol, but fortunately this has now practically died out.

This estimate was presumably based on the working of a distillery with a plant capacity of about 1,500 gallons per day. The writer however is convinced that in a distillery of sufficiently large capacity, the cost of production of power alcohol without the addition of any denaturant, would not exceed Rs. 0-4-6 per gallon, with molasses at -/4/- per maund delivered at the distillery. One of the most important factors to

bring about this reduction is the fact that within the last month an agreement has been reached by which the patentees of one of the most important processes for manufacturing power alcohol are to charge only a nominal sum for the use of their patent in place of about 5 pies per gallon which they at first wanted to charge.

Cost of generating power with alcohol fuel—In an ordinary engine designed for running on petrol, it has been found that the consumption of fuel when using alcohol of 96% strength, may be about 0.66 litre per B. H. P./hr.

The following results were obtained by Prof. Wawrzinick, in experimenting with 96% spirit and petrol in different makes of motor car engines. The engines were of the following make:—

	Power.	Compression Ratio.	Volume of the engine cylinder.
I. Daimler, Lorry motor	35 H.P.	4.0	5.5 litres.
II. Adler, Private car motor	10/30 H.P.	4.2	2.62 ,,
III. Elite, Private car motor	10/40 H.P.	5.5	3.14 ,,

The results are tabulated below:—

Engine.	Fuel.	Effective power developed. 500 r.p.m.	1000 r.p.m.	Average consumption of fuel. kg/H.P. hr.	Litre/H.P. hr.
I	(*i*) 96% spirit	17.4	27.1	0.517	0.630
	(*ii*) Petrol .	18.5	31.25	0.331	0.440
		800 r.p.m.	2000 r.p.m.		
II	(*i*) 96% spirit	10.80	24.40	0.645	0.789
	(*ii*) Petrol .	11.75	28.00	0.448	0.590
		900 r.p.m.	2000 r.p.m.		
III	(*i*) 96% spirit	14.2	37.60	0.512	0.626
	(*ii*) Petrol .	25.0 (1150 r.p.m.)	38.5	0.347	0.461

It would be seen that the engines experimented upon had comparatively low compression ratio. One would therefore reasonably expect that in a properly designed engine of high compression and using dehydrated alcohol denatured with say 6-8% of kerosene, the consumption of fuel per B.H.P./hr, be very nearly the same as with petrol in an ordinary petrol engine. In other words, we may safely assume that in the alcohol engine, the consumption of fuel may be reckoned at about 0.55 litre per B.H.P./hr. If the fuel is available at -/6/- per gallon, the cost of the fuel would be about 11.2 pies per kWH.; in other words, the overall cost of generating power in an alcohol engine may be within one anna per unit.

This compares quite favourably with the charges for hydro-electric energy in the U.P. In answer to a question in the Legislative Council, the spokesman for the Government is reported to have given the information that the total cost of providing each unit sold in the hydro-electric scheme during 1936-37, was 11.64 pies and the average sale price per unit sold was 12.24 pies, and further that the charges were already so low that there was no room for further reduction for some time to come.

Excise Restrictions—One factor which may impede the development of power-alcohol in this country is the existence of excise restrictions framed many years ago before power-alcohol entered into consideration. It is essential that restrictions against the use of power-alcohol should be relaxed considerably, and this is possible only when a suitable denaturant has been found.

Power-Alcohol and Provincial Government revenues—There is one point of paramount importance in connection with the use of power-alcohol. Under the Government of India Act of 1935, any excise duty levied on alcohol used for generating power or for the matter of that for most industrial purposes is liable to go to the central revenues. At the same time, it is yet doubtful if any kind of vend fee can be levied by the Provincial Government on power-alcohol. The only way therefore in which the Provincial Government can derive any revenue from the power-alcohol industry is to take up the monopoly of the industry as has been done in most other countries. There should not be any serious objection to this, as a scheme can easily be devised by which without affecting the interests of the existing distilleries, the industry may be made to yield some revenue to the province as a small recompense for the loss on account of the introduction of prohibition. By a clever adjustment of the sale price of denatured alcohol for general power purposes in comparison to that of kerosene, it may not be difficult to make an average net profit of about annas two per gallon without entailing any hardship on the consumer.

Concluding remarks—I have endeavoured to show that the only fuel, apart from wood, available in the United Provinces is alcohol, for which there is at present an abundant supply of raw material in the form of molasses. While most of the countries of the world are willingly suffering financial losses in trying to replace imported petrol by indigenous alcohol, in these provinces it would be possible to use power alcohol with considerable financial gain to the country.

It is therefore submitted that the technical and economic aspects of developing power for agricultural purposes—wherein the problem of distributing cheap power over a wide spread area with small intermittent consuming units is acute by means of alcohol engines should receive serious consideration when developing any consolidated scheme for the efficient conservation, utilization and distribution of power in these provinces.

Perfected Fluorescent Lumiline Lamps

Invisible sunrays, imprisoned within tubular glass bulbs, and bombarding chemical powders which serve as energy transformers, are now being used to produce cool light sources that duplicate all the pastel tints of the rainbow.

The new light sources, designated as fluorescent lumiline lamps, provide htitherto unobtainable tints of colored light with, in some cases, as much as 120 times the illumination, for the current consumed, as filament lamps of the same color, and with only a fraction of the heat. One of them produces the nearest approach to natural daylight ever achieved by any artificial illuminant.

Fluorescent powders, compounded in the Nela Park laboratories of the General Electric Company and specially heat-treated, hold the secrets of efficiency and color-producing qualities of the new lamps, it has been revealed. Activated by ultra-violet, and functioning as transformers, the powders absorb the short, invisible ultra-violet rays and re-radiate this energy in those higher wave-bands that comprise the color range of the spectrum. Each powder has its own characteristic wave-band with which it responds to the ultra-violet, thus forming its own particular color of emitted light.

Within the bulb of the new fluorescent lamp is a trace of mercury, a small amount of argon gas at low pressure, and a coating of the fluorescent powder. When the current is turned on, the argon serves as a "starter," and in a fraction of a second a feeble blue light with a large component of invisible ultra-violet radiation is generated inside the tube. The ultra-violet radiation strikes the fluorescent coating and is re-radiated in the visible range of the spectrum. Like all electric discharge light sources, the fluorescent lamps require speical transformers, or chokes, which serve as valves in controlling the flow of electric current. Unlike some other types of mercury-vapor lamps, however, they attain full brilliancy in a few seconds.

Among the many fields of application for the new fluorescent lamps might be listed the following: theatres, hotels, specialty shops, stores, beauty parlors, art galleries, architectural built-in- lighting in many forms, railway cars, and so on.

—*Scientific American*

MEDICINE AND PUBLIC HEALTH

Causal Factors in Epidemic Dropsy

The September issue of the *Calcutta Medical Journal* contains an article by Dr R. B. Lal on the possibility of certain toxic constituents of mustard oil acting as a causal factor of Epidemic Dropsy. These toxic constituents might arise from adulterants or diseased seeds. Experimental and epidemiological evidence points to its being a chemical poison rather than a living virus. Allylisothiocyanate and bromacetic ester are the common adulterants used to impart pungency to the oil. Hydrogen cyanide has also been shown to be present in comparatively large amounts in certain consignments of mustard oil. In view of Dr Lal's experiments, it is difficult to support the contention of Dutt (Dutt, S,—SCIENCE AND CULTURE; *3*, 255, 1937; also Mukherji, B,—SCIENCE AND CULTURE; *3*, 441, 938) regarding the role of hydrogen cyanide.

The vitamin and rice-theories now seem to be abandoned. Sufficient attention has, however, not been paid to fungal disease in mustard seeds, the most frequent of which is *Alternaria Brassica*. A thorough study of the fungal diseases of mustard seeds is, therefore, urgently called for.

Swiney Prize for a Work on Medical Jurisprudence

The prize, which consists of a cup valued at £100/- *plus* money to the same amount, is offered by the Royal Society of Arts, John Street, Adelphi, London, W. C. 2, alternately for medical and general jurisprudence, but if at any time the Committee is unable to find a work of sufficient merit in the class whose turn it is to receive the award, it is at liberty to recommend a book belonging to the other class. The next award of the Prize will be made in January, 1939. The work is to be submitted to the Secretary of the Society, not later than November 30th, 1938.

The Extent and Intensity of Extreme Ultra-Violet Solar Radiation at Calcutta, with Special Reference to its Therapeutic Value—*by Prof. P. N. Ghosh, Dr A. C. Ukil and Mr M. K. Sen,—Jour. Ind. Med. Assn., Nov. 1936.*

This investigation recorded, for the first time, the extent and intensity of biologically active (3800A° to 2900A°) zone of the ultra-violet radiation of Sun's rays at Calcutta.

The authors described in detail the characters of solar radiation and discussed the experimental methods for measuring the intensity of ultra-violet radiation. For their own investigation they have adopted a photographic photometric method which is, they think, better than photo-chemical method as "it is capable of evaluating accurately the energy of the aforesaid biologically active region of the spectrum uniquely."

The investigation determined the intensity of the radiation and its variation during the course of a day and also for the different months of a year. Their findings showed that the maximum intensity of the radiation was present for about three hours of the noon time. It declines in the mornings as well as in the evenings. The month of June recorded the highest intensity and July the maximum extension. The fall is rather quick both in May and in July.

In the months of March, April, May, June and July the rate of increase of the longer wavelengths is much more quick than in the other months. This seems to indicate that along with the increase of ultra-violet rays there is also an increase of both luminous and heat rays in those months.

The months of March, April and May recorded much weaker ultra-violet radiation. The reason probably was the scattering of the rays by finer dust particles carried high in the atmosphere by the norwester winds.

The intensity of the morning rays was very much less than that of the midday in the months of May to September and also in the winter months. The authors thought this to be due to the scattering effect produced by suspended particles in the atmosphere and by the smoke of house fires in the winter months.

—*P. K. S.*

International Post-Graduate Medical Courses in Berlin

The Berliner Akademie für ärztliche Fortbildung, is holding the following medical post-graduate courses in autumn of 1938.

1. Course in the field of internal diseases in which lives are suddenly endangered (from 3rd to 8th of October)—Fee: RM. 50,
2. Post-graduate course on the subject of ailments of muscles and joints (from 10th to 16th of October)—Fee: RM. 50,
3. Progress in the field of hormones and vitamins (from 17th to 22nd October)—Fee: RM. 50,
4. Course on tuberculosis in the Berlin Municipal Hospital for Tuberculosis (from 24th to 29th of October)—Fee: RM. 50,
5. Course in diseases of the ear, nose and throat (from 26th of September to 8th of October). Fee for the whole course: RM. 150; for the theoretical part of the course:—Fee RM. 100,
6. Course in accident-surgery (from 17th to 22nd of October)—Fee: RM. 70,
7. Post-graduate course on the subject of neurotic diseases (from 24th to 29th of October)—Fee: RM. 50,
8. Propaedeutic respectively additional training course in homeopathy (from 10th of October to 5th of November). The course is divided into two parts. The fee for part one is RM. 25,—Part two can be taken independently from part one at a fee of RM. 50,—Both parts together RM. 75,—For assistant doctors RM. 15, RM. 30 and RM. 40 respectively.
9. Special courses in all branches of medicine with practical work at the bedside and in the laboratory, to be held every month. For these courses participants are requested to communicate their wishes in order to find a complete programme on their arrival.

Courses 1 to 8 will be held in German, and the special courses also in foreign languages. For programmes and further information apply to the Geschaftesstelle der Berliner Akademie für ärztliche Fortbildung, Berlin NW 7, Robert Koch-Platz 7 (Kaiserin Friedrich-Haus). Foreign doctors and German doctors resident abroad are granted a reduction of fare of 60% on the German Railways Company's lines; a foreign doctor can reduce the cost of his stay considerably by utilizing the so-called "registered marks"; it is advisable to arrange matters with the local bank before starting.

Medical Article for October

The following article 'The Gland that makes a woman what she is' has been contributed by Dr S. K. Mukherji for our 'Medicine and Public Health' Section of the present issue of the journal.

The Gland that Makes a Woman What She Is

Santosh Kumar Mukherji
Editor, Indian Medical Record.

Woman is woman mainly by reason of her ovaries. Her beautiful figure and soft voice of which the poets have sung for ages depend to a great extent on these small glands. They are to the woman what the testes are to the man.

The ovaries are two little glands, one on either side of the uterus or womb. They are flattened ovoid bodies. The surface of the ovary before puberty is smooth, but after puberty it becomes puckered in appearance. In old age ovaries become atrophied. The ovary is made of a stroma, with numerous follicles scattered in it. The follicle contains an ovum and a transparent fluid.

Function of the Ovaries

(1) At the onset of puberty—

The ovaries contain follicles. At the onset of puberty or the beginning of the period of sexual activity the hormone or internal secretion of the front portion of the pituitary, a small gland inside the skull, stimulates these follicles in the ovaries. As a result of this action the follicles mature and secrete a hormone, the *estrin*, producing striking changes as a result of their activity.

This follicular hormone of the ovary plays an important part in the development of the secondary sex organs in woman, that is, the uterus (organ for holding the child during pregnancy) and breasts. The breasts enlarge, the uterus increases in size, menstruation and discharge of ova begin and the girl is transformed into the woman. Removal of ovaries *before* puberty results in failure of development of the uterus and the feminine characteristics.

(2) From the time of puberty up to the age of 45 or 50—

Puberty is a period of great change in girls and three important events are started at this time, namely—

(*i*) Expulsion of eggs from the ovary, which is necessary for conception.

(*ii*) Menstruation.

(*iii*) The formation of a new structure, the *corpus luteum*, secreting an internal secretion or fluid.

These three events are related to each other. We shall now describe them in brief.

(*a*) *Expulsion of eggs from the ovary*—The follicles in the ovary contain the ova or the eggs. It is the combination of these female ova or eggs with the sperms (Spermatozoa) in the semen of men that brings about reproduction. About the time of a menstrual epoch the follicles mature and burst, discharging the ovum.

(*b*) *The formation of the corpus luteum*—The ruptured follicle is transformed into a yellow body known as the *corpus luteum*. Not only is the appearance of the follicle altered, but there is, at the same time, a change in the nature and character of the internal secretion produced by it. It no longer secrets the follicular hormone (estrin), but a new hormone with completely different action is now produced. The hormone secreted from the corpus luteum is called the *progestin*. The function of this hormone is to prepare the uterus or the womb for the reception of the fertilised ovum. If conception occurs, the corpus luteum persists; but if there is no pregnancy the corpus luteum rapidly disappears.

(*c*) *Control of Menstruation by the Ovaries*—The menstruation in woman depends on the hormones of the ovary. If both ovaries are removed, there results a complete cessation of menstruation, which may be re-established by grafting an ovary under the skin.

Menstruation represents the failure of conception and a step in the preparation for a new ovum and a new possibility of pregnancy. The follicular hormone produces growth of the inner layer (endometrium) of the uterus, as a preliminary preparation for the reception of the ovum. By the 14th to 16th day of menstruation the follicle bursts, the ovum is expelled; and the follicle is changed into the corpus luteum secreting a new hormone. Under the influence of this corpus luteum hormone the final preparation of the inner lining of the uterus for the reception of the ovum becomes complete. The bed is now ready.

If the ovum fails to embed in the uterus, there will be no pregnancy. In such case, the corpus luteum in the ovary disappears and, as a result of the withdrawal of the corpus luteum hormone, the newly formed thickened inner coat of the uterus degenerates. The interior of the uterus becomes denuded of its covering, resulting in a large wound surface from which bleeding takes place. This periodical bleeding from the uterus is known as the menstruation. The bleeding continues for about four days.

The cycle begins again with other follicles in the ovaries assuming importance.

Menstruation thus represents a failure of impregnation and has been described in a poetic language by some as the uterus weeping for the lost ovum.

The menstrual cycle thus consists of—(*i*) Rupture of the follicle and expulsion of the egg and transformation of the follicle into the corpus luteum. For about fifteen days the corpus luteum continues to act, stopping further expulsion of eggs and helping in the preparation of the bed in the uterus for the ovum which had already come out of the ovary. The ovum, however, fails to embed. Corpus luteum degenerates. (*ii*) Bleeding from the uterus takes place as a result of destruction of the newly formed bed for the egg. (*iii*) New follicles and eggs now begin to develop. This period occupies about ten days and is followed by the first period described above.

Pregnancy and the Ovaries

When the ovum combines with a sperm and becomes embedded in the uterus, pregnancy results. When conception takes place the corpus luteum does not disappear but persists and continues to secrete its peculiar hormone. By its action the inner coat (endometrium) of the uterus becomes changed into the "decidua" for support of the fertilized egg until the foetus no longer needs sustenance from it. The corpus luteum prevents the ripening of the follicles and also further expulsion of eggs from the ovary, thus helping in the undisturbed development of the foetus.

Relation between the Ovaries and the Uterus

From the time of puberty periodic changes take place in the ovaries and the uterus, until 45 or 50 years of age. The cyclic changes in the ovary consist of ripening of the follicles, expulsion of the ova of eggs and formation of the *corpus luteum;* while in the uterus structural changes, which accompany the menstrual cycle, consist of the growth of the inner mucous coat followed by its destruction with bleeding (menstruation) and a period of rest. There is thus an intimate relationship between the periodic changes in the ovary and the uterus.

Result of Disorders of the Ovaries

In a normal woman the ovaries act normally. Excessive or deficient action of the ovaries is injurious to health.

(1) *Before Puberty*—

The results of over-action and deficient action of the ovaries before puberty are given below. The effects of the absence of the ovaries have been studied after the removal of these glands by operation.

Over-action	*Deficiency or absence of action*
Precocious development of sex characteristics and sexual desire, namely—	(*a*) Immature development of sex characteristics, namely—
(*i*) Early growth of breasts.	(*i*) Failure of growth of the breasts.
(*ii*) Early appearance of hair in the pubic region and armpits.	(*ii*) Hair in the pubic region and armpits fail to develop.
(*iii*) Early menstruation.	(*iii*) Menstruation fails to begin at puberty or becomes irregular.
	(*iv*) Uterus undeveloped.

(*b*) Obesity—deposit of fat under the skin.

(*c*) Tall, slender skeleton.

(2) *After Puberty*—

The results of the absence of ovaries have also been studied in women whose ovaries had to be removed by operation for some disease. When the period of maturity is reached, the changes produced by the removal of both ovaries are not so extensive. The symptoms are almost similar to those which appear normally in women at the age of 45 to 50 during cessation of menstruation and the end of active sexual life.

Excessive Ovarian Secretion leads to—	*Absence of Ovarian Secretion* (result of castration of the ovaries) leads to—
Profuse menstruation	Cessation of menstruation.
Increase of sexual activity.	Emotional disturbances, such as irritable temper, depressed and sad feeling, sensation of hot flushes and pains in various parts of the body, fainting sensation, etc.

Deficiency or Absence of Ovarian Hormone

Infantilism

At the time of puberty, a girl, who has not differed much from a boy of similar age becomes transformed into a woman. When, however, for some reason or other the ovaries fail to exert their influence before puberty, the appearance of the girl does not change with age. This abnormal condition is known as Infantilism.

The cause of Infantilism is great insufficiency or a total absence of the follicular hormone of the ovary.

(*a*) Absence of ovarian hormone—

In some cases there may be a defect in the development of the ovaries from birth and these glands have never given evidence of their power. Rarely ovaries are removed by operation for tumour, etc., with the result that the body does not get the benefit of the hormones at puberty.

(*b*) Insufficient secretion of the ovaries—

In most cases the ovaries are injured as a result of infectious diseases, such as syphilis, etc., and fail to exert their proper function. In the case of primary ovarian deficiency, the body gets little or no follicular hormone. The anterior pituitary hormone, the controller of the ovaries, may be over-active in such cases; but as the ovaries are diseased the anterior pituitary hormone cannot exert their action.

Deficiency in secretion of the ovaries may also result from low activity of the anterior pituitary. In these cases the ovaries are all right, but cannot act for want of stimulus from the anterior pituitary hormone.

Symptoms

When the ovaries fail to exert their influence at puberty, the usual transformation of the girl into a woman cannot take place.. The breasts remains like those of a little girl or boy and the public and axillary hairs fail to develop. Menstruation may be entirely absent or is scanty and irregular.

Certain changes occur in appearance of the girl. Normally at the age of 14 or 15 the epiphysis and diaphysis of the long bones unite, as a result of the action of the ovarian hormone. So morally there is practically little growth in the long bones after puberty. But, where the ovarian hormone is absent, the long bones fail to unite at puberty and continue to grow under the influence of the anterior pitutary hormone. There is thus increased growth of the lower limbs with the result that the lower portion of the body becomes longer than the upper, like that of an eunuch. The uterus remains like that of a little girl.

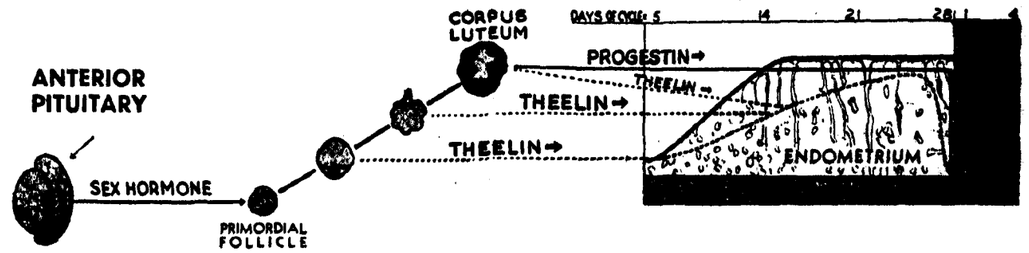
Treatment

In treating cases of infantilism it is at first necessary to consider whether (*i*) the deficiency is primarily in ovarian hormone; or (*ii*) it is secondary to defect in the motor of the sexual organs—the anterior pituitary.

Where the ovaries themselves are at fault it is necessary to replace the deficient follicular hormone (estrin). This hormone is also the general growth

hormone for the entire female genital system and therefore it comes to have a great importance for the development of the secondary female characteristics, particularly the breasts. If the case is seen early the use of estrin has been found to promote feminine development.

Inactive ovaries may sometimes be stimulated by X-ray. Ten per cent of the dose producing redness of the skin is the safe limit. Exposures are given every fifth day and continued only for two weeks. Only three exposures in all are thus given. It should be remembered that there is danger of damage to the ovaries even under such mild exposures and none but expert radiologists should be allowed to undertake X-ray treatment.



A diagrammatic representation of the development.

Ovarian Deficiency

A slender delicate emotional woman with delayed development of feminine characteristics and deficient or lacking menstruation—these are the characteristics of ovarian deficiency.

Menstruation depends, as we have seen, on the activity of the ovarian hormones. If the ovaries be defective, there is atrophy of the inner coat (endometrium) of the uterus. As a result of this, the menstruation is either stopped or becomes scanty and the woman becomes sterile.

Treatment

In these cases too, the treatment depends on whether the ovaries, anterior pituitary or both are deficient.

(*a*) In primary ovarian deficiency—

Where the ovaries are defective estrin is given as substitution treatment. Unless the inner coat of the uterus is damaged beyond repair, menstrual flow may be established again by injection of this hormone.

(*b*) In some cases the anterior pituitary and the ovary are both defective. The patient shows signs of deficiency of anterior pituitary hormone and this hormone is absent in the urine. In such cases it is reasonable to give both anterior pituitary hormone and estrin. The object is to stimulate the slowly maturing follicles into increased activity and to supply the deficient hormone.

Artificial Menopause

In women menstruation ceases for good at the age of 45 to 50 This is known as the menopause. In case of removal of the ovaries by operation after puberty symptoms similar to those at menopause occur. Menstruation ceases and the patient complains of headache, fainting, feeling of heat etc.

Treatment

In cases of artificial menopause, estrin should be used as replacement treatment. There is relief of symptoms and menstruation may also be produced. Cases which have been treated with estrin have shown an abatement in vasomotor and nervous symptoms.

Excessive Action of the Ovaries

An over-secretion of the ovarian follicular hormone is also harmful.

Causes

An over-production of estrin is generally due to infections or malposition of the uterus.

In some cases it is the result of deficiency in anterior pituitary hormone. Owing to want of sufficient

stimulus from the anterior pituitary, the maturing follicles in the ovaries fail to rupture and expel the ova. As the follicles do not burst, no corpus luteum can be formed. Consequently the follicles continue to enlarge and the continued production of estrin from the non-ruptured follicle keeps the inner coat of the uterus in an over active phase, leading to bleeding.

Symptoms

The local effects of excessive ovarian secretion may be seen in more *profuse and protracted menstruation*, lasting for 8 or 10 days or more. It is seen in many cases in girls about and just after puberty and in women in whom the correlation of the internal secretions in regard to the altered conditions have not been finally adjusted. In cases where it occurs at the period of puberty, the first menses are precocious and plentiful, last from 8 to 10 days and reappear at each period with the same characteristics. This excessive menstruation may be explained by the fact that the ovaries have a direct bearing upon the inner coat of the uterus producing congestion of blood. Such excessive menstruation may lead to anaemia.

An excessive ovarian secretion leads to an increase in sexual activity. These women are generally coquettish and seek male companions. They are sometimes found to resort to masturbation and other sexual perversions.

Treatment

In excessive menstruation at puberty, the anterior pituitary hormone has been used with advantage in some cases. Bleeding at puberty is in most cases due to the unopposed action of follicular hormone of the ovaries (estrin) as a result of deficiency of the anterior pituitary sex hormone. The injection of anterior pituitary hormone will supply the necessary stimulus to the ovary. The object is to convert a persistent follicle into a corpus luteum. Large doses of anterior pituitary hormone are therefore required. The treatment should be continued until the flow becomes normal.

In cases of excessive or prolonged menstruation of young women, good results may often be obtained by using corpus luteum hormone in conjunction with anterior pituitary hormone. The object of giving anterior pituitary is to stimulate the ovary to cause expulsion of ova and thus lead to formation of corpus luteum which will in its turn check the bleeding. The advantage of the antagonistic action of the corpus luteum hormone may also be taken.

Relation of the Ovaries with other Glands

Anterior Pituitary—The anterior pituitary secretion contains two important hormones controlling the activity of the ovaries. One of the hormones in the anterior pituitary secretion stimulates the ovarian follicles leading to the production of estrin. This is known as the follicle stimulating hormone (*Prolan A*). The other factor (*Luteinizing*) hormone in the anterior pituitary secretion causes transformation of the follicle into a corpus luteum. Ovulation is probably due to a balanced action of the follicle stimulating and luterinizing hormones at a definite stage of follicular growth.

Thus the hormone of the anterior pituitary and the ovaries are interdependent in their action. The cycle may be described diagrammatically as follows:—

Anterior Pituitary.	Follicle-stimulating hormone (Prolan A)	Luteinizing hormone (Prolan B)
	↓	↓
Ovaries	Ovarian follicle =estrin	Corpus luteum =Progestin
	↓	↓
Inside coat of the Uterus.	Preliminary preparation of the uterine mucosa for the reception of the ovum.	Formation of the bed for the foetus (deciduu) if pregnancy occurs.

Posterior Pituitary—The hormone of the back portion of the pituitary gland produces contraction of the uterus in women. There is an antagonism between the internal secretion of the posterior pituitary and that of the corpus luteum. During pregnancy, the corpus luteum dominates the scene and the action of the posterior pituitary hormone in causing contraction of the uterus is kept in check. At the end of pregnancy, however, the corpus luteum degenerates. Then the pituitary hormone gets an opportunity to act on the uterus and brings on labour pain.

Thyroid—The thyroid plays some part in the production of sexual characters in both sexes. Puberty and menstruation do not take place, as a rule, in women with inactive thyroid glands. In a cretin the ovaries are ill-developed with infantile uterus.

Graafian Follicle Hormone—Estrin

Estrin is the name given to the hormone secreted by the follicles of the ovaries. It is so called because of its power of promoting heat (Oestrus) in animals.

When this hormone was first discovered it was named Folliculin. It was also called Theelin, a name derived from thelu, the Greek equivalent for the female sex.

Nature of the Hormone—Estrin has been isolated and prepared chemically. The chemical formula of estrin is $C_{18}H_{22}O$. It is interesting to note that crystalline testicular hormone has the formula of $C_{18}H_{22}O_2$. Estrin is soluble in water. It is stable towards heat and cold; and treatment with acids and alkalies does not injure it.

The hormone capable of producing heat in animals was first isolated from the ovarian follicles by Doisy. This hormone has now been found to be a dihydroxy form of estrin (œstradiol). In this form it circulated in the body.

Subsequent tests disclosed the presence of this hormone in the urine of pregnant women and in great abundance in the placenta and the amniotic fluid. Estrin is present in the urine of pregnant women in the proportion of 1: 1,000,000. Beginning with the second month of pregnancy there is a constant increase of estrin in the urine, and it then completely disappears by the tenth day after delivery. This hormone is identical in activity to that found in the ovarian follicle; but chemically it is a keto form of follicular hormone. Hydroxy-ketonic form of estrin (Oestrone) has been found to be the excretion form of the hormone.

Method of Preparation—Estrin may be prepared from the urine of pregnant women; but as it is present in such a minute proportion (1: 1,000,000) one can imagine the huge volume of urine of pregnant women that is necessary for its preparation. Recently the urine of pregnant mare has been found to be a much richer source of estrin than any other hitherto available.

The usual method of isolation of estrin is to extract acidified urine with a lipoidal solvent(such as ethyl acetate), and then remove it from the solvent with dilute caustic soda. Further purification depends upon solution in benzine, ether and ethyl acetate.

Preparations of Estrin—Estrin is available in three forms—hydroxy-keto form, di-hydroxy form and tri-hydroxy form.

(1) Ketohydroxy-estrin (Oestrone)—It is an excretion form of the hormone, and is prepared from the urine or amniotic fluid of pregnant cattle. It has been adopted as the standard in the assay of the preparations of estrin by the League of Nations. The preparation sold under the trade name of Theelin belongs to this group. Theelin in oil is available in two strengths—2,000 and 10,000 international units per c.c. The advantage of an oily preparation is that it may be given in larger doses than an aqueous solution.

(2) Di-hydroxy-estrin (Oestradiol)—It is the actual sex hormone which circulates in the body. The preparation known as Progynon B is the benzoic acid ester of di-hydroxy-estrin. Progynon B in oil is available in two strengths—10,000 and 50,000 international units per c.c. The usual dose is 2,500 I. U.

(3) Tri-hydroxy-estrin (Oestriol)—If two hydroxyl groups are added, the resultant compound is tri-hydroxy-estrin. Its activity is less than that of the other forms, but it has an advantage over them in that it may be taken with benefit by mouth. The preparation known as Theelol belongs to this group. It is available as capsules. Each capsule is equivalent to 200 I. U.

Method of Testing Potency—The potency of a preparation of estrin is tested by its power of inducing the ovarian cycle in an adult female rat the ovaries of which had been previously removed. Menstruation in women and œstrus in rodents like the rats have certain features in common, though they are not the same phenomena. It has been found that synchronously with the cyclical changes in the ovaries, there occurs cyclical changes in the uterus and vagina. During œstrus there is growth of cornified cells in the vagina, and the vaginal secretions, if examined at this stage, show these cells. Castrated animals can have no ovarian cycle and their vaginal secretions show cornified cells. But when estrin is administered to a castrated

animal it supplies the deficiency and thus induces ovarian cycle though the ovaries had been removed. As a result of this, cornified cells appear in the vaginal secretions of the animal.

The least amount of the estrin that will produce cornified cells in the vaginal secretions in the adult castrated female rat is known as the rat unit. An international unit has now been adopted by the League of Nations. The method suggested by the League is also based upon the changes in the vaginal secretions produced by the subcutaneous injection of a given dose of estrin into castrated adult female rats. The standard adopted is a quantity of pure crystalline keto-hydroxy-estrin, which is preserved at the National Institute for Medical Research, London. The unit of activity is taken as the specific power of inducing œstrus of 0.0001 mg. of this preparation. One rat unit previously used as a standard is equivalent approximately to 8 international units.

The potency of estrin is determined by administering it to rats previously deprived of their ovaries, and by determining the changes that occur in the vaginal secretions during œstrus. Vaginal smears are taken once a day and examined under the microscope for the presence of cornified cells.

Determination of estrin in the urine—The quantity of estrin present in the urine of a woman is the best method of determining the activity of the ovaries. A normal woman excretes throughout her menstrual cycle 10 to 20 rat units of estrin per litre of urine. The estrin in the urine may be determined by the method of Kurzro and Ratner based on a method of obtaining crystalline hormone.

Action of Estrin—Estrin plays a great part in the development of the secondary sex characters. It stimulates the growth of the breasts. It also produces changes in the inner coat of the uterus.

The Results of Over or Under-Secretion of Estrin

1. *Deficiency of Estrin*—Deficiency or absence of estrin before puberty may lead to under-development of the secondary sex characteristics and lack of menstruation. The ovaries may be primarily at fault or the deficiency may be due to want of stimulus from the controller of the internal secretions of the ovaries—the anterior pituitary.

If the ovaries are removed by operation or rendered inactive by X-ray exposure, menstruation stops for good and certain peculiar symptoms such as hot flashes, sleeplessness, melancholia etc. may arise. In these cases no estrin is found in the blood or urine of the patient.

2. *Over-production of Estrin*—Patients suffering from excessive bleeding during menstruation frequently have excess amounts of estrin. In some cases of bleeding at puberty, the cause is unopposed action of estrin as a result of deficiency of anterior pituitary hormone.

Uses of Estrin

As estrin promotes feminine development and is a factor in the promotion of the menstrual cycle, it is used in cases of genital under-development and deficiency in menstruation.

In women with under-developed breasts and infantile uterus, the ovaries or the anterior pituitary or both may be at fault. Where the defect lies primarily in the ovaries estrin is given to supply the deficiency in this hormone. In some cases there are associated signs and symptoms of anterior pituitary deficiency. In such cases both the ovary-stimulating principle (anterior pituitary hormone) and estrin should be given. The object of administration of anterior pituitary hormone is to stimulate the slowly maturing follicles into increased activity.

In cases of lack of menstruation (amenorrhœa) due to atrophy of the inner coat of the uterus resulting from failure of ovarian secretion, the administration of estrin has been found to be beneficial. Unless the atrophy of the inner coat of the uterus is too far advanced, the menstrual flow may reappear.

The troubles which appear after the removal of the ovaries can very often be obviated by giving estrin.

Corpus Luteum Hormone—Progestin

The corpus luteum is an accessory gland concerned with pregnancy, formed inside the ovary. It secretes a hormone known as the Progestin or Lutein. It was named Progestin on account of its action in preparing the uterus for conception and maintaining preganacy *i.e.*, gestation.

Progestin was first obtained from the corpus luteum by Corner and Allen. It was prepared in crystalline

form from natural sources by Slotta and by Buttenandt. Shortly afterwards it was also prepared artificially from pregnandiol, a sterol occurring in pregnancy urine and also from stigmasterol from soyabean. Pure crystalline corpus luteum hormone has been named Progesterone and is prepared in the form of needles. It is closely related chemically to estrin.

Method of Testing Potency—The assay is based on the degree of proliferation produced in the inner coat of the uterus of the rabbit. This can be applied to the female rabbit deprived of the ovaries after coitus or to the immature female rabbit after treatment with estrin.

Preparations—Corpus luteum hormone is now available under the trade names of Gestone (Payne and Byrne), etc. Gestone ampoules contain 1 or 2 international units of progestin.

Action—The Corpus luteum hormone supplements the action of the follicular hormone (estrin) by further changes in the inner coat of the uterus, It causes branching of the glands in the mucosa with deep embedding. These changes are necessary for the implantation of a fertilized ovum. If a fertilized egg does arrive, the corpus luteum persists and continues to support the decidual endometrium until the inhabitant no longer needs sustenance from it. So progestin is a synergist in the fact that it finishes the uterine cycle begun by estrin.

Should conception take place, persisting corpus luteum inhibits further ripening of follicles and its output of estrin. Progestin thus acts as an antagonist of estrin this manner. In addition to this the corpus luteum hormone also helps the growth of the secretory system in the breasts.

Relation between the follicular and corpus luteum hormones is expressed below:—

Action on.	Estrin.	Progestin.
Uterus	Produces proliferative changes in the endometrium of the uterus.	Acts upon the endometrium built up by estrin; prepares it for implantation of the fertilised ovum.
	Excites uterine contraction.	Inhabits contraction of the uterus and thus prevents premature labour.
Ovaries	....	Prevents further expulsion of ova in case of pregnancy.

Disorders of Corpus Luteum—If the corpus luteum fails to rupture in time the result would be long intervals between the menstrual periods. Once the corpus luteum ruptures the stimulus to menstruation is liberated and the flow starts.

Excessive menstruation of young women may be due to the failure of the follicle to rupture and form a corpus luteum. The continued production of estrin from the non-ruptured follicle keeps the inner coat of the uterus in an over active state which bleeds. This phase is not supplanted by the formation of the bed for the foetus because of absence of corpus luteum formation.

Some cases of sterility in women are due to the disorders of the corpus luteum. These women menstruate regularly, but still do not bear any child. The cause is probably the failure of the corpus luteum to bring about changes in the inner coat of the uterus preparatory to implantation of the placenta.

Uses of Progestin—In treating cases of excessive or prolonged bleeding during menstruation caused by over-action of the estrin, advantage may be taken of the antagonistic action of the progestin.

Habitual abortions not due to organic diseases may sometimes be prevented by the use of progestin injected under the skin.

Sterility in women menstruating regularly may be treated with the corpus luteum hormone.

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RESEARCH NOTES

Optical Harmonic Analyzer

A periodic function is often conveniently represented by a Fourier Series. The actual harmonic analysis of such a Fourier Series is often very troublesome and generally some mechanical device is adopted to analyse the Series. An Optical Analyzer with simple automatic control measuring as many as thirty harmonics in a minute and a half has been reported to have been perfected by H. C. Montgomery of the Bell Telephone Laboratory (*Bell Sys. Tech. J. 17*, 406, 1938.)

The principle underlying the method is quite simple. As is well-known, the co-efficients of the terms in a Fourier Series are expressed as integrals over one complete period, of the product of two terms—the function f(x) and a sine or cosine term of the form sin nx or cos nx.

f(x) and cos nx are recorded on photographic films by either the variable area or variable density method. If two or more such records are superposed, the light transmitted through the combination will be proportional to the product of the functions provided, of course, not more than one of them is of variable area type. A cos nx term can be converted to sin nx by shifting the corresponding record through a quarter of a wave-length. A measure of the intensity of light transmitted through the combination enables one to calculate the various co-efficients—the cos nx record being moved in different position to get the different co-efficients. To analyse a function f(x) into various harmonics we require as many different cos nx records.

The experimental arrangement of the optical harmonic analyzer is as follows:—Light from a strong source is condensed by a system of lenses on the f(x) record and the image is magnified by another system of lenses. The cos nx record is moved at the required rate in front of the magnified image of f(x) by mechanical arrangements. The light after passing through the combination is focussed by a lens on a photocell. The variations in the photocell output are recorded by an instrument similar to a high speed level recorder differing from it chiefly in having a linear instead of a logarithmic scale.

The instrument designed as described above can analyse records of f(x) which are from "$\frac{1}{10}$ to $\frac{5}{10}$" long and not higher than their length *i.e.*, analysis can be made upto the 30th harmonic approximately.

The records of the optical harmonic analyzer agree quite closely with those of other mechanical analyzers and the measurements of the former are done far more rapidly and conveniently.

—*A. K. B.*

Purine Synthesis in Mammalian Metabolism

Nothing definite is known about the precursor of the purine nucleus as synthesised in mammalian metabolism. Ackroyd and Hopkins showed that the removal of arginine or histidine from diet diminished the excretion of allantoin by 40 to 50%. The high content of arginine in placental protein suggested this amino-acid as the important precursor for the embryo. Harding and Young fed placental and meat proteins to puppies and found that more allantoin and uric acid were excreted on the placental diet. Rose and Cook, from their experiment with rats concluded that histidine and not arginine act as the mother substance of allantoin. But György and Thannhauser (Hoppe—*Seyl. Z. 180*, 286) failed to detect any influence of added histidine on the excretion of uric acid in infants of 4 to 8 months fed on milk and casein free from arginine and histidine.

RESEARCH NOTES

Crandall and Young (*Biochem. J. 32*, 1133, 1938) attempted to contrast for the puppy the metabolic effects of synthetic diets, high and low in arginine and histidine, and to determine whether the level of purine excretion could be related to the level of ingestion of histidine or arginine.

Three mongrel puppies 4-8 weeks old were confined in metabolism cages, the urine was collected under toluene in 24 hr. periods and its total nitrogen was estimated by the Kjeldahl method, creatinine by Folin micro-colorimetric, uric acid by Christman and Ravwitch and Allantoin by the method of Larson. Regarding diet the basal requirements of Cowgill was followed, supplemented by yeast concentrate, halibut liver oil, salt mixture and bone ash.

From the results of their experiment the authors conclude that the excretion of uric acid and allantoin in the puppy is dependent upon the type of protein in essentially purine-free diets containing a single protein. Haemoglobin, high in histidine, causes the largest excretion and arachin, high in arginine, the lowest.

It is suggested that the conversion of histidine into purines by the puppy occurs in excess of anabolic needs and is demonstrable by increased urinary excretion of uric acid and allantoin, dependent upon the type of dietary protein.

—*H. N. B.*

Unique Electrically Recording Foucault Pendulum

In an unoccupied elevator shaft at Mundelein College for Women, Chicago, a Foucault pendulum is being installed, by which rotation of the earth on its axis may be demonstrated and measured. Swinging nine stories, the pendulum is 120 feet long, the longest of its kind in existence and the only one of its kind, so far as is known, to have its movements recorded by an electric spark.

The suspension consists of two cylinders at right angles, rolling on flat surfaces. It is a device credited to Alaeine Cummings Longdon, of Knox College. The pendulum ball, which swings in the pit 120 feet below the suspension, is supported by wires from the upper cylinder. The contact surfaces are hardened and polished, resulting in very low friction.

Recording of the azimuth of the swing is by means of a spark discharge which punctures a coated paper disk, eight inches in diameter, on a suitable table below the pendulum. The table holding the paper disk is made of hard rubber, 12 inches in diameter, supported by a tripod casting. A brass ring about 8.5 inches in diameter is inlaid in the top surface and is connected to a terminal below.

A high voltage transformer is connected between this terminal and the ground. Thus as the pendulum swings across the ring, a spark jumps between the ring and a platinum point on the ball. The coated paper on the ring is thus marked by the spark flashing through it. The brass ring is graduated in degrees to read the angular position of the points on the coated paper.

—*Scientific American*

UNIVERSITY AND ACADEMY NEWS

National Academy of Sciences, India

(Allahabad, 25th August, 1938)

(1) "The Mathematical Theory of a New Relativity (Generalised Gravitation)," by the Hon'ble Sir Shah Muhammad Sulaiman.

(2) "The Solution of certain types of Differential Equations," by Prof. A. C. Banerji and P. L. Bhatnagar.

(3) "New Avian Trematodes (Family—*Diplostomidae*) from Indian Birds," by R. D. Vidyarthi.

(4) "Tungsten and Molybdenum powder in Organic synthesis," by Gauri Shanker Basu and Dr S. B. Dutt.

(5) Chemical Examination of Indian Molasses Fusel oil from the Patent Still Distillery of Messrs Carew & Co., at Rosa, Shahjehanpur," by Dr S. B. Dutt. Chemistry Department, Allahabad University.

(6) "Cadmium powder as a Synthetic Reagent" by Anil Chandra Chatterji and Shikhibhushan Dutt.

(7) "The Formation of Liesegang Rings in the presence of precipitates," by Binayendra Nath Sen.

(8) "Annotated list of the Helminths recorded from domesticated Animals of Burma," Part I.—Trematoda, by R. C. Chatterjee,—Rangoon.

(9) "Changes in respiration and H-Ion concentration in Wounded Potato Tubers," by Dr B. N. Singh and M. L. Mehta, Benares.

The Dacca Botanical Society

(Dacca, 1st August, 1938)

(1) Some aspects of Respiration and Respiratory Quotient of Plants by N. K. Chatterji.

(2) A Note on the study of *Sclerotium oryzae* by S. Hedayetullah and S. P. Ray Chaudhuri.

(3) Utility of a planned Garden attached to Schools in Bengal by P. N. Mazumdar.

Indian Physical Society

(Calcutta, 27th August, 1938)

(1) Theory of absorption in Ionised gases—Part II, Optical properties of liquid metals (Com. by Dr R. C. Majumdar) by Mrs B. Majumdar.

(2) Dissociation in Sulphuric Acid with temperature (Com. by Dr I. R. Rao) by P. Koteswaram.

(3) Structure of aromatic compounds IV, Space Groups and Atomic arrangements in Phloro-glucine di-hydrate by K. Banerji and R. Ahmad.

(4) On the electronic condition due to '4f' electrons in some trivalent rare earth compounds by K. P. Ghosh and B. P. Ghosh.

(5) Thermal co-efficient of rock-salt by X-ray reflection (Com. by Prof. K. Prosad) by S. Basu and A. T. Maitra.

Also, Dr M. N. Saha delivered a lecture on "Cosmic rays" which was followed by discussions.

Research Work in India

We publish below a short connected account of the researches carried out in the physics laboratory of the Royal Institute of Science, Bombay, during the year 1937-38. It is our desire to publish regularly statements of progress of researches in the different branches of science from the various research centres all over India. These short reviews are expected to be useful for the other research workers in the country and we hope it will prove interesting to our readers, who may pursue the subject of their choice with full details from the respective centres. We invite the co-operation from the various universities and research institutes in the form of reviews of the works done there for use in our columns.

Royal Institute of Science, Bombay (1937-38)

The investigations (during the year 1937-38) related to scattering of light, spectroscopy, and also to some problems of industry and engineering.

Scattering of Light.—The nature of light scattered by a cloud of drops much larger than the wave-length of light has been investigated both experimentally and theoretically, extending in the latter case, Mie's theory to drops considerably larger than wave-length of light. The dependence of the nature of the light transmitted by a cloud on the wave-length of light has also been studied. Technique for the quantitative measurement of intensities of light has been developed, using a photo-electric cell for the purpose, and with the help of this technique, the change of depolarisation of light scattered by gels with the setting of the gels is being investigated.

Spectroscopy.—Band spectra of some molecules in the photographic infra-red region have been studied. Technique has been developed for heterochromatic photographic photometry of spectral lines and using this method, experimental investigations have been made on the emission of Swan bands under various conditions of excitation, on the quantum laws governing the distribution of vibrational energy in relation to rotational energy, on the dependence or otherwise of transition probabilities and on the condition of excitation and temperature equilibriums in various sources. By using these methods, investigations have also been made on the combustion in flames and on the ultra-violet content of sunlight at Bombay. Studies in these lines are being pursued with the first positive bands of nitrogen and the relative statistical weights of electronic levels in molecules are being investigated.

Viscosity of gases.—An improvement has been introduced in the capillary tube method for the measurement of viscosity of gases and the results obtained with a few gases by this method are in good agreement with those obtained by previous workers using different methods.

Dielectric constant of Liquids.—The dielectric constant of a large number of oils has been measured and from these results, the molar and electronic polarisations as well as the electric moment have been calculated.

Problems of Industry and Engineering.—Attempts are being made to investigate whether it is possible to coat silk and cotton threads with silver and gold for industrial purpose. In the preliminary investigations it has been found possible to coat these non-conducting surfaces with fast adhering graphite in the colloidal form. These investigations are being pursued using copper and nickel electrolytes in order to coat the surfaces with copper and nickel by the electric method.

Stresses developed in a square metal plate clamped at the boundaries and subjected to uniform pressure over one of the faces have also been successfully worked out.

—

BOOK REVIEW

"TABLE OF FUNCTIONS" *by Jahnke and Emde (B. G. Teubner, Leipzig. 3rd edition, 1938: with 181 figures and covering, 305 pages; price, cloth R. M. 15).*

This is a revised edition of that world-renowned book, "*Funktionentafeln,*" first published in 1909 in German language. Since that time it has passed through two revised editions, one in 1933 and the other, the present one, just appeared. Dr Emde is to be congratulated on his publishing the revised and enlarged editions since the death of his collaborator Dr Jahnke in 1921. The English rendering of the subject matter given side by side with the original German has enhanched the utility of the book to the English-speaking countries. The Table contains exact representations of the functions and the perspective reliefs are executed in a remarkably vivid style, so that the applications of the higher functions to actual practical problems leave nothing to be desired, and we have every reason to believe that the Table will serve the purpose of an indispensable *vade-mecum* to the mathematician, the physicist and the engineer. In this new edition the elementary functions, *e.g.*, exponential function, elementary transcendental equations, circular and hyperbolic functions of a complex variable and other topics have been excluded, which were incorporated in its predecessor, and we hope these will be dealt with in a companion volume which, we are given to understand, is to appear shortly. Chapters on confluent hypergeometric functions and Mathieu functions are welcome additions to the topics dealt with in the second edition of this Table. Under complete elliptic integrals formulæ and numerical tables have been added for other than the Legendre standard forms, thus numerical calculations have been much improved. The sections on Bessel functions have been admirably written throughout, and the computations are moderately extensive to suit the volume of such a handy table. A new feature is the complete numerical tables for the Lommel-Weber and Sturve functions of orders zero and one. The Table is devoted to eleven chapters in all and there are various sections under each. The bibliography appended at the end of each chapter will be found very useful to those who wish to learn more about the theories on the basis of which calculations are carried through in this Table. The price of the book is a little reduced from that of its predecessor. The ability, care and patience that have been taken by the publishers to bring out this attractive volume will be amply rewarded if the Table of Functions command a wider sale, thus enhancing the usefulness of the book all over the scientific world.

—*K. B.*

DAS AUFBAUPRINZIP DER TECHNIK *by P. Wessel. (Verlag Von Ernst Reinhardt in Munchen. 1937 pp. 39).*

In the introduction the author states how right bodies become the basis of all measurements and how they form parts of apparatus. In the first chapter the author discusses how rigid bodies are deformed to suit the various purposes in modern industry. In the second chapter practical geometry and linear measurement is treated from a basic stand-point The third chapter deals with the various ideas of assembling different types of instruments, the idea of coupling and construction forming the fundamental of machine practice. This is a very interesting little book of 40 pages, apart from the material in the book the general idea and its presentation is indeed very interesting.

—*P. N. G.*

SOCIOLOGY: *A brief outline. By* K. *Motwani. Ganesh & Co., Madras) 1937. Np. 63 and a Bibliography. Price not stated.*

This is a lucidly-written introductory outline to modern Socialogy. Dr Motwani is a scholar with reseach and lecturing record in American Universities. The brochure is the introductory chapter to the second edition of his "MANU: A STUDY IN HINDU SOCIAL THFORY," and deals with the various approaches to the study of the subject and is refreshingly Catholic and up-to-date in attitude and content. It is a good primer for the uninitiated.

—*B. N. B.*

PHYSIK FUR STUDIERENDE AN TECHNIFCHEN HOCHFCHULEN UND UNIVERSITATEN *by Ing. Paul Wessel. (Verlag Von Ernst Reinhardt in Munchen). 1938 page 514 and an index price*

There are numerous text books on the theoretical aspects of Physics, but for the students attending universities or technical colleges there is at present hardly any that would satisfy the conditions required for engineering students. Dr Wessel's book really, therefore, supplies the essential elements of Physics needed for engineers. In the introductory chapter one finds, classification of Physics and systems of measurement. Newton's law is introduced in connection with Mechanics of Solid Bodies. For liquid bodies the propagation of pressure and molecular action is treated in a very simple fashion. For gaseous bodies, the laws of Avogadro and Boyle and molecular effects have been discussed. The second part of this first section is devoted to a study of harmonic motion, sound production and conduction in acoustics, heat and one finds a fairly good chapter on Photometry, the Laws of Reflection, Dispersion, Interference and Polarisation. In section 2 a general account of the magnetic phenomena, the optical effects of magnetic fields, electrostatic field, electric potential and capacity have been discussed. Electronics and electro-dynamics are fairly well discussed including X-rays, Electron beams, Isotope Effects and Atom disintregation. The growing important of this subject for engineering students are being slowly recognised and as such this book will really serve a very useful purpose. The section 3 is really a summary and collected data of the previous sections dealt with in the form of interesting questions covering the entire domain. The last section is that of tables and the selection in a short compass is fairly instructive. Care has been devoted specially to those properties of material which are of importance more to the engineering than to the students of Pure Physics. Though written in German, unless the language problem is note of great difficulty the subject matter and the method of presentation would certainly appeal to all students.

—*P. N. G.*

LETTERS TO THE EDITOR

[The Editor is not responsible for the views expressed in the letters.]

Weather Conditions and Radio Reception at Long Distances

The significant part which weather plays in the propagation of radio waves suggests a relationship between the propagation of these waves and the meteorological conditions. Ranzi[1] finds that the reception also depends much on the conditions of the troposphere. Several investigators[2, 3, 4], studied the effect of the main meteorological conditions, *i.e.*, temperature, pressure and humidity to the received signal. Their results show that the received signal is dependent on the above factors at the receiving end. Schwers[5] and Glover[6] show that the changes in sensitivity at the receiver appear to be highly correlated with humidity in the atmosphere while Stratton[7] has shown that rain and fog have no effect on the propagation of radio waves.

Collwell[8] has shown that the variation in the field strength can perhaps foreshadow weather conditions from twelve to twentyfour hours ahead. His results from a transmitter, 80 miles distant, show that increasing signal after nightfall indicates a tendency towards rain, while decreasing signal showed clearing weather.

But so far as long distances are concerned there are practically no data available which could possibly be the meteorological factors most likely to affect the propagation of wireless waves. In order to determine the probability of these relations a statistical study was made of the daily signal intensities of a distant transmitting station. This material is then utilized to derive information regarding the possible connection of weather conditions on the propagation of these waves. The present note contains the results of the study of the above relations observed continuously for a long time. The receiving system consisted of a sensitive receiver with Wheatstone Bridge system to nullify the action of the local receiver disturbances and to receive the strength due to the transmitting station only. Observations were made on the carrier of the Delhi station of the All-India Radio working on 340m.

It has been found that the rapid fluctuation in signal intensity is greater in winter and on clear nights. From day to day variations, it is concluded that the signal intensity varies inversely as the temperature and decreased with the falling off of the barometer at the receiving station. It is generally found that the falling of the signal intensity indicated the following day as rough and cloudy while a continuous increase showed a clearing weather. These results seem to be different than those found previously by some investigators for short distances.

The author has great pleasure in thanking Prof. P. Dutt, M.A., (Cantab) and Dr S. S. Banerji for the facilities in carrying out the work.

Physics Laboratory, R. D. Joshi.
College of Science,
Benares Hindu University.
2-9-1938.

[1] Ranzi, I., *Nature*, *130*, 369, 1932.
[2] Wymore Shiel, I. J., *Proc. Inst. Rad. Eng.* *19*, 1683, 1931.
[3] Minohara, T., *Jour. Inst. Elec. Eng. (Japan)* *47*, 225, 1927.
[4] Pickard, G. W., *Proc. Inst. Rad. Eng.* *16*, 765, 1928.
[5] Schwers, F., *Proc. Phy. Soc.*, *29*, 150, 1917.
[6] Glover, R. P., *Proc. Inst. Rad. Eng.* *18*, 683, 1930.
[7] Stratton, J. A., *Proc. Inst. Rad. Eng.* *18*, 1064, 1930.
[8] Colwell, R. C., *Proc. Inst. Rad. Eng.* *18*, 533, 1930.

Investigations of Vitamin 'C' in Ripe Tomato Juice

The isolation of vitamin C from paprika and its synthesis in recent years have led to an extensive therapeutic investigation of this important substance. Very striking effects of vitamin C in a number of grave diseases like diptheria,[1] pneumonia,[2] mental disturbance,[3] typhoid fever,[4] etc., have recently been reported. For people in health, however, the natural products containing vitamin C have not lost a whit of their popularity.

Amongst various common articles of dietary of the Bengalees tomato is a very good source of this vitamin. The extreme cheapness of tomato has rendered its easy access possible to the rich and the poor alike.

Of all the known vitamins, vitamin C or ascorbic acid has so long been known to be the most susceptible to heat. As our countrymen are generally averse to taking raw tomato, it is worth while to find out the loss of vitamin C in tomatoes when they undergo the usual cooking process practised in Bengal.

In the present paper the effect of temperature as well as dilution of the tomato juice with varying quantities of water has been observed. The stability of ascorbic acid in the juice containing tomato pulps in suspension as well as the juice from which the pulpy matter has been removed by heat coagulation has also been incidentally studied to determine if the pulp has got any stabilizing effect on the vitamin.

Vitamin C in fresh juice and in the juice freed from protein matters by heat coagulation

A few of the tomatoes are washed thoroughly and the adhering water is soaked in a piece of dry cloth. These are then cut into pieces, pressed and passed through twill cloth. 10 gms of the juice obtained, are taken in a beaker with water and centrifuged, and the centrifugate is made up to 100 c.c. It is then titrated against 2·6 dichlorophenol-indophenol by the well known method of Harris & Roy[4] as modified by Guha and Ghosh[4] and Ghosh and Guha[7]. Another 10 gms of the juice are taken in a beaker and kept over water bath for a few minutes so that the temperature rises up to 70°C. The proteins are coagulated thereby and it is then filtered through cotton wool. The filtrate is made up to 100 c.c. and titrated against 2·6 dichlorophenol-indophenol in a similar way. The values obtained are given in table No. I.

TABLE I

Ascorbic Acid in mg. per 1 gm. of the juice

	Unfiltered juice.	Filtered juice.	Simple sugars in unfiltered juice.	Other sugars in the unfiltered juice.
Lot I.	0.291	0.285	2.56%	Trace
Lot II.	0.298	0.308	2.53%	„
Lot III.	0.327	0.327	2.70%	„
Average	0.305	0.306	2.59%	„

Effect of heating the pressed juice with different quantities of water both before and after the coagulation of the proteins.

25 c.c. of the press juice are taken in a beaker and boiled for 10 minutes. It is then cooled and centrifuged. The centrifugate is made up to 250 c.c. and tritrated in the usual way. The experiment is repeated by boiling 5 c.c. of the juice with 12.5 c.c., 25 c.c, 75 c.c. and 100 c.c. of water respectively and the results obtained are tabulated in table No. II. About 200 c.c. of the original juice are taken in a flask and kept over water bath for a few minutes. The proteins are coagulated and the resulting liquid is then passed through cotton wool so that a clear liquid is obtained. This is also treated as above and the results obtained are given in table No. II.

TABLE II

Ascorbic Acid in mg. per 1 gm.

	Boiled without any H_2O.	Boiled with 12½ cc. H_2O.	Boiled with 25 c.c. H_2O.	Boiled with 50 c.c. H_2O.	Boiled with 75 c.c. H_2O.	Boiled with 100 c.c. H_2O.
Tomato juice unfiltered.						
Lot I.	0.277	0.270	0.270	0.256	0.250	0.213
Lot II.	0.294	0.294	0.278	0.256	0.238	0.204
Lot III.	0.357	0.345	0.333	0.333	0.307	0.307
Average.	0.309	0.303	0.294	0.282	0.265	0.241
Loss p. c.	..	1.94%	4.88%	8.73%	14.24%	22.01%
Tomato juice filtered after heating at 70°C						
Lot I.	0.256	0.256	0.238	0.213	0.137	0.094
Lot II.	0.259	0.256	0.232	0.186	0.133	0.095
Lot III.	0.270	0.246	0.243	0.185	0.125	0.090
Average.	0.262	0.253	0.238	0.195	0.132	0.095
Loss p. c.	..	3.43%	9.16%	25.57%	49.61%	64.50%

Effect of Heating the Juice at Different Temperatures

25 c.c. of the press juice are taken in a beaker and diluted with water and centrifuged. The centrifugate is made up to 250 c.c. and titrated against 2·6 dichlorophenol-indophenol in the usual way. Another lot of 25 c.c. of the juice is taken and kept at a temperature of 40°C for 10 minutes. It is then diluted with water and centrifuged. The centrifugate is made up to 250 c.c. and titrated in the usual way. The experiment is repeated by heating the juice at 60°C, 80°C and at last by boiling at 100°C. The results obtained are given in table No. III.

TABLE III

Ascorbic Acid in mg. per 1 gm.

Tomato juice unfiltered.

	Ordinary temp. 30°C.	Temp. 40°C.	Temp. 60°C.	Temp. 80°C.	Temp. 100°C.
Lot I.	0.400	0.400	0.400	0.348	0.344
Lot II.	0.408	0.408	0.392	0.392	0.377
Lot III.	0.323	0.323	0.307	0.298	0.290
Average	0.377	0.377	0.366	0.346	0.337

Effect of Cooking the Juice

A few gms of the tomato are washed and made into thin slices. 10 gms of the substance are taken in a mortar with a few gms of Merck's sea-sand and 2.5 c.c. of 20% trichoracetic acid. These are then ground with distilled water and centrifuged. The centrifugate is made up to 100 c.c. and titrated as before. The remaining portion is then cooked with necessary ingredients in the usual way, cooled and weighed, and

the weight in gms equivalent to 1 gm of the uncooked juice is calculated. 10 gms of the cooked substance is then titrated as before and the ascorbic acid content of that weight of the substance equivalent to 1 gm of the uncooked variety is attained. The percentage loss of the vitamin C in the process of cooking is calculated from the difference of the two values and the results are given in table No. IV.

TABLE IV

	Ascorbic acid in mg.per 1 gm.	Ascorbic acid in mg. per 1 gm.	Loss percent.
Lot I . .	0.235	0.200	14.89%
Lot II . .	0.271	0.234	13.65%
Lot III . .	0.277	0.231	16.60%
Average . .	0.261	0.222	15.05%

From table I it is evident that vitamin C is not lost in the process of coagulation of the protein. Table II shows that greater the quantity of water added during heating the greater becomes the loss of vitamin C. So in the process of cooking care must be taken to add minimum quantity of water. The best way is to cook without adding any water at all. It is also evident from the table that the loss of vitamin C becomes more prominent in the case of the protein-free juice and this is accelerated by the rise of temperature. Table III shows that only a very small amount of vitamin C is lost by heating. This may be attributed to the fact that some ascorbic acid in the combined state called 'ascorbigen' by Pal and Guha[5] may be present in the juice which breaks up on heating and compensates the loss thereby. Furthermore, it is found from table IV that the loss of vitamin C in the process of cooking is about 15% only.

Our sincere thanks are due to the authorities of the firm.

Biochemical Laboratory,
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Pharmaceutical Works Ltd.,
Calcutta.
16-8-38.

K. L. Das.
H. G. Biswas.

[1] K. Kumagail, *et al, Klin Wochenschr, 16*, 97, 1937.
[2] E. Bohnholtzer, *Deutsch. Med. Wochenschr., 63* 1001-1003, 1937.
[3] G. Vermeylen, *Brux. Med., 17*, 383-386, 1937.
[4] N. Narkoff, *Deutsch. Med., Wochenschr., 63*, 131-33, 1937.
[5] *Biochem. Journal, 27*, 303, 1933.
[6] *J. Ind. Chem. Soc., 12*, 30, 1935.
[7] *Curr. Sci., 2*, 390, 1935.
[8] Pal & Guha, *Proc. Biochem. Soc.*, Calcutta, 3, 8, 1936-37.

Notes on the Theory of the Elastic Pianoforte Hammer

The elastic hammer, which is supposed to behave like a hard load backed by a weightless spring, strikes the string at $x=a$: the string under tension T, and of linear density ρ, is fixed at $x=o$ and $x=l$.

If Y_a Y_1, and Y_2 are the displacements, at $x=a$, $x<a$, and $x>a$ respectively, then we have, in the usual manner,[1] (as $T=c^2\rho$)

$$\left.\begin{aligned} Y_1 &= Y_a \frac{\sinh Dx/c}{\sinh Da/c} \\ Y_2 &= Y_a \frac{\sinh D(l-x)/c}{\sinh Db/c} \end{aligned}\right\} \quad .. \quad (1),$$

where D stands for the operator (d/dt), and $b=l-a$.

The pressure P exerted by the load is given by

$$P = m\, d^2z/dt^2 = T\triangle(dy/dx)_{x=a} = -Eu \text{ (Hooke's Law)} \quad .. \quad (2),$$

where the displacement z of the hammer is given by

$$z = Y_a + \text{the compression } u \quad .. \quad .. \quad .. \quad (3),$$

Now with the help of Equations (1) and (3), Equation (2) gives,

$$\left.\begin{aligned} &[mD^2 + D.T/c(\coth D.a/c + \coth D.b/c)]Y_a + mD^2u = JD \\ \text{and} \quad &mD^2Y_a + (mD^2 + E)u = JD \end{aligned}\right\} \quad (4),$$

where $J=mv_0$, v_0 being the velocity of impact.

From (4), we have,

$$Y_a = v_0 1/F(D)$$

and

$$u = T/Ec(\coth D.a/c + \coth D.b/c)DY_a \quad .. \quad (5),$$

where

$$F(D) = D + (D^2\, T/Ec + T/mc) \times (\coth D.a/c + \coth D.b/c) \quad .. \quad (6).$$

As the hammer strikes near the end, b becomes large compared to a, and we get

Lt. $b \to \infty$, $\coth D.b/c = 1$, and
Lt. $a \to o$, $\coth D.a/c$ is equal to

$$c/Da\,[1 + (B_1 + L^1)(2\,Da/c)^2 - (B_2 + L^1)(2\,Da/c)^4] \quad .. \quad (7),$$

where $B_1 = \frac{1}{6}$, $B_2 = \frac{1}{30}$ are Bernoullian numbers.

With the help of Eqs. (7) and (6), (5) becomes

$$Y_a = \frac{EV_0c}{T}\left\{\frac{e^{\alpha t}}{(\alpha-\mu)^2+\nu^2} + \frac{e^{\mu t}}{\nu\sqrt{(\alpha-\mu)^2+\epsilon^2}}\sin(\nu t+\varepsilon)\right\} \quad (8),$$

where α, $\mu+i\nu$ and $\mu-i\nu$ are the roots of the cubic:

$$\frac{T}{Ec}D^3 + (1+\rho a/3m + T/Ea)D^2 + D.T/mc + T/ma = 0 \quad .. \quad (9),$$

and are given by

$$\left.\begin{aligned} \alpha &= -\left(\frac{m_1}{m} \cdot \frac{Ec}{T} - \frac{c}{a}\right) \\ \mu &= -\frac{T}{2m_1C} \\ \nu &= \sqrt{\left(\frac{T}{m_1c} - \frac{T^2}{4m^2_1c^2}\right)} \end{aligned}\right\} \quad (10)$$

and

$$\left.\begin{aligned} m_1 &= m + \frac{a\rho}{3} + \frac{Tm}{Ea} = m_0 + \frac{Tm}{Ea} \\ \varepsilon &= \tan^{-1}\frac{\nu}{\alpha-\mu} \end{aligned}\right\}$$

When the hammer is hard, *i.e.*, $\varepsilon \to \infty$, Eq. (8) becomes the same as given by Kaufmann. The expression for Y_a (Eq. 8) is perfectly general and is free from Kaufmann's assumption for the 'mass correction'. Attempts were also made to study a similar case by previous works[2], but these works have substituted the 'effective mass' of the hammer, that was assumed by Kaufmann, as such for the actual value of the same.

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August 1938.

Mohini Mohan Ghosh.

[1] *Operational Methods in Mathematical Physics*—Jeffreys, p. 57, 2nd Ed. (Camb.).
[2] *Phil. Mag.* 47, 1141, 1924; *Phys. Soc. Proc.* 40, 29, 1927.

An Anomaly in the Elastic Behaviour of India Rubber

For some time past I have been studying the elastic behaviour of India Rubber, which is very interesting, for, as is now known, it does not behave like ordinary elastic materials. Some recent experiments have shown a great disagreement betwen the values of modulii of elasticity determined by statical and dynamical methods for different loads and at different temperatures. An attempt to idendify the statically and dynamically determined values with the isothermal and adiabatic modulii was but natural. But the results which have been obtained and which will be published shortly elsewhere do not support this view.

In the case of the modulus of rigidity thermodynamical reasoning shows that the isothermal and the adiabatic modulii should be equal, whereas in the case of Young's modulus the two modulii must be different, the ratio depending upon the temperature, co-efficient of expansion and other factors, such as stress, etc. It is found that the dynamically determined values both for rigidity and Young's modulus are about double the statical values for ordinary temperatures. Further, in the case of rigidity it is found that for a given stress when the temperature is increased, the ratio of dynamical to statical rigidity decreases and when for a given temperature the stress is increased, the ratio increases. Thus for example, for a stress of about 4.9×10^6 Dynes/cm^2, the ratio decreases from 2.06 to 1.45 when the temperature increases from 0°C to 60°C, whereas for a stress of 11.32×10^6 dynes/cm^2, the variation of ratio for the same range of temperature is from 2.67 to 2.27.

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Delhi.
22-8-38.

A. N. Puri.

A. N. Puri, *Proc. National Academy of Science*, India, Vol. VII, Part I, 1937.

Fibre Saturation Point of Wood

Moisture is present in wood in three different forms, *e.g.*, (1) bound with the protoplasm of cells, (2) absorbed by cell-walls, and (3) free in cell cavities. On drying wood, the third form of water evaporates first, and then begins the evaporation of the second form. It is at this stage that the wood has the minimum moisture content which is in equilibrium with a saturated atmosphere and is called the fibre saturation point of wood. This critical point of wood has an important bearing on its various physical properties. Thus the strength, shrinkage, and electrical resistance enormously increase, while the thermal conductivity decreases with progressively reduced moisture contents beyond this point. A study of variation of these properties of wood at different stages of drying is obviously interesting, and the curves thereof will have each a sharp break at the fibre saturation point.

The author has had occasion to determine the fibre saturation point of wood by three different methods, namely shrinkage, electrical resistance and thermal conductivity measurements. The details of the work will be reported later, the following giving only a brief survey of the results obtained:—

The specimens selected for shrinkage measurements were rectangular ones 3"×1", and were progressively dried in an electrical oven at 100°C. Both radial and tangential shrinkages were measured at intervals by means of a caliper and the moisture contents noted (computed on weight of dry sample). Tangential shrinkage was always greater than the radial. Shrinkage was plotted against moisture content, and the break at the curve was taken to indicate the fibre saturation point.

Electrical resistance of wood is practically the same until the fibre saturation point is reached. But as drying

proceeds beyond this critical level, the resistance suddenly begins to increase. Observations were made on specimens cylindrical in shape, 2″ long and 1″ in diameter, with the grain running lengthwise. The arrangement of the apparatus was similar to that used by Myer and Rees of Syracuse University with certain modifications.

Thermal conductivity on the other hand decreases with progressive drying of timber. It may be noted that the break in the curve at the fibre saturation point is not so pronounced as in the two preceeding cases. The conductivity varies with regard to (*a*) direction of heat flow and (*b*) coarseness of the grain. Longitudinal conductivity is the greatest, then comes the radial, while the tangential conductivity is the least. The specimens used for the purpose of measuring thermal conductivity were some discs 4.7 mm. thick and 50 mm. in diameter. The method of measurements was similar to that employed by Griffiths and Kaye.[1]

The following are some of the results obtained:—

Timber.	*Fibre saturation point of wood as determined by.* Shrinkage % moisture.	Electrical resistance. % moisture.	Thermal conductivity. % moisture.
Shorea robusta (sal) ..	32.1	30.3	27.4
Mangifera indica (mango)	24.3	28.0	26.6
Cedrella Toona (toon) ..	26.4	32.2	28.1
Odina Wodier (jhingan)	29.2	30.6	26.3
Terminalia Arjuna (arjun)	28.6	31.2	24.2
Terminalia Tomentosa (laurel)	26.8	28.3	32.1
Canarium euphyllum (dhup)	30.0	27.4	31.2
Dalbergia latifolia (rose wood)	29.4	32.3	31.7
Chloroxylon Swietenia (satin wood)	27.3	23.4	29.9
Dichopsis elliptica (pali)	23.6	25.7	25.3
Adina cordifolia (holdu)	28.2	24.3	26.5
Bombax malabaricum (semul)	30.3	33.1	26.4
Pinus longifolia (chir)	22.8	26.4	25.1
Juglans regia (walnut)	28.7	30.9	32.3
Boswellia serrata (salai)	26.9	24.7	25.8
Cedrus Deodara (deodar)	23.7	26.8	30.0

It is not intended here to go into the details of the work and the mass of data collected. They will be reported in due course, when an attempt will also be made to account for certain discrepancies in the results given above. The fibre saturation point of the timbers that have been examined lies roughly between 23 to 33 per cent moisture content.

Calcutta. B. N. Mitra.
28-8-38.

[1] *Proc. Roy. Soc. A., 104,* 70, 1923.

A Note on the Estimation of Maleic Acid and Fumaric Acid

Lucas and Pressman[1] have developed a method for the estimation of maleic and fumaric acids by bromide-bromate mixture in acid solution with $HgSo_4$ as a catalyst. About 30 minutes were required by them for the completion of the reaction. In view of the long time required for the bromination, it was thought desirable to investigate whether maleic acid and fumaric acid could be estimated in presence of succinic acid by this method. The effect of phosphates was also studied.

The experimental arrangement was similar to that described by Lucas and Pressman[2]. It was found that maleic and fumaric acids could be estimated in presence of succinic acid by this method, and succinic acid did not interfere. When phosphates were present, a large excess of $HgSo_4$ had to be used otherwise low results were obtained. Probably phosphoric acid acts as a retarder to the bromination of maleic and fumaric acid in acid solution. This is contrary to the observation of Szegedy[3] who actually obtained high results in presence of phosphates at *pH* 8.4 H_3PO_4 probably acts as a retarder of the bromination whereas HPO_4'' and H_2PO_4' probably act as accelerators.

A detailed paper is being published elsewhere.

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5-9-38.

[1] *J. Ind. & Eng. Chem., 10,* 140, 1938.
[2] *Loc. Cit.*
[3] *Z. Annal. Chem., 109,* 316, 1937.

ERRATUM

For formula in Vol IV, No. 2, p. 184, col. 2, l. 4, *read*—

$$\text{Specific gravity} = \left\{ V + (W_2 - W_1) \Big/ \left\{ \begin{matrix} \text{density of} \\ \text{mercury at} \\ \text{the temp.} \\ \text{of exp.} \end{matrix} \right\} \right\} \times \left\{ \begin{matrix} W_1 \\ \hline \text{density of} \\ \text{water at} \\ \text{the temp.} \\ \text{of exp.} \end{matrix} \right\}$$

Publications Received

LUCKNOW UNIVERSITY STUDIES

PARASITIC WORMS AND DISEASES: LECTURES ON CERTAIN ASPECTS OF HELMINTHOLOGY, by Dr. G. S. Thapar, M. Sc., Ph.D.

SALTATION IN FUNGI, by Dr. S. N. Das Gupta, M.Sc., Ph.D., D.I.C.

LIESEGANG RINGS AND INFLUENCE OF MEDIA ON THEIR FORMATION, by Dr. A. C. Chatterji, D.Sc.

RECENT ADVANCES IN INDIAN PALAEOBOTANY, by Dr. B. Sahni, M.A., Sc.D., D.Sc., F.R.S., F.G.S., F.A.S.B.

PHOTOCHEMICAL PROCESSES, by Prof. P. S. MacMahon, M.Sc., B.Sc., F.I.C.

NITROGEN FIXATION AND ALKALI SOIL RECLAMATION, by Prof. N. R. Dhar, D.Sc., I.E.S.

THE GENERAL FIELD THEORY OF SCHOUTEN AND VAN DANTZIG, by Prof. N. G. Shabde, D.Sc.

THE THEORY AND CONSTRUCTION OF NON-DIFFERENTIABLE FUNCTIONS, by Dr. A. N. Singh.

ANNUAL REPORT (1937-38) OF THE INDIAN LAC RESEARCH INSTITUTE, RANCHI.

THIRD REPORT (1934-47) OF THE ROYAL INSTITUTE OF SCIENCE, BOMBAY.

REPORT (1936-37) OF THE WORK OF EDUCATION DEPARTMENT, HIGH COMMISSIONER FOR INDIA, LONDON.

REPORT OF THE LEAGUE OF NATIONS, Economic Committee on Preliminary investigations in to measures of a national or international character for raising the standards of living.

YEAR BOOK OF ROYAL ASIATIC SOCIETY OF BENGAL, Vol. II, 1936.

TABLES OF FUNCTIONS, by Dr. Eugene Jahnke and Fritz Emde. (G. Teubner, Leipzig).

Mathematical and Physical Sciences

Logic and Probability in Physics

—C. G. Darwin

AFTER the great loss suffered by England, nay, by the whole world, in the death of Lord Rutherford, it is inconceivable that one can do full justice to an address on Physical Science without mentioning him and his qualities. Like many of the modern physicists of repute I had the good fortune to serve in his labroatory in Manchester. From personal experience and from some of the interesting episodes we can form an estimate of the general traits of his character. I remember the occasion of a Sunday evening supper when he told us about the discovery of the nucleus that had arisen out of investigations into the scattering of α-particles in a sheet of good foil, and I remember being astonished at the use he could make of the vague recollections of what he had learnt in school about the hyperbola. It was subjected to various criticisms at the outset, but Rutherford got it right. It was a process I have heard described by saying that if Rutherford went into a chemical laboratory for a reagent he would somehow always go to the right bottle even if there were no labels. Of his later work, disintegration and so on, I will not speak, but only refer to one characteristic he showed in it. This was his capacity for changing his methods. When we try to assess the qualities of Lord Rutherford it would be difficult to classify him under a dichotomy of qualities for great men of science. For, he had that singular quality of being prepared for anything, of making each discovery fit on to the last and suggest the next.

In going over to the general subject of the address—Logic and Probability in Physics—I will only add that the life and work of Rutherford is the best possible text I could choose for the kind of view which I want to put before you. Recent scientific history has revealed a deep schism between the professional philosophers and the scientists, and this schism is worthy of examination. The position stands thus: There is a notable contrast between the way we think about things and the way we ought to think about them. We have set up as an ideal form of reasoning the formal logic which has held the field since the days of Aristotle. We rarely conform to this ideal. In as much as the old logic was devised for a world that was thought to have hard outlines, and that now the new mechanics have shown that the outlines are not hard, the method of reasoning must be changed. The key to the modification has already long been in our hands in the principle of probability, but whereas in the past constant attempts were made to fit this into the old system, the new mechanics suggests the possibility of a different synthesis.

Let us examine the position more critically. Why do we believe in the various theories that we are all agreed to accept? Once a theory has become well-established we usually get to work to find a system of axioms, postulates, indefinables and so on, from which it may be derived. For example, classical mechanics is based on Newton's Laws, or whatever system has been substituted for them by later criticism. The direct derivation of everything from an axiomatic basis has an attractive simplicity, but it tends to make us think that, we believe in the theory because of the axioms, whereas the axioms are only a convenient shorthand summarizing a wide field of information, and they are believed in merely because we believe in the theory.

Looking from a different angle, the 'logic' school of thought often takes recourse to the idea of a 'crucial experiment,' that which gives the answer 'yes' or 'no' to the whole theory. The most crucial experiment ever done was the Michelson-Morley experiment on ether-drift, which was made the basis of the whole Theory of Relativity. Michelson and Morley showed that to the limits of the precision of their apparatus there was no ether-drift. For some twenty years the Theory of Relativity grew enormously, based on this one experiment. Later Dayton Miller undertook the task of repeating the experiment of Michelson and Morley with better equipment. He failed, however, to verify the exact vanishing of the ether-drift. The crucial experiment thus failed. But nobody doubted relativity. There must, therefore, be some unknown sources of error which had upset Miller's work; and, as Miller was improving on Michelson, it follows that Michelson's work must have had two unknown sources of error which happened to cancel one another. In spite of the crucial experiment we do believe in relativity, on the ground that we see that it is a number of cumulative pieces of evidence which all fit together, and it is this cumulation, and not any one of its pieces, that makes us believe in the Theory of Relativity.

From such examples we conclude that an axiomatic basis, of the kind demanded for the operations of formal logic, is too narrow for the understanding of the physical world. Something wider is needed. It has been known also that this widening must be effected by the inclusion of "probability" in the narrow fold of the old logic. Attempts have been made, and are still being made, to bring probability into our system of reasoning, but these attempts have been always abortive. To any one who has thought seriously about the world, or, at any rate, has made an elementary study of mechanics, there is nothing more absolute than the "Law of Causality". By this it is meant that the future is completely contained in the present. Obviously there are examples that are true to this law—the orbits of planets and the paths of projectiles are such. But let us consider the tossing of a coin. We know that there is an even chance of heads or tails. Even though we could eliminate the human factor by taking recourse to a mechnical device of tossing the coin the results would not be otherwise. We try to explain away any question of probability: we do not feel that the fall of the coin is determined by chance, but we regard the uncertainty we observe as due to our ignorance of all the detailed causes. At any rate, we start prejudiced *against* probability and *in favour of* causality. But time is come when we are being freed from the absoluteness of causality.

The development of physics in the first quarter of the 20th century is the most remarkable period in the history of human thought. In 1901 Planck started the Quantum Theory. The work went rather deep into statistical theory, and there were many for long afterwards who were not convinced of its compelling force. And Planck knew that he had got something involving the revolutionary idea—the quantum. Einstein's theory of photo-electric effect, and of the ionization produced by X-rays, his theory of specific heats later improved by Debye, and Bohr's theory of spectra, all involved the same revolutionary idea. This was a conflict with the idea of the 19th century. Whereas Fresnel had *proved* that a beam of light was a system of waves Einstein was insisting on a composition of arrows! What does a rational being do when faced with two mutually contradictory ideas based on evidence? It was a nice test of the critical spirit and it revealed a wide divergence of choices. About the time when the Kinetic Theory of Gases was firmly established and the statistical theories of matter formed as essential part of physical education based on the works of Maxwell, Gibbs and Boltzmann, there was no common habit of thought on statistical lines. On the other hand, the laboratory workers, dealing with atoms and electrons, could not fail to be more impressed with the discontinuous phenomena and the beautiful way these could be explained by the quantum. Many accepted the Bohr orbits as a complete explanation of the hydrogen spectrum, ignoring the absurdity of supposing a sharp jump from one orbit to another for a train of waves shown by the spectroscope to be lasting for quite a long time. Bohr and other leaders recognized the difficulties and expected that a higher synthesis would emerge to fit everything in proper coherence.

As time went on the idea of quantum got stronger and stronger until about 1925, guided by the Correspondence Principle, things were moving towards a tentative theory of the refractive index, which suggested a break in the contradictions. Acting on a hint given by the theory of refraction, Heisenberg was led to the suggestion that the contradictions of the atomic theory would disappear if one adopted the idea of non-commutative algebra in dealing with the motions of electrons in an atom. Then the flood-gates opened and the whole New Quantum theory burst forth. A quite different approach was made independently by de Broglie and Schrödinger.

At first the work was of a formal kind,—a complete synthesis of the rival doctrines of particle and wave mechanics, but a very interesting point arose in connection with the discovery. In his first paper Heisenberg laid great stress on the idea of

building theory only on directly observable quantities. The electron's orbit is certainly not observable, much less the electric force which is the amplitude in the light-wave emitted by the atom. So he modified his theory to remedy the defect by means of the Uncertainty Principle. This Principle asserts that it is impossible simultaneously to measure the position and velocity of any body, because the measurement of either inevitably produces a change of indeterminate amount in the other. This Principle showed up the fallacy in the old arguments about causality. It is now easy to see, that there is nothing wrong with the old inference that if one knows all about the present one can forecast the future exactly; the trouble is the impossibility of knowing the present. So the doctrine of theorizing only about the observables was not really a useful doctrine. In fact, we may well ask what an observable is, and if we go at all beyond direct sensations—such as physicists intend to do—the answer becomes perfectly indefinite. The idea of causality has thus been relegated from its absoluteness to its proper place; and the New Quantum Theory has convinced us about the failure of the causality principle and has replaced the classical mechanics in the light of observed facts. The idea of logic needs a change in a like manner so that the idea of probability may be brought within the fold of the old logic.

In the early days of Kinetic Theory the central problem was the law of distribution of velocities of the molecules and attempts were made to prove the law absolutely from dynamics. Here we want to know something about the behaviour of a complicated system composed of a great many parts; say, we want to know the pressure of the gas in some vessel. If we tried to attack the question by pure mechanics, we should be faced with an enormous number of mechanical equations for the motions of the molecules, and even if these could be solved the solution would be of no use, because it would depend on the initial positions and velocities of the molecules, and these we should not know. Gibbs considered a very large number of possible states of motion, which have some character in common, such as their total energy, but which were otherwise unrelated. Though each specimen of the motions is quite independent of all the others, he looked at them all together and formed an idea of a canonical *ensemble*. The behaviour of the gas, according to this view, will be determined by the average of the millions of such specimens of the ensemble. With the old mechanics all this involved ideas were hard to accept. The principle of probability, embodied in the averaging over the ensemble, was frankly laid on top of the logical principles of Newtonian mechanics. The real gas in the vessel is not merely one specimen of the ensemble, but is itself the whole of the ensemble. We used to think of the gas as *either* in the state A, *or* in the state B, *or* in C, but according to the new physics we have to think of it as in *all* the states A *and* B *and* C. The principle of probability, which used to be loosely superposed on the old logical principle, is now with the new mechanics fully united with it in a higher synthesis.

We come to the conclusion that the new physics has definitely shown that nature has no sharp edges, and if there is a slight fuzziness inherent in absolutely all the facts of the world, then we must be wrong if we attempt to draw a picture in hard outline. In the old days it looked as if the world had hard outlines, and the old logic was the appropriate machinery for its discussion. Things went wrong when it was found necessary to call in the help of the principle of probability; this appeared first as an alien, but there was hope in the old days that the alien might be naturalized. How far it will be possible to make a full synthesis of the new and the old I do not know, but that some day a real synthesis will be made like that of the NEW Quantum Theory, so that a reformed scaffolding may be constructed on a new principle of reasoning.

In this connection a point may be suggested to the authorities of education. Although the point may be subjected to all sorts of criticisms yet I think that the subject of probability ought to play an enormously greater part in our mathematical-physical education. Things are better now than they were, but mathematicians are still so interested in the study of rigorous proof that all sorts of emphasis go against the study of probability. This should be immediately remedied. This is not to say that special new courses are needed, but rather a change in the spirit of our old courses. When a boy learns about the weighing machine the teacher should emphasise its sensitivity and the length of time that must be taken for the weighing. In giving a problem on projectiles the boy must be taught to consider the zone of danger and not merely the point of fall. For a rather advanced course, I hope at the school, the teacher should introduce the idea of a distribution law; for example, in doing central orbits Rutherford's law of scattering must be worked out and so on. All these things ought to be examples of a familiar train of thought, and not merely a highly specialised side branch of mathematics at the University.

If these reforms are carried out I shall hope that generations will grow up which have a facility in thinking about the world in the way which the quantum theory has shown to be the true one. Inaccuracy in the world will not be associated with inaccuracy of thought, and the result will be, I am sure, a fuller and better understanding of the basis of natural philosophy.

K. B.

Economic Science and Statistics

Scope and Method of Eonomsi

—R. F. Harrod

THE voice of the new economists—trying to answer to the challenge of the chaotic economic situation on the one hand and of the jeremiads of economists and others on the other,—ring clear and true through Mr Harrod's address, Mr Harrod begins with a short disquisition on the rôle of the methodologist.

> Each science or discipline has its own special limitations and conditions; its method of progress has its own special characteristics; within the wide field of logical possibilities some are selected as especially adapted to its problems; it is with this selection that methodology is concerned. And for this reason the methodologist is bound to occupy the rear and not the vanguard. He studies the specific nature of the selected principles after the selection has been made. Methods of course change from time to time; but the actual worker on special problems is more likely than the methodologist to be able to judge the best line of advance. The methodologist's contribution is more indirect.

> On first glance this relegation of the methodologist to the rear might seem to give public endorsement to what has all the time been the inward suspicion of the pioneer that he is an utterly useless being. But in fact by reducing his claims he at once becomes much more useful. The forward worker is inevitably influenced by methods used in the past; methods that have already achieved good results may be expected to achieve more; tools ready to hand are taken up. By going over the old ground and making a stricter survey, the methodologist may considerably modify this influence of the past upon the present.

The Economic Criterion

The criterion which the economist has in mind in appraising institutions and practices and making recommendations is that of the "economic good" which determines preferences. It is on the basis of this criterion that economists have been prone to make suggestions. Such advice has been discounted from two quarters, *viz.*, the zealous protagonists for the scientific character of economics, and politicians or moral philosophers. The former group have suggested that

> the economist in his advisory capacity should state that a given interference will lead to certain consequences X, Y, Z . . . and then remain silent, leaving his client to decide whether X, Y, Z . . . is a state of affairs which he wishes to bring about. This formulation is in manifest conflict with the actual practice of economists. Also this formulation claims both too much and too little.

It claims too much because it gives an exaggerated idea of the economist's power of prediction at the present juncture. It claims too little because it entails that his advisory power is confined within the narrow limits of his predictory power. Moreover it would make him present his information in a form in which it would be of no use to his client.

The second group of objectors argue that ends are to be determined by them and the economist's function is to prescribe the "economical way" among the infinite alternatives. This criticism, according to Mr Harrod, is not valid, because the economist

> uses his criterion both to give advice *simpliciter* and to give it subject to an overriding end furnished to him. If it were true that there is a latent ethical or political bias when he gives advice *simpliciter*, it would be equally true when he advices on the means to achieve an end laid down by moralists or politicians. Without his own criterion, he is entirely stultified. With it, he can give advice of precisely equal validity and freedom from ethical bias whether a specific end is furnished to him or not.

The Analytical Map

The mechanism for testing whether the requirements of the criterion are fulfilled or not is based on the analytical map. The complex phenomena of markets and prices might be regarded as "the result of the efforts of individuals to inform each other of their preferences."

Economists have constructed a map or model in which individuals are seen informing each other of their preferences.

The map is to some extent hypothetical. It supposes that various activities may be interpreted as notifications of preferences. On the other hand it is drawn with reference to the facts of the situation, assuming, if appropriate, such matters as private property, private ownership of land, unequal division of wealth, even special types of banking institution, company organisation, etc., and traces how the mutual notification, which it supposes to be intended, operates in these conditions.

By means of the map we are enabled to get a view of the economic field as a whole. This is necessary for prescription. A particular piece of legislation may be well designed to secure its specific object. All reasonable men will wish to know, and it is the economist's task to say, how this fits in with the larger purpose, for which the whole economic mechanism is designed. To what extent does the specific objective militate against or further the more general purpose?* This can be studied by reference to the analytical conspectus.

How far the facts of real life correspond to those envisaged in the map is a matter of observation and it should be subjected to continuous check. Economists of the past were perhaps too hasty in assuming exact correspondence.

More recently there has been a proper tendency to go beyond this negative attitude and to consider what interferences might be introduced to make the real world more like the map. Recommendations of this sort must be based on a vigilant observation of the actual working of real institutions (but they do not rest on causal laws or predictory powers).

Validity of Economist's Prescription

The rôle of the economist in formulating schemes and giving his judgements becomes, in Mr Harrod's opinion, "more and not less important" in view of recent wide-spread growth of government interference.

Officially sponsored rationalisation schemes, arrangements for the semi-public operation of services, public policy with regard to road and rail transport, marketing board arrangements all require vigilant scrutiny in the light of the criterion, to say nothing of more full-blooded socialist programmes. Even if public policy appears to violate the advice which the economist would give *simpliciter*, this is no excuse for him not to take an interest in the fulfilment of his criterion subject to the overriding demands of policy. He may think that there is no case for giving agriculture special protection; in the face of the opposite policy he has scope enough to criticise the arrangements introduced to give effect to it. If he loses interest in this field of thought, the country is only too likely to get tied up with red tape and be subject to vast avoidable wastage.

A more general objection to the scope of the economist's prescription is disposed of by Mr Harrod in the following lines:

> The distribution of income is intimately connected with the balance of social and political forces, the study of which is outside the economist's province. In prescribing here he knows without being told that there are other considerations. This is not to say that he should avoid all questions with political entanglements, for then again he would be almost completely stultified. Most vested interests can whip up some political support. It is a matter of degree and sense of proporion.

It might further be urged that since redistribution is a straightforward matter widely understood, the economist might well leave it alone, since he can but reinforce in technical language an argument already before the public. Projects of redistribution, however, may have complicated ramifications which the economist is especially qualified by his other training to trace out. For instance, in his *Public Finance* Prof. Pigou has worked out with great elaboration the principles and consequences of a redistributive system of taxation. It may safely be said that this work would have been beyond the powers of any but a highly trained economist.

Dynamic Economics

The most significant portion of the address, however, deals with the study of 'dynamic' economics, as a department wherein future progress is likely to lie. The 'pure theory of traditional economics' has been concerned mainly with the 'static theory' of value and distribution, which were elevated by Ricardo to the status of being regarded as "the principal problem of Political Economy." Mr Harrod is critical of the potentialities of this line of investigation.

The theory of value and distribution seeks to show how a number of circumstances taken as given (the fundamental data)—namely, the preferences and capacities of individuals and the available resources—serve to determine a structure of output and prices. If a change in these data occurs, the theory professes ability to predict the consequences within certain limits on the price-output structure. This professed ability to predict implies that we have available certain general laws concerning the succession of events, causal laws in fact.

The causal laws of static theory are deducible from the law of demand. This is well based on a very wide experience; it is in no need of verification; further attempts to verify it could not add to the assurance with which we already hold it. But the laws are of a very general form and little prediction can be based upon them, nor are they the source of the recommendations of traditional economics. More specific laws would have to be based on detailed empirical research and would be highly conjectural. While great interest attaches to such empirical work, it is not clear that this should be the main avenue for future developments; but, if it is not to be, then the general theory of value must itself be displaced from its central position.

His plea for a departure in methodology in relation to the study of 'dynamic' economics will be explained by the following extracts:

> I believe that there ought to be alongside of static theory a body of laws relating to the increase (or decline) of economic magnitudes, and that with the aid of a very few empirical generalisations, having high authority if somewhat less than the law of demand itself, it may be possible without more ado to construct such a body of laws. I conceive the analogy between the relation of dynamics to statics in mechanics and that of this branch of economics to the static theory to be much closer than that implied in recent uses of the word dynamics in economics. While the equilibrium price determined by the maintenance of a steady flow of demand and supply corresponds to a state of rest, new equations would be formulated to determine regular movements in the economic magnitudes under the influence of growth of population, savings, inventions, etc.

This line of thought is not, of course, new. The classical economists attached great importance to the alleged tendencies of rent to rise and profits to fall. Such considerations are not absent from Marshall. But generalisations of this kind have tended to recede from view both to their conjectural character and to the more precise formulation of static propositions in a mathematical garb. The existence of this formulation has in turn tended to lead monetary and trade cycle theorists, who are interested in change as such, to regard the phenomena of their study in terms of transitions from one static equilibrium to another. It may be that they would be greatly assisted if they could regard them as departures from or oscillations about a path of growth; but they can only do this effectively if the laws governing increase are as precisely formulated as the static laws. We need a system of fundamental equations using simplifying assumptions; *cf.* the frictionless surface, etc., in which rates of increase will themselves figure as unknown terms.

Empirical Studies

The concluding section deals with what the speaker realises to be 'the most difficult, the most tentative, and withal the most important' studies; which he expects to be 'the most important in the future.' The high importance of the work of classification, constituting the 'major part of traditional economic theory,' should be recognised; and the empiricist, however radical, is warned, that unless he can use this as an indispensable tool for further investigation, he is likely to founder. Undoubtedly, a large part of economic classification is based on experience but what is wanted is closer investigation. Taking an instance from the study of trade cycles, over which Mr Harrod very justly, though humourously claim "certain proprietary rights," he states:—

> It is an accepted generalisation, not indeed possessing the universal validity of the law of demand but none the less of substantial authority and interest, that in the upswing of production prices have a rising tendency and in the downswing a falling tendency. It may safely be said this could not be deduced from the propositions of static theory nor from that part of momentary theory which is deducible from them. Falling prices would be regarded as an equally (if not more!) likely accompaniment of rising output and *vice versa*. The generalisation is a direct result of observation, an excellent example of the facts speaking for themselves. And if theoretical explanations have subsequently been woven round it, this must not blind us to the true source of our knowledge. If rather crude observational data can yield appetising morsels of this sort, may we not legitimately hope that when subjected to refined statistical treatment they will yield more fruit in plenty? It will still be necessary to relate such generalisations to each other and to those of a more deductive origin in an orderly fashion.

Mr Harrod puts in a strong plea for the 'endowment of full-time workers of the right temperament and the provision of adequate laboratory

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* If I interpret him aright, this account is in accordance with the view expressed by Prof. Robbins in his section on 'rationality' in the concluding section of the *Nature and Significance of Economic Science*. Cf. also Prof. G. Cassel, *Fundamental Thoughts on Economics*, p. 14.

equipment and skilled assistants' and ends in an optimistic note.

I believe that we may be on the eve of a great advance in economic theory, taking us right outside the ambit of the static system of equations. The wealth of statistical data, together with the indications resident in the trade cycle that the succession of events is governed by laws still undiscovered, should be a spur to the inventiveness and enthusiasm of every student to whom the ways of science make appeal. He may reasonably feel that any day he may light upon some general relation of wide validity, satisfying to the intellect and capable of yielding vast benefit to humanity. The prospect is an inspiring one.

An Indian reader might pertinently observe in Mr Harrod's address a justification of the empirical investigation and analysis carried on under the name 'Indian Economics.' The study of economics must needs be supplemented—and that in an adequate manner—by close observation of the facts and factors around us. For such a task if British academic workers are handicapped because of the heavy burden of 'teaching and administrative duties,' how much more true it is of workers in India. The state and community can only neglect to note the need for economic research and field-work, at their own peril.

B. N. B.

Chemistry

Recent Investigations in the Chemistry of Gold

—Prof. Charles S. Gibson

PROFESSOR Gibson in his address has made a review of the recent work on the preparation, properties and the structure of gold compounds, specially of those containing organic radicals or co-ordinated organic molecules. A notable contribution to the subject has been made by Prof. Gibson himself and his co-workers.

By the results of these investigations it is now realized that there are fewer anomalies among the metals of the sub-group I B, copper, silver and gold, than was formerly believed. These, however, differ widely from the alkali metals except in the fact that they are all capable of being univalent. This difference between the metals of the two sub-groups is to be attributed to their different electronic structure. The metals of the sub-group I B have eighteen electrons in their penultimate electronic group whereas the alkali metals have only eight electrons in that group. The multivalency of copper, silver and gold results also from this eighteen electronic group. The univalency and bivalency of copper and silver are well-established, but gold can exist only in the univalent and tervalent conditions. This distinguishes it from copper and silver.

Argentous silver differs greatly from cuprous copper and aurous gold. There is no evidence for the existence of any normal aurous salt and some cuprous salts are very unstable. Cuprous and silver halides, on the other hand, in the solid state are non-ionic and isomorphous. As cuprous chloride is bimolecular, the cuprous atom in its halides is possibly bi-covalent. From recent chemical evidences, this is also true of aurous gold in aurous halides. Hence it is concluded that cuprous copper, argentous silver and aurous gold in their halides are 2-covalent and have the general formula

where X=halogen. 

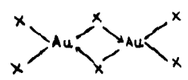
Unlike bivalent copper, bivalent silver is unstable and exists only as a complexion, *e.g.*, *bis-aa'* dipyridyl argentic persulphate, *tris-aa'* dipyridyl argentic nitrate, perchlorate etc. Hence bivalent silver may have co-ordination members of 4 and 6. On the other hand, bivalent silver resembles bivalent copper in forming an inner mettallic complex with picolinic acid having a planar structure as shown by Cox, Wardlaw and Webster (1936).

That cuprous copper and argentous silver can exhibit 2-and 4-covalency is well established. This is evident from the composition of various cupro- and argento cyanides. But the only complex cyanide

of aurous gold—potassium auro-cyanide—has only a co-valency of 2 for the aurous atom. This is also evident from the crystallographic investigation of tri-alkyl phosphine and tri-alkyl arsine derivatives of cuprous, silver and aurous halides. Study of the compounds of thioacetamide with cuprous, argentous and aurous halides leads also to the conclusion that aurous atom cannot exhibit a co-valency higher than two.

The tervalent gold alone is always co-ordinated and is 4-covalent, with a planar configuration. Hence optical activity can only be sought in 4-covalent aurous compounds, if they can be prepared, with tetrahedral configuration.

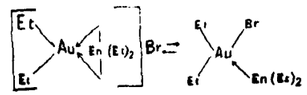
Like the aurous halides, aurichalides are also complex and should not be represented in the normal way, auric gold is always 4-covalent. This is true also of more recently investigated compounds like hydronitroauric acid, hydrosuccinimido chloroauric acid, hydrophthalimido hydroxyauric acid and hydromethyl glyoxivinylboromo auric acid. It was already shown by Fisher (1929) that molecular formula of auric chloride is Au_2Cl_6. The composition of this and the analogous bromo-compound should be represented by general formula



(X=Cl or Br). They should, therefore be termed tri-chloro, and tri-bromo gold.

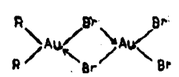
Chief advances in the chemistry of gold have been achieved by Prof. Gibson and his colleagues from a study of the organic derivatives of gold and specially of certain types of organic sulphur compounds.

As a product of the interaction of the Grignard reagent and the pyridinotrichlorogold, di-alkyl halogeno gold compounds were prepared. These were found to be non-electrolytes, with molecular weights twice that represented by their empirical formula. They and their co-ordination compounds all contained 4-covalent auric gold. This led to the conclusion that the 4-covalency is an essential feature of all auric compounds. Among these compounds mention may be made of diethylmonobromo gold, aminoethylbromo gold, pyridinodiethylbromo gold, dibenzyl sulphidediethylbromo gold and acetylacetonediethyl gold. The change of mono-ethylene-diaminotetra-n-propyldibromodi gold by heat indicated that suitable organic gold compounds may be the potential source of free radicals and that it is possible to prepare mixed auric-aurous compounds containg 4-covalent auric gold and 2-covalent aurous gold in the same molecule. Other cases of compounds containing two 4-covalent auric gold atoms in the molecule, which similarly break down with the initial production of free radicals and simultaneous formation of a mixed auric aurous compounds have also been reported. Such decompositions suggest the possibility of establishing the existence of auro-auric halides of the formula Au_2X_4 (formerly written as AuX_2 and given as examples of bivalent gold) as intermediate products in the decomposition of the trihalides to the monohalides. The interaction of diethylmonobromo gold with the asymmetrical N-diethylethylenediamine (Brain and Gibson, 1938) results in the production of a colourless crystalline compound soluble both in water and benzene. It appears therefore to be both a salt and a non-electrolyte. This constitutes a unique case of tautomerism, of course, not resonance. It dissociates in aqueons solution but shows considerable association in organic solvents. Its constitution should be represented as:



where Et=ethyl group; $En(Et)_2$=N-diethylethylenediamine.

Monoalkyl (ethyl and n-propyl) dibromo gold compounds also have been prepared by the action of bromine upon dialkylmonobromo gold compounds. Their molecular weights show that they are dimeric —$(RAuBr_2)_2$ and their high dipole moments suggest an unsymmetrical constitution:



This is in keeping with their formation from equimolecular quantities of dialkylmonobromo gold compounds and tribromo gold and with their physical and chemical properties. Their decomposition into alkyl bromide and aurous bromide (Au_2Br_2) furnishes a chemical evidence concerning the constitution of the latter. Chemically these compounds behave as equimolecular mixtures of gold tribromide

and the dialkyl monobromo gold. The preparation of a 4-covalent complex auric salt with a tervalent cation—diethylenediamine gold tribromide [Au En_2] Br_3 and a univalent cation—ethylenediamine dialkylgold bromide [R_2AuEn] Br have also been reported (Gibson, Simonsen and Colles, 1930, 1931). The former belongs to the class of complex auric ammines described by Weitz (1915).

By the direct action of silver cyanide on the dialkylmonobromo gold compounds Prof. Gibson and his colleagues have succeeded in preparing the corresponding cyanoderivatives. These compounds have unique properties and their detailed investigations have revealed a number of interesting features in connexion with the general chemistry of gold.

Unlike their anologues, the dialkylmonocyano gold are tetrameric and contain therefore four atoms of tervalent gold in the molecules. In the molecule of such compounds gold atoms must be attached to the carbon atoms of the cyanogen groups and the nitrogen atoms must be co-ordinated to neighbouring gold atoms.

This gives rise to a symmetrical twelve atom planar ring structure. This is in keeping with the stereochemical configuration of the cyanogen group, with the low dipole moment for the n-propy compound, with the 4-cavalency of the auric gold atoms and with the result of X-ray crystallographic investigation. The decomposition of these compounds have been quantitatively investigated. As intermediate products of decomposition mixed 4-covalent auric and 2-covalent aurous compounds have been obtained as in the halide series. The final product is monocyano gold (aurous cyanide). This decomposition affords chemical evidence regarding the constitution of the aurous cyanide, indicating that it is a non-electrolyte 2-covalent tetrameric aurous compound and that like its parent compound it is planar. As in the case of the halide series the decomposition of the parent compounds proceeds with the evolution of gas indicating the initial production of free radicals. These latter were not identified as such but as the paraffin hydrocarbons to which they should give rise.

As a result of X-ray crystallographic investigations by Powell and his collaborators on organic gold compounds, on Mann's co-ordination compounds of aurous gold by Wells and potassium bromoaurate by Cox and Webster, the planar configuration of the four valencies of tervalent gold and the linear configuration of the two valencies of aurous gold have been well established.

The result of the X-ray study of the simplest organic gold compound, diethylmonobromo gold has been discussed and the projection of the molecule on the plane of the gold and bromine atoms is represented by diagrams. An interpretation of the X-ray study of the much more complicated compund, di-n-propylmonocyano gold, illustrated by figures, is given, which strikingly confirms the constitution deduced from the chemical and physical properties of the substance. In the case of the previous compound also the structure suggested by the X-ray data is in agreement with that deduced from molecular weight determination and electronic structure.

A detailed consideration of the properties of the bis (dibenzylsulphidodibromo gold), which is prepared by mixing equimolecular quantities of 2-covalent aurous compound, dibenzylsulphidomonobromo gold and 4-covalent auric compound, dibenzylsulphidotribromo gold in a suitable solvent, present certain interesting features. The apparent molecular weight of the substance in freezing bromoform affords no information as to its constitution. The knowledge of the chemical and physical properties in this particular case is inadequate for determining the constitution of the substance in the solid state. The constitution suggested on the basis of the recognized principles of co-ordination can only be tested by a careful crystallographic and X-ray analysis. Two possibilities in the linking up of aurous and auric compounds in this case have been suggested by Prof. Gibson: (a) the aurous gold atom may become 4-covalent with a tetrahedral configuration assuming an Effective Atomic Number of 86, or (b) the auric gold atom may become 5-covalent with a pryamidal configuration and assuming an Effective Atomic Number of 86. For a decision on this point and similar vexed problems chemists, as Prof. Gibson points out, will have to rely almost completely on crystallographic technique for the determination of the constitution of substances.

P. R.

Geology

Development and Evolution

—Prof. H. H. Swinnerton

Biologists and palaeontologists both agree that a a specific individual, in developing from an embryo to an adult, through epembryonic or neanic stages, recapitulates at a certain stage of its life-history, the general or some specific character observed throughout the evolution of its race, or more technically and concisely, 'Ontogeny repeats Phylogeny.'

Now the point in dispute between these two classes of workers, is whether or no the adult conditions of the race are recapitulated in the young stages of the individual. Some thinkers, especially upon the biological side, say emphatically 'No.' Others, especially, invertebrate palaeontologists, say 'Yes.' The divergent views have arisen chiefly because of the different types of material the two classes of workers handle. But in so far as they are on the whole dealing with different portions of the same life-history, the biologists being concerned with embryonic, larval and foetal stages and the palaeontologist with the neanic stage which is more abundantly preserved in the fossil state, their observations and conclusions are not contradictory but suplementary. It seems appropriate therefore that an attempt should be made to re-examine the evidence in the hope of gaining a clearer understanding of the relationships of the various view-points to one another. From such a survey geology and biology have much to gain.

The two viewpoints may be summed up here: (1) 'The young stages in the development of an animal are not like the adult stages of other animals lower down in the scale but are like the young stages of those animals' (Von Baer), and (2) Haeckel's teaching, *viz.*, 'The adult stages of the ancestors are repeated during the development of the descendants, but are crowded back into the earlier stages of ontogeny, therefore making the latter an abbreviated repetition of Phylogeny' (v. de Beer). This is variously referred to as the Theory of Recapitulation, the Principle of Palingenesis and the Biogenetic Law.

Any consideration of the relationship of development to evolution must deal with the subject from two aspects, *viz., retrospective* and *prospective,* that is whether the evolutionary changes of the past are reflected in development and if so, to what extent (retrospetive) and whether future evolutionary changes of sudden or of sequential character are foreshadowed in development (introspective).

Restrospective Aspect

An examination of the forms typical of various phases in the evolution of the coral gens *Zaphrentis delanouei,* through the *Z. delanouei* (*s. str,*) *Z. parallela, Z. constricta,* and *Z. disjuncta* (early, typical and advanced) stages, showed clearly that specific recapitulation of adult characters had taken place. Thus the penultimate stage in the growth of *Z. parallela* bears a much closer resemblance to the adult of the ancestral species *Z. delanouei* (*s. str.*) than it does to the adult of *Z. parallela.* Similarly, the penultimate stage in the development of *Z. constricta* repeats the sum-total of the characteristics distinctive of the adult ancestor *Z. parallela,* whilst the antepenultimate stage exhibits a similarly close resemblance to the ancestral adult *Z. delanouei* (*s. str.*).

A more recent examination of the same material revealed several earlier stages than those just mentioned—these however closely resemble the correspondingly young stage of the ancestor *Z. delanouei* (*s. str.*). They provide therefore an excellent example of the recapitulation of juvenile conditions described by Von Baer and emphasised by modern biologists, as the later growth stages provided for the recapitulation of adult conditions reiterated above. Further, one also recognises that the embryo in this case appears to retain features characteristic not only of the embryonic stages of other species of *Zaphrentis,* but also of other members of the phylum. This fact also shows that the principle is applicable to forms belonging to different periods of time as well, and that its application is not restricted to contemporary animals alone.

The embryonic condition must be regarded as the culmination of a long process of evolution of embryos in which many factors which concerned the adult life have played no part, but in which factors foundational to adult development have been preserved. The neanic stages, on the other hand, have recapitulated the adult condition exhibited by the preceding members of the gens to which the species belongs. Further, within the neanic stages, the principle of acceleration or tachygenesis is perfectly exemplified, but its action so far as the adult combination of the features is concerned, does not penetrate back into the transitional and embryonic stages.

The same phenomena as described above are also met with in foraminifera, (*e.g.*, in the *Operculina—Heterostegina—Cyclocypeus* series), in lamellibranchs (*e.g.* the gens *Gryphǽa incurva*), and in other groups of animals as well. From a general survey of all groups of animals, one overruling fact seems to emerge, viz., that the more lowly and simple the organism the more complete is the recapitulation.

Localised Recapitulation and Recapitulation in Colonial Organisms

Phenomena of localised recapitulation which have a bearing upon the problem under discussion are commonly observed in those parts of the body which are metamerically repeated or are reproduced by budding, *e.g.*, the ambulacral plates of echinoids. In *Hemiciduris*, the newly formed plates in the upper part of the body are like those fully grown plants of the earlier genera Lepidocentridae in form and number of pores, which is an instance of adult recapitulation. Similar phenomena are also observed in the metamerically repeated parts of organisms living in colonies, *e.g.*, the polyzoon genus *Stromatopora*.

However complete and specific the recapitulatory record may be at the outset, in subsequent generations it becomes curtailed as the result of increasing acceleration in individual development. This leads to the skipping of stages either by a 'mere shortening of ontogeny' in cases where evolutionary trends remain constant, or by a 'straightening of ontogeny' where new trends, out of accord with the foregoing, set in. The record also becomes vitiated as the result of the fact that acceleration is not constant for all features, and consequently the combination of characters exhibited by the adult ancestor becomes broken up, or even eliminated from the development of the descendants.

Prospective Aspect

Though Haeckel's main emphasis was upon recapitulation, he realised that factors which were at work, tended to vitiate the developmental record. Among these was the appearance, in larvae and embryos, of features which were adaptations to the conditions under which these immature organism lived (Cœnogenesis). Although some cœnogenetic characters apparently exert no appreciable direct influence upon the later stages, there are others which may possibly have exerted a radical influence upon subsequent growth and evolution, *e.g.*, the rotation through nearly 180° of the visceral hump with its shell in some gastropods whilst they are still in an embryonic stage. This cœnogenetically introduced character does not displace but plays its part along with those which belong to the ancient category.

There are other cœnogenetic characters however which extend gradually, during the process of evolution, into later stages, (Proterogenesis) as in the case of the *Rhynchorthoceras-Lituites-Cycloli-tuites series*. In the first, the shell is wholly straight or slightly curved, in the second various degrees of coiling are shown, and in the last the shell is almost completely coiled.

As opposed to cœnogenesis, there is the case of the appearance of new characters at the latest of the gens *Gryphǽa incurva* in stages (Deuterogenesis), *e.g.*, the coiling in late forms of the gens *Gryphǽa incurva* were anticipated in late stages of growth in the earlier forms.

Whilst in some groups new types appear in sequence at relatively wide intervals of time, in others, they come on quite rapidly, and in yet others they appear almost, if not quite, simultaneously. In the last case, the process at work, may be neither tachygenesis nor proterogenesis, but simultaneous mutation in the biological sense. The close resemblance to progressive evolution with the passage of time may thus be due not to evolution but to elimination. This is illustrated, among

others, by the suberaspedites fauna (ammonites) of the basement beds of Spilsbury sandstone. Here, side by side in the same layer, which is only several inches thick, occur a series of forms ranging from *S. primitivus* in which the whole shell possesses a fine ornamentation, to *S. cristatus*, in which very coarse ribbing is dominant.

The condition of preservation of the specimens in the actual deposits proves that the individuals whose remains have been found were practically contemporaneous with one another. Although the case for such an explosion of serial mutants cannot be regarded as established, yet there is sufficient evidence to warrant us in taking this suggestion seriously. Should its occurrence be established, it would provide a marked contrast to the type of mutation made familiar by the experimental work of biologists. The contrast should probably be regarded as due to differences in methods of study and of material. The experimenter breeds with isolated and controlled pairs, whilst nature breeds in a large freely mixing population with pairs drawn together by instincts that are yet beyond the experimenter's ken. Made matches do not necessarily yield the same results as love matches.

The Inter-relationship of Processes

While, for the sake clearness, the several processes concerned in the survival during development of old characters and in the arrival of new ones have been considered separately, this is not the mode of their occurrence in nature. On to the background of characters representing the survivals from the past, viz., the features forming the basis of the theory of recapitulation, characters which express in gradually varying degrees the similarity between the forms in the succession of stages passed through in development and attained in evolution, are superposed all new characters. These, generally speaking, belong to one or other of two categories, *viz.*, (*a*) *Unit or 'biocharacters*—features which appear fully expressed from the outset and undergo no subsequent change, *e.g.*, torsion in gastropods, and (*b*) *Trend characters* or *bioseries*—features which at the time of appearance are almost imperceptible but which in subsequent developments become progressively more fully expressed, *e.g.*, length of septa in corals, coiling in *Gryphǽa*.

Unit characters may appear cœnogenetically, that is to say, at some early stage in development, and may or may not open the way to other changes of a serial quality. Trend characters on the other hand, arise either cœnogenetically or deuterogenetically and proceed proterogenetically or tachygenetically towards later or earlier stages in life-history respectively in successive generations. In both cases the advancement of the trend is accompanied by a displacement of homologous characters—that is to say, characters situated in or on homologous parts. In the former case displacement is towards late life and culminates in the disappearance of older characters at the end of life. In the latter, displacement is towards early life and ends, usually at the junction of the embryonic and neanic phases, in the elimination of these characters (lipopalingensis).

Although there seems to be reason why both types of development should not proceed simultaneously in a series of solitary organisms for different sets of characters, but hitherto no examples of this has been detected. That they may occur in sequence or simultaneously in closely allied organisms is well-illustrated by the history of certain colonial forms, more especially graptolites.

P. K. G.

The Changing Outlook of Engineering Science

—Prof. R. V. Southwell

PROFESSOR Southwell stated that previous presidential address mainly dealt with particular problems, *e.g.*, the organization of applied research, training of recruits for industry, certain topics of practical engineering etc. It is, however, desirable under the present conditions to have a general stock-taking—to view the trend of engineering science from both practical and academical standpoints, both as an art and as a field of study, teaching and research. And meanwhile all the circumstances which should influence our policy—the trend of modern physics, the attitude of industry towards the university graduate and the nation's organisation for applied research, have altered profoundly. Such trend of engineering concerns the teaching profession as well as those engaged in practical engineering. He presents his views under three main headings:—(*i*) our policy in regard to the teaching of the engineering science; (*ii*) our policy in regard to engineering research; and (*iii*) foreign policy of our relations with the community.

Engineering, he says, was defined by Thomas Tredgold as 'the art of directing the great Sources of Power in Nature for the use and convenience of man': engineering science, therefore, is defined as science studied with a view to application. It can be supposed to trace its ancestry back to Archimedes or even further; for its name shows geometry to have originated in surveying. But notwithstanding this very respectable pedigree, until 1840 it was not admitted as a subject for university studies. Hence from the university standpoint its history is short: nor from the experience gained in allied subjects of university teaching it is possible safely to argue regarding its present policy. Unlike other university studies, the problems relate very largely to those of practical value, not simply as a means of training the young generation to lead to proper thinking. The content of the subject is determined not only by the growth of knowledge but by the actual trend of practice. What should be the content of university training? What is to be the policy in the face of this continuous accretion of knowledge, seeing that there is no corresponding increase in the capacity of the under-graduates to absorb?

The policy must be dictated by circumstances. and our circumstances have changed most drastically since the war: first by the trend of modern physics which has profoundly altered the relation of pure and applied sciences; secondly by an unprecedented growth of industrial and government institutions concerned with scientific experiments. As to research it has always been held that in universities it must find justification not in what is consequence: the utility of its result—but in what is intrinsic: the urge of the scientist to discover like the urge of an artist to create is something that will not be denied. Engineering is not, like Chemistry and Physics, a separate branch of natural philosophy but natural philosophy studied from a particular standpoint and with a special purpose. One can, therefore, argue that as a logical outcome the study of engineering is that of a non-specialist. The industry would demand more and more for specialists and therefore they would seek for people trained in laboratories appropriate to pure sciences.

The aforesaid reasons indicate that at the present moment a dilemma confronts all teachers of engineering science. On the one hand more and more specialised knowledge finds applications in engineering practice and on the other hand our industrialists are well disposed to the engineering graduate and they seem agreed in demanding that students shall come to them as men who have been educated to take wide views, trained to think and qualified to negotiate and control. It is not possible to reconcile specialisation in training as well as to secure a wide outlook. The power of the average under-graduate to absorb and assimilate has not been found to have attained noticeable increase nor the period of study could be extended. There is thus the problem for the university teacher to decide not what subjects of instruction should be included because of value but what can be omitted on the ground that, pushed into a mind already taxed it will push out something still more valuable.

So every lecturer will want, as he approaches the allotted boundary of his subject, to move that boundary just a little back, into fields he sees that are rich and fruitful. There is, however, a danger in this procedure since neither in a lengthening nor in an intensification of courses shall we find more than a temporary and makeshift solution of our problem, since it would fail to satisfy the demand of industrialists for men of personality educated to take wide views.

First of all, we must decide the purpose which our courses are meant to serve. The view point is clear cut: their purpose is to train recruits for industry and the taking of a good degree in the final examination should indicate an assimilation of engineering principles adequate in a man who is starting a professional or industrial concern—but *not more than this.* One can object that this makes no provision for the really first class man. Is it possible in a written examination to detect first class ability? If by first class ability it is meant ability to do research, the answer would be—examinations are not its best detector since their proper function is to test that what has been taught has been absorbed. It can only be revealed by research actually performed. About examinations, Prof. Southwell urges *"On all counts let us shun harder papers in our examination"*. At the worst the subject matter of the harder papers are based on some special course of lecture delivered with a view to some special paper.

What is wanted, therefore, is to work out a plan whereby the industrialists may be provided with men who with adequate knowledge of engineering principles combined with some breadth of background and who by intercourse with men of other training have gained maturity of bearing. We must not forget the importance of leisure to the formation of personality. Stated broadly it is emphasised that lecturers should not exclude matters not found in a syllabus.

Regarding problems of research every teacher will feel that life would be a duller thing if teaching were all, if we ceased to have zest for the unsolved problem and the rarer thrill of the problem solved that every researcher knows though the poblem is of interest to himself alone.

There is, however, the pessimistic forecast that engineering research at universities is doomed to ultimate extinction because as engineering comes to make ever fuller use of mathematics, physics and chemistry, more and more its problems will be such as only specialist in those subjects can investigate while for *ad hoc* experimentation generous provision exists and will increase in government institutions and in the research departments of our larger works. This view of pessimism seems at first sight most strong. It is however most easily answered, from the consideration *viz.*, that the attitude of the engineer to his problems is something both peculiar and worth preserving.

As an explanation, a comparison with the outlook of mathematicians and physicists will be interesting. The physicist thinks that his problems are inexorable. If he finds difficulties of progress along an attempted path he is free to try some other; the engineer has to solve the problem as it is presented and some solution he must have, even though it be only approximate. It has been the fashion of late to jeer at the engineer's "factor of safety"—changing its name to "factor of ignorance" and ascertaining that like charity it covers a multitude of sins. This criticism, one admits, to be largely true as regards the past: but the time is near when the 'factors of safety' would be decided by values strictly dependent on the reliability of our materials. The pure physicist can choose his materials according to his own need whereas the engineer is not free to choose. His materials are dictated by various factors *e.g.*, constructional or manufacturing requirements, the consideration of strength of cost, etc. Practical engineering has evolved to its present state and there are problems far too difficult for routine investigations—there will still be the scope for academic engineers, they possess a sense which is worth considering. They can visualise and the engineering student who intends research, this gift of visualisation would be a great asset and must be fostered deliberately.

Time is coming when the engineer shall have methods of his own for doing most of what hitherto they have looked up to professional mathematicians to do for them. These methods may not be (exact in the mathematical sense but they will be) none the worse for that, even philosophically speaking. In practice data are subject to a margin of error, no less than the quantities required and such methods, therefore, are of extreme help in working out real problems.

The school of engineering will find problems different from those which engaged their engines a generation ago. Prof. Southwell is of opinion that university research is approximating more and more closely with the passage of time to what in the last century was called—Pure Physics. Avoiding mention of the living, it is in Osborne Reynolds and Ewing—yes, and Clark Maxwell, Rayleigh, Kelvin, Heaviside in some of their manifold activities—that future professors of engineering will find them ideals which they should aspire to emulate. Their aim will be, not so much to make inventions in the manner of Bessemer Parsons, Otto, Diesel or to test the working of large prime movers or to break new ground in physics that has application to engineering—more specially near the border lines that tend always to be drawn too sharply when research is highly organised. In future, the universities must maintain that irresponsible quality which otherwise research is in danger of losing precisely because now it is taken so seriously, as a matter of national concern.

Coming to the third heading, viz., "The Public Relations" or engineering as its concerns the community, there seems to be an implication in much that is written nowadays that because range of engineering includes guns, battle-ships, aeroplanes and tanks, engineers are to be regarded as a class, more than other, responsible for the horrors of modern war. Prof. Southwell records his protest against these implications and quotes from the presidential address to the Association by Sir Alfred Ewing.

"The cornucopia of the engineer has been shaken over all, scattering everywhere an endowment of previously unpossessed and unimagined capacity and powers. Beyond question many of these gifts are benefits to man making life fuller, wider, healthier, richer in comforts and interests and in such happiness as material things can promote. But we are acutely aware that the engineer's gift may be grievously abused. In some there is potential tragedy as well as present burden. Man was ethically unprepared for so great a bounty. The command of nature has been put into hands before he knows how to command himself".

There is no subject in which clear thinking is wanted to-day. The desire to hand on responsibility is so deep-seated, that the will to believe that we could have had the benefits of sciences without its risks and temptations has gained ground. But knowledge is of good and evil; it is of its essence that we can not know how to cure poison without knowing poison and its action, how to control and use explosives without acquiring power for harm as well as for good. Knowledge is not moral. Good and evil are its opposite sides inseparable in its very nature. One can not have sympathy with the plea for a cessation of scientific activity: it is arguable that on balance knowledge is undersirable. When men talk of beneficient or destructive science as though one could be free to pick and choose, it is proper to say that they have not even begun to understand what science is.

Increasingly it appears that nations are inclined to put trust in adroitness rather than in the sincerity of their statesmen. Ethics are out of fashion and while as individuals we may still admit the moral imperative, the notion that motives recognisable as moral can have place in international affairs seems now to be rejected as impracticable idealism.

Prof. Southwell believes that some scientific leaven is beneficial in almost any body of administrative humanists. Rather than seeking to defend the activities of engineers from the charge that evil can come of knowledge misapplied, might it not be better to undertake a harder task, trying to instil into the mind of the public a clearer notion of the aims with which the real scientific work is done. Never have greater powers of exposition been devoted to the popularisation of science. It is not of the treasure found, but of the *quest*, to show the true man of science, neither as a care-free dilettante nor as a philanthropist but seeking truth like the artists; a spirit that breathes in every book of science worth the name. Let the scientist have the courage of the artists to exalt our calling while deploring the folly that has led us and other men to misuse them. Let us not weakly question that the gifts of science hold potential good. The record of engineering is not such that one needs feel ashamed of the calling.

P. N. G.

Anthropology

The Orient and Europe

—Prof V. Gordon Childe

PROFESSOR Gordon Childe upheld the claims of Prehistory as an experimental science. He pointed out that Prehistory is based upon solid facts like "relics and monuments" which are always available for all to be examined and verified.

Prof. Childe critically examined the axioms propounded by Montelius in 1899 in his "*The Orient and Europe.*" The fundamental assumption of Montelius was *Diffusion.* Montelius compared the written records of the Orient with those of illiterate Europe and came to the following conclusions:—

(1) Civilization in the Orient is extremely ancient;

(2) Civilization can be diffused;

(3) Elements of civilization were in fact diffused from the Orient to Europe;

(4) The diffusion of historically dated Oriental types provides a basis for bringing prehistoric Europe within the frame work of historic chronology;

(5) Prehistoric European cultures are poorer than contemporary Oriental cultures.

The antiquity of oriental cultures is firmly established. Excavations in Egypt, Mesopotamia, Syria, Anatolia have proved it beyond doubt. Recent excavations by Prof. Frankfort at Tel Agrab, Tel Asmer and Khafaje have emphasised the antiquity of the oriental civilization and the long duration of the Early Dynastic Age. Further excavations at Erech by the German school have led to the discovery of the wall stumps of a gigantic edifice below the earliest dynastic temple ruins (Jemdet Nasr period) rested upon the ruins of a no less imposing building, which has been called the Red Temple. The Red Temple was constructed on another imposing cathedral known as Limestone Temple, because of its unusual stone foundations. Below the floor of the Limestone Temple 18 layers, marked by various associations of human occupations were discovered. Prof. Childe puts the date of the above culture roughly at 4500 B.C.

Geologically the delta of Lower Mesopotamia is very recent and none knew that it was the cradle of food production. The al' Ubaid culture was already mature and the spades of Mallowan and Speiser in Syria and Assyria have yielded the earlier stages of al'Ubaid. Relations with Lower Mesopotamia were so close and continuous that the discoveries from the prehistoric levels of Gawra, Nineveh and Chagar Bazar were found to be parallel to those from the protohistoric levels of Sumer. Prof. Childe puts the date of these prehistoric finds to the 6th millenium B.C. approximately. These prehistoric finds in the Near East resemble European neolithic in having the continued use of the polished stone adzes and some other tools; but the earliest cultures of the Fertile Crescent like its Early Dynastic cities are so unlike anything known in Europe "as to seem incommensurable". The Oriental Institute of Chicago has also discovered the evidences of intercourse between Anatolia and Mesopotamia. The Anatolian chalcolithic, according to Prof. Childe seems to be rooted in 4th millenium B.C. but the earliest remains are quite uncertain. All these above would appear to support axiom (1) of Montelius but the connections between Asia and Europe have recently been proved by Heurtley's excavations in Macedonia. Heurtley has convincingly demonstrated the Anatolian ancestry of the Early Macedonian Bronze Age. The Macedonian relics can be well compared with the Danube basin and there was a cultural continuum traversing the Balkans connecting the Aegean coasts with the Danube basin." These justify the validity of the axiom (3) of Montelius *i.e.*, diffusion from Asia to Central Europe.

Turning to the prehistoric chronology of Central Europe, Prof. Childe remarked that the tentative suggestion of the culture sequences made by him some ten years ago have now been fully corroborated by Buttler's investigations in Germany and Banner's researches in Hungary. These phases have no counterpart in the Orient. The earliest

bronze objects found in Central Europe are associated with Aunjetitz culture and all the type-fossils can be traced back to about 3000 B.C. in the Orient. Thus the beginnings of the Continental Bronze Age according to Montelius' axiom should be nearer to 2800 B.C. than 1800 B.C. Oriental parallels can be found to the types found in the earlier period of Central Europe of which Danubian I belongs to the earliest neolithic culture. The latter can still be limited by Tel Halaf and Prof. Childe would assign the date of 6th millenium to both the above cultures, and according to him the Danubian VI belongs to 1200 B.C., the Danubian V to 1700 B.C. and the Danubian IV to 3000 B.C. Under the 4th axiom of Montelius only upper limits of the oriental analogies are provided and Montelius' 5th axiom appears now to be fully justified on the findings of early settled cultivated life beneath the Tel Halaf villages and they thus seem to be more advanced than that of the ancient Danubians. The Vardar-Morava culture even can hardly be put in relation to Oriental cultures. Objective proofs of cultural continuity between the Near East and Central Europe by diffusion are still lacking and the beliefs regarding the foundations of agriculture, stock-breeding etc. are mere hypothesis. The Balkan regions are yet unexplored and we must wait till confirmatory evidences are forthcoming from there.

Psychology

Eye and Brain as factors in Visual Perception

— R. H. Thouless

WE not only see with eyes but also with brain, therefore the full statement of the physiological mechanism of vision would include not only the sensitive retinal surface and the visual areas of the cortex but the whole system which includes retina, optic nerve, visual area of the cerebral cortex and other sensory areas of the brain as well.

The problem of vision can be studied by considering only the activity of the retina to the neglect of other factors. This is the view that is generally found in the work of Helmoholtz and his followers. They proceeded on the assumption that the essential process of vision is the formation of an optical image on the retina and its transmission to the visual centres of the brain by means of the optic nerve. Differences between the sensations transmitted to the brain and the finished perception which appears in experience were attributed to the action of the higher processes of judgment and the influence of past experience. The 'transmission theory' of vision has no doubt enriched the sensory physiology of the retina but it left most of the field of perception untouched.

Although the way was paved for the criticism of transmission theory, the real attack did not begin until the publication of Wertheimer's research on 'phi-movement' in 1912. That the transmission theory is not adequate to explain the phenomena of vision can be seen from a very simple experiment. We place on a table an elliptical object with its long axis pointing directly to and from the observer. If his head is directly above the object, it will, of course, look elliptical. If now he moves his head from the position directly above, but still keeping it in the vertical place passing through the long axis, the object will at first look elliptical, but with a smaller apparent elongation than when it is viewed from directly above. If the head is now lowered, but still kept in the same plane, the apparent shape of the object becomes more and more a circle. It then becomes truly circular and if the head is still further lowered, the object appears elliptical again only now with the really longer axis apparently the shorter. The height at which the ellipse looks circular, it is found that the retinal image is not of a circle but of an ellipse with the vertical axis much shorter than the horizontal, that is, an ellipse flattened in the opposite direction. It is as if the shape that is seen (phenomenal shape) is in between the real physical shape of the ellipse and the shape that is projected on the retina (the stimulus shape).

The arguments put forward in support of the transmission theory are untenable. Likewise, the statement that an object can be seen in its stimulus character by adopting a special 'critical' attitude is wrong and untenable. Experimental data show that the visual characteristic of an object is not a product only of the corresponding local stimulation of the retina or of a projection of this local stimulation on the corresponding area of the visual cortex but the product of the combined action of the different activities of the visual cortex. Further analysis proves that not only do various parts of the visual cortex contribute to the visual appearance of the particular object but other sensory areas of the cerebral cortex also contributes. This hypothesis can well explain the phenomena of size-weight illusion. The research shows that the exact height at which each subject reports the ellipse as looking circular is somewhat variable and may depend to some extent on his mental attitude, but the limits within which variation occurs in any one individual are small compared with the differences between different individuals. In the case of an individual the apparent shape of an inclined object to its real shape remains more or less constant and a correlation as high as 0'92 was found when two sets of tests were given at an interval of two years. Similarly persons who have a tendency to see real size of an object tend also to have a tendency to see the real shape and the real whiteness. The correlation between these tendencies are found to be above 0.6.

Experimental facts prove that for a given individual the apparent size of an object (*i.e.*, disc)

decreases as the distance becomes greater. A relation between phenomenal and stimulus linear dimensions of an object at different distances has been found which can be expressed by the equation $P=a+b\ S$, that is to say for any one individual under uniform conditions of observation, the apparent linear dimensions of an object at different distances change as if they were made up of the sum of two parts, one of which remains constant at all distances while the other is inversely proportional to the distance. The above relations hold good up to a distance of 10 m. meters. Exception to this law has been noted but the case is rare. It has also been found that the tendency to phenomenal regression increases with age. Phenomenal regression to real colour is also reported to have been observed in fishes and in chicks of three months old.

On the practical side of phenomenal regression, it can be said that a person with high phenomenal regression can drive cars more easily through a traffic. This fact corroborates the findings of the National Institute of Industrial Psychology. The phenomenal regression is affected by certain drugs, *e.g.*, alcohol decreases it while caffeine increases it.

In conclusion it can be said that psychological study of vision has undergone a change during the last 25 years. Vision is no longer considered as a function of the eye alone but of the eye and higher centres, that is to say the psychology of vision is not the sensory physiology of the eye.

A. N. D.

Educational Science

The Function of Administration in Public Education

—J. Sargent

MR Sargent believes that the administrative machine, particularly in the public education service, is an instrument which, if improperly employed, may distort experimentation and hamper research into method. This impact of administration on education is the subject of his review.

"Political thinkers throughout the ages have frequently defined or described the function of administration. Of all their attempts the one which appeals most to a harassed official is the late Lord Fisher's cynical aphorism that it consists in the intelligent anticipation of agitation. From a somewhat less negative point of view it may be regarded as compounded of deliberation and execution, of which the latter should but does not always follow the former.....Until 100 years ago the main interest of government was to restrain men from living evil lives; since then the intention, however mysterious in operation, has been to help them to live good ones."

"But if devolution is to remain a necesssity, and granted the continuance both of a democratic system and of the parental interest of the State, there seems no alternative. The really disconcerting problems for the future seem to me to arise from the present nature of the local government bodies themselves. The first difficulty would appear to lie in the unit, *i.e.*, in the size and geographical distribution of local government areas. Recognised authorities, who are mostly foreigners and seem to regard our political institutions with greater enthusiasm than we do ourselves, tend to congratulate us on our ingenuity in adjusting them to meet new social and economic needs as they arise. It would be difficult to detect this evolutionary process at work so far as local government boundaries are concerned."

Amateur Versus Professional Elements

Dealing with the question of amateur versus professional personnel of the Local Education Authorities, Mr Sargent writes:

"The most serious aspect of the problem to my mind is the steady and even accelerating deterioration in the amateur personnel which has taken place since the War. This is particularly marked in the case of the elected representatives of the people. The reasons are as plain as the fact. The most obvious of course is the gap caused by the War itself in the ranks of those who, if they had survived, would probably have been the first to offer themselves for public service. But this is by no means the whole or even the main explanation. The vast increase in the responsibilities laid upon local authorities by legislation since the same period makes it necessary that any member who is to become really *au fait* with the business of education should be able to devote a considerable amount of his weekly time to it, whereas before the War it was possible for a person of average intelligence to grasp not only the general lines of policy but also day-to-day happenings by occassional attendance at committee meetings."

Mr Sargent notes the "increasing tendency of Education Authorities to consist of people who have retired from work, or have never had work, or who are in fact professionals rather than amateurs because, as officials of political or other associations, it is expedient for them to become members of Local Education Authorities from the point of view of promoting the objects which their associations have at heart. It is no reflection on the personal integrity of these last to express the opinion that they constitute a serious danger to the system on the ground that if there is a bureaucratic habit of mind, and if as some people believe it is inimical to good government, these people possess it and bring it to bear on their consideration of educational problems without the saving grace of the professional educationist's training in and knowledge of the particular branch of administration with which he is dealing."

He objects to this development because of the risk "which is more than theoretical, of intellectual dishonesty creeping into the discussion of educational affairs when the Authority contains any substantial number of members who are pledged to a set of opinions which may have a cross-bearing on purely educational considerations."

B. N. B.

Geography

Correlation and Culture

—Griffith Taylor

THE importance of geography in the realm of general education, its correlation with history, culture etc., were among the problems discussed by Prof. Griffith Taylor in his presidential address delivered before the Geographical Section of the British Association for the Advancement of Science, Cambridge, 1938.

The feature of geography which gives it a special place in a general education is, according to Taylor, that it is too wide-spread in its interests to fit into any rigid division of disciplines, *viz.*, the Physical, Biological and Social Sciences and the Humanities.

It links up the environmental sciences of Geology, Physics, Astronomy and Botany with the human Sciences of History, Anthropology, Sociology and Economics. The techniques learnt in the realms of Geography, Biology and Geology may be carried across to Anthropology, History and Sociology. Geography is defined as a discipline concerned with the description, localization and explanation of the data which relate man to his material environment.

Localization or charting the data being the essential feature of Geography, the speaker, following Huntington deplores that many historians regard a court intrigue as more important than the influence of climate, relief, occupations, *etc.*, upon national character or upon specific historical situations. Many economic historians seem to know little about how the geographic environment influences not only the available resources, but also man's desires and the energy with which he works to satisfy them.

According to Matthew the cradle-land stages of evolution of various related groups of higher mammals can be deduced wholly from their distribution in time and space, the marginal forms representing the older stages of evolution, while the latest forms occupy the centre. This constitutes the *Zones and Strata phenomena*. The Salient Control of the environmental stimulus centred in South-Central Asia was responsible for the vast biological changes involved in changing something like an antelope to a sheep. This stimulus persisted in the same region from early Tertiary times to about 10,000 B.C., when the first stable civilized communities of man developed. The different racial groups of man must have originated in the same region in about half a million years. The major culture-changes are also essentially responses to environment—only far more rapid than biological changes. The same region of high stimulus must have witnessed the development of man from the nomadic hunter to the settled village-dweller.

Whereas the Alpine, Mediterranean and Australoid races are generally held to have originated in Central Asia, the author, led by the marginal distribution of the Negroes and Negritos assumes a similar origin for them. Thrust out from the cradle-land by climatic changes, they migrated mainly to Africa, which was easy of access, and partly to Melanesia by circumventing the mountains of South-East Asia, across the East-Indies, probably using the alternately open and drowned corridors of the Sunda and Sahul lands. The next drift was towards Australia. Migrations to America must have passed *via* North-East Siberia, during warmer interglacials when the Behring route was feasible, and included the Australoids, and Eskimos. The Alpine-mongoloids migrated into the New-World at a time when the American corridor was available.

Diagrammatically illustrating the movement of ice-caps in Scandinavia, the author shows how about 18,500 B.C. Sweden lay under the ice-cap, while Tundra plants were growing in north Germany and Denmark. About 9,000 B.C., the ice-front retreated northward halfway along Sweden. At this time fir trees were growing and neolithic man appeared in Germany, though not on the Baltic. About 4,000 B.C. the ice retreated further north, and the fir covered Scandinavia. Along with the oak, the higher culture of bronze tools appeared in North-Germany. At the dawn of history modern conditions came to prevail; the beech became the dominant tree on the Baltic and the Iron-age man appeared. Charting the distribution of human races before the period of modern migrations, the author shows that all the progressive nations of the world are built up of the same three stocks, *viz.*, Alpine, Nordic and Mediterranean. Differences like those separating the Europeans, Japanese, Chinese, Indians, Polynesians and Amerinds have been smoothed away in European Soil by their component stocks in Neolithic times. But a real racial barrier being much more difficult to overcome than cultural differences, it would take a long time for the Negro problem to be solved.

A common language is often the chief cement, linking the various races and cults to form a nation. The main language groups with their inter-relations constitute an evolving complex arising in South-Central Asia and affected by wide migrations, the marginal languages being the earliest. In the Occidental area the languages evolved in the following order:—the agglutinative Bantu and Turkish, the amalgamating Hamitic-Semetic, Basque, Sumerian, and the infectional Aryan with its three subdivisions,—the *Kentum*, the P and the *Sateru* languages. The study of the latter by stage diagrams correlates our scanty knowledge as to the early wave-fronts of the Aryan languages and shows how they spread towards India, Persia and Europe.

Aryan is now spoken by Alpines in Central Europe, by Nordics in the north and Mediterraneans in the south. It may be assumed that originally each of these races had a distinct culture and language. Who then, were the first Aryan speakers? It is suggested that the marginal Mediterraneans of South and West Europe orginally spoke Hamitic before being conquered by the Aryan speakers. On the northern margin of the Aryan realm, where the Nordics dwell, there are the Altaic speaking Finus, many of whom are Nordic, like some north-Asiatics as the Altaic speaking Ostiaks of the Yenesei. The Altaic languages seem to have been pushed to the margin by later Aryan speeches. The Teutonic group of Aryan has certain resemblances with the speech of the Finus and the Ostiaks. Hence it is suggested that the Nordics of Germany and Scandinavia originally spoke Altaic and later adopted Aryan.

The Basque, a non-aryan language, has some affinities with Abkasian in the Caucasus, Altaic and some Amerind tongues. Peake suggests that the earliest Aryan tongues were introduced into Europe by the Alpine race from Asia about 1,500 B.C. Some four millenia before this, the Alpines were represented among the Danubians and at Ofnet. The author believes that the Amerinds who were pouring into N. America about this time were of much the same race as the Alpines. The Pre-Gaelic Alpine invaders of Europe were of the same linguistic zone and spoke Baskue. Subsequently the pre-Aryan language made room for Aryan, leaving relics like Abkasian.

The graphs of culture-growth help to create a mental picture of the processes involved in culture spreads. Stage diagrams illustrating the growth of a city like Chicago show how it resembles a cone, starting at the humble houses of the original settlement and expanding with passage of time. This phenomenon is comparable to a series of concentric craters built by the lavas in a gradually increasing volcano, each lava-flow covering part of the preceding flow and pushing some of the earlier lava to the periphery. Such "Craters of Growth" help us in our search for affinities of isolated tribes, speeches and cultures, and are used by the author for studying the racial and linguistic distribution.

During the twentieth century Geography has trended away from the belief of Ritter in Providential control and from Environmental control as expounded by Ratzel, towards the possibilistic theory of Vidal de la Blanche, according to which our material evolution depends on which of the possibilities we choose. His experiences in Canada and Australia where the possibilities offered by Nature are more meagre than in Britain or U. S. A. incline the author to the second or geocratic view. Illustrating the industrial development in Canada, he shows how fishing, farming and fur were confined about 1750 to the east. By 1810 farming had extended to Detroit while Mackenzie was exploiting the Mackenzie river-basin for furs. In 1870, gold silver and iron mines were being exploited near the St. Lawrence and on the Fraser river. About 1880 began the migration to the wheat-fields of the prairies. Since then modern conditions have come to prevail. As wheat grows only under favourable conditions, all the fur country could not be utilised for wheat. Hence man has not been a free agent in all this evolution. He can only accelerate, slow or halt a country's evolution, but does not alter its direction. The evolution of present social groups in Europe depend very slightly on national or tribal characteristics, but is almost wholly determined by the environmental controls of climate, topography and coal.

Culture in the Twentieth Century

Our education is still a battleground between conservatives and liberals. Interests in the classical literature of a bygone age are still powerful in conservative school, college and university education. Since most cultured folk receive the main part of their education in the years from fourteen to twenty-two, these years must be wisely spent. Our youth must be trained to deal scientifically with existing conditions. Besides the specialised knowledge needed for a profession, education should include Biology, History and Geography. The attention of youth for a generation or two should be directed away from Physical Science to the difficult problems of Social Science, *e.g.*, Communism, Socialism, Judaism, Nordicism etc.,—creeds which are cultural facts and more vital to the man of culture than a conservative education based on art, music or classic.

A. M.

Conference of Delegates of Corresponding Societies

The Importance of National parks in the preservation of the Fauna of Great Britain

—The Rt. Hon. the Earl of Onslow

THE Rt. Hon. the Earl of Onslow who presided over the Conference delivered an address on the "Importance of National Parks in the Preservation of the Fauna of Great Britain." In defining the term 'National Park' he referred to Article 2 of the Convention for the Protection of the Fauna and Flora of Africa held in London in 1934 (quoted below) and clearly distinguished the term as understood in Great Britain and in other countries.

ARTICLE 2

"1. The expression 'national park' shall denote an area (a) placed under public control, the boundaries of which shall not be altered or any portion be capable of alienation except by the competent legislative authority, (b) set aside for the propagation, protection and preservation of wild animal life and wild vegetation, and for the preservation of objects of aesthetic, geological, pre-historic, historical, archaelogical, or other scientific interest for the benefit, advantage, and enjoyment of the general public, (c) in which the hunting, killing or capturing of fauna and the destruction or collection of flora is prohibited except by or under the direction or control of the park authorities."

"In accordance with the above provisions facilities shall, so far as possible, be given to the general public for observing the fauna and flora in national parks."

"2. The term 'strict natural reserve' shall denote an area placed under public control, throughout which any form of hunting or fishing, any undertakings connected with forestry, agriculture, or mining, any excavations or prospecting, drilling, levelling of the ground, or construction, any work involving the alteration of the configuration of the soil or the character of the vegetation, any act likely to harm or disturb the fauna or flora, and the introduction of any species of fauna and flora, whether indigenous or imported, wild or domesticated, shall be strictly forbidden; which it shall be forbidden to enter, traverse, or camp in without a special written permit from the competent authorities; and in which scientific investigations may only be undertaken by permission of those authorities."

"3. The expression 'animal' or 'species' shall denote all vertebrates and invertebrates (including non-edible fish, but not including edible fish except in a national park or strict natural reserve), their nests, eggs, egg-shells, skins, and plumage."

The African Powers recognised two types of preservation of the fauna: (i) by the establishment of National Parks intended to afford as much access as possible to the general public; (ii) by the establishment of Natural Reserves intended for scientific purposes and, therefore, not open to the public except under very definite restrictions. The applicability of the African Convention to the utilisation of National Parks of Great Britain was examined by him in detail. The Standing Committee on National Parks of the Council for the Preservation of Rural England and Wales laid down the policy that Government should declared that the establishment of National Parks is an essential national service and should set up two National Parks Commissions, one for England and Wales and the other for Scotland, with a joint committee coordinating the two, and provide funds.

The principle of the establishment of a National Park devoted mainly to the preservation of our fauna has been adopted by a number of authoritive Societies interested in the matter. The President suggested that the thousands of acres of deer forest on the West coast of Scotland would be the most suitable in Great Britain for the creation of the National Park, and discussed in detail and from various points of view why such a Park should be in deer forest and not contiguous to grouse ground, and how the three species of deer—red, roe, and fallow deer—can be kept under check. It is essential in a Park to keep sufficient deer to be visible to the public in their native haunts, and to shoot poorer animals and older stags and hinds, sparing the big stags with the good heads. He thought also that

National Parks could very well be utilised for the preservation of the stock of various other species of animals such as wild cattle and goats, foxes, badgers, stoats, weasels and others. Some species which are becoming rare as the wild cat, the pole cat, and the pine marten which live in woodland country might also be afforded adequate protection in the National Parks. The preservation of rodents in the northern climate might not prove as difficult as that of the rarer bats which are restricted to the South of England.

The National Park might also be made to serve as a strict Bird Sanctuary, and if at least a part of the Park is close to the sea the breeding of sea birds could be encouraged.

The President next discussed the question whether it would be desirable in a National Park to attempt to acclimatise animals which have become extinct in Great Britain. The elk which became extinct in pre-historic times might not do well if reintroduced, but the reindeer, the wild pig and the beaver which became extinct only in the last few centuries might profitably be reintroduced. The only difficulty would be in regard to the right type of food to feed them with in Scotland. But he would, however, be on the side of caution in regard to the whole question of the introduction of species which have become extinct. Exception might be made of the Irish stoat which is a denizen of the British Isles or of the lemmings, but the case of the musk rat and the grey squirrel which proved to be a nuisance should make one very careful about the introduction of species of foreign origin.

The address next dealt with the difficult questions of finance and management of the National Park. Forest country in Scotland was a good deal cheaper than it used to be, and it should not be impossible to acquire with the aid of Government or by means of public subscription a large area of forest land. A National Park would not be as expensive to the nation as a deer forest to the rich man, for there would be a steady income as in the case of the National Kruger Park of South Africa. A hotel or rest-house which would maintain itself, roads and footpaths to enable people to get about and see the animals, a staff of keepers, pony men, dog men, and watchers to keep the animals within bounds, ward off poachers, and to prevent sightseers disturbing the sanctuary are all that would be needed for the efficient management of the National Park.

In regard to the management of the property in Scotland housing the National Park the address referred to the ideas put forward by Sir Peter Chalmers Mitchell. According to him the popular functions of the National Park would be entrusted to delegates appointed by Edinburgh, Glasgow, Dundee and Aberdeen, working with delegates appointed by the Council of the Counties in which the Park was situated. The Governing Body of the National Park would include a panel of naturalists interested in Botany, Zoology, and two field naturalists with special knowledge of plants and birds. The members of this panel might be selected by the Principals of the four Scottish Universities and by the Presidents of the Royal Society of Edinburgh and of the Highland and Agricultural Society. Apart from the staff concerned with the general regulation of the Park, the scheme contemplates the appointment of a warden or ranger chosen by the panel of Naturalists, whose sole duty should be the constant study of wild life in the Park and all its fluctuations.

H. S. R.

[Abstracts of the Presidential Addresses of the Botany and Zoology Sections are to appear in the next issue.]

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the greatest importance in the progress of our knowledge of ancient Indian History, the fact was not mentioned by any of the distinguished historians assembled at Allahabad. Ancient Indian History owes a good deal to the pioneering works of the European scholars like Prinsep, Senart, Bernouf, Maxmüller, Sylvain Levi and others. It was only somewhat late that the Indians began to interest themselves in the work. The early labours of Bhau Daji, Bhagwanlal Indraji, Raja Rajendralal Mitra and Mm. Haraprasad Sastri should not be forgotten at the present times nor should we fail to pay tribute to the searching intellect of Lokmanya Gangadhar Tilak, who unearthed from the Atharva Veda reference to Babylonian mythology, long before the discoveries at Mahenjo-Daro placed material evidence of such connection at our disposal.

But even 25 years ago, a well-known book on the history of ancient India began with an account of Alexander's invasion of India. Some European historians were under the impression that Indian civilization started only after the Macedonian Greeks under Alexander made their much-talked-of inroads into India. Thanks to the discovery of Indus Valley Civilization in 1924 by the late R. D. Banerji, it is now possible to date Indian history to as hoary an antiquity as that of Egypt or of the Near East. The inscriptions and seals which have been discovered, however, await the genius of a James Prinsep before they can be made to yield their secrets. It is also a matter of extreme regret that the work so auspiciously begun by the Indian Archaeological Department had to be suspended owing to alleged dearth of funds, though the extensive survey by the late lamented N. G. Majumdar, has revealed a number of sites quite as promising as those of Mahenjo-Daro and Harappa in Sind and the Punjab, and even as far south as Gujrat. Another promising attack on this period of Indian history has been made by Rai Durgaprasad of Benares who by his searching analysis of signs on punch-marked coins has been able to demonstrate that these were minted by the Mauryan and pre-Mauryan imperial dynasties and by showing their analogy to many of the symbols used in the Mahenjo-Daro seals has shown that the Mahenjo-Daro tradition persisted even after the Aryan conquest; he has thus opened a promising way for penetrating into this dark period of Indian history (300 B.C.—2600 B.C.) echoes of which are preserved in the older Sanskrit literature.

A mere glance at the names of various sections and at the papers which have been read at the Historical Congress shows the immensity of the task before the Indian historian. Within the last 20 years, Indian scholars have risen to the occasion and made substantial contributions to almost all the epochs in Indian history beginning with the Buddhist times. In this labour, not only professed historians but also scholars of Sanskrit, Pali and even Indian scientists (chemists, astronomers, and medical men) have collaborated. But unfortunately there has been no synthetic presentation of the great panorama of Indian history. The average reader will much welcome the compilation of such a volume, as he has neither the time nor the leisure to go through the learned original works and treatises by the specialists. We, therefore, very heartily welcome the resolution moved at the Conference by the doyen of south Indian History, Dr Krishnaswamy Iyenger, that a committee be appointed consisting of a number of ancient Indian historians, with powers to co-opt, to examine the *feasibility* of preparing a scientific and comprehensive history of India with instructions to report at the next session of the Congress. The resolution provoked a good amount of discussion, some eminent historians like Dr Ishwari Prasad, objecting to the term '*feasibility*' and holding that there could be no point in debating about the feasibility of the project because this had already been demonstrated. The materials were already there and they had only to organize a powerful body of experts to carry out the objective. The discussion, however, showed a great divergence of opinion and ultimately the resolution as originally worded was passed.

Much as we welcome the motive underlying the above resolution, we consider that it is not possible for a body of experts to compile a synthetic history of India. All that they can do is to present us with a collection of chronicles dealing with the various epochs in all their aspects. But synthetic history can only be the product of a single original mind like that of Von Ranke, Mommsen, or a Maspero. There is great need for such a history

inasmuch as history is a subject, the teaching of which cannot be avoided; but as they are at present reported to the younger mind, they tell us a rather very disheartening story about the past of India. In fact, it is nothing but a collection of stories of murders, assassinations, large-scale famines, foreign invasions and large-scale destructions of cities, kingdoms and civilizations. Sometimes it sounds, as Voltaire remarked, as if we were listening to a never-ending story of highway robbery. But certainly as the Hon'ble Mr Sampurnanand, Minister of Education for U. P., remarked in opening the Congress, the actual history could not have been so black, as otherwise the Indian Nation would not have survived and most of the monuments and ancient literature would have disappeared without leaving any trace.

This original stamp on Indian history, as we read in college and school text-books, was given by the early compilers and it is a misfortune that subsequent authors are like the proverbial *Gaddalika* following the old groove. One rarely comes across any critical analysis of the great mass-movements, or the economic causes leading to the great political events. A school book on Indian history, even while talking of the British period, scarcely gives any idea of the economic revolution which led to the disappearance of Indian arts and crafts during the fifties of the last century, leading to the present day large-scale pauperization of the Indian masses. Neither does it deal in a very intelligent way with the current nationalistic and industrial movements nor discusses why India has not shared in the general world prosperity. The text-books are often crowded with useless illustrations which invoke no feelings in the Indian mind. Even while dealing with the Muhammedan history it is rare to come across any intelligent account of the great cultural contribution of Islam to India. In fact, the events are presented in such a way that communal bitterness is not only excited but accentuated, whereas the efforts of the great Muhammedan rulers at evolving a suitable system of government and promoting national life centering entirely round Indian interest are completely ignored.

We would very much welcome a history of India written from a new point of view and with a proper perspective, which will enable us to follow in an intelligent way the past historical events and enable us to grasp clearly the factors which were responsible for the successes and failures of the great human and political movements on this continent. History, as Croce said, ought to be written only by philosophers and philosophy by historians, as less competent men generally lose sight of the essential points for the detail. They mistake the tree for the forest. Of course even if such philosophers can be found, we cannot eliminate the personal factor. As in Europe, some may interpret history as the Interpretation of Divine Will, while others may see in it nothing but a succession of chance events which nobody can control. There may be, besides geographical interpretations, economic interpretations, as well as a racial interpretation. Europe passed through such phases of history-writing which had their great repercussions on politics. The economic interpretation of history started by Karl Marx led to the great socialist movements and culminated in the establishment of the great Soviet Republics. The racial interpretation started by Count Gobineau and carried on by Madison Grant and Houston Chamberlain led to the Nazi movement in Germany with its great influence on contemporary history.

No Indian history has yet been written from any such unitary standpoints. As a matter of fact, the art of history writing in India is still very crude and medieval. What is wanted for the future is a history which will pay more attention to the basic qualities of the great social and political movements, the causes of their success and failure; and thus enable the political philosopher to evolve a new Philosophy of Life and Action, involving society, politics, and private life to which every young Indian, irrespective of his province, caste or religion, can offer instinctive homage.

A Short History of Thermodynamics

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Henri Bergson in analysing the causes of laughter came to the conclusion that one laughs only when an incident or an object indicates human frailties. A man stumbles and hurts himself, and we laugh over it, not because we are cruel but because of his inability to overcome an obstacle. As human beings our first interest is in the man himself. The less sophisticated we are the more interested are we in the man, his activities and achievements. Interest in abstract truths comes later in life as we grow older and perhaps wiser. A Bengali poet sang centuries ago " Man is the supreme fact and there is nothing higher."

Students entering college life are young and unsophisticated and an interest in science must be created in them not only through scientific facts but also through a vivid description of the lives of the great scientists, their human greatness and weakness, their failures and successes. A proper narration of the age and the surroundings they live in and the facilities at their disposal are no less important for an adequate apprisal of the importance of their contributions towards the advancement of human knowledge.

To illustrate the point, let us take the history of the development of thermodynamics. Laws of thermodynamics are fundamental laws *i.e.*, they are not derived from some other laws, but are the shortest possible generalized statements of the results of our accumulated observations and experiences. They can be mathematically stated but not derived, and their validity can be proved only by experiments. Observations and experiences have been going on since the dawn of human intelligence and have been at times recorded as isolated facts. The underlying truth in all of them did not reveal itself all in a flash. It required master-mind to discover the principles pervading all of them. At last the First Law of Thermodynamics was clearly and unambiguously defined by Helmholtz in 1847. The Second Law preceded the First, and the Third Law was really discoveries third in order of sequence. These laws, dealing not with any particular material objects but with matter in general and being independent of the time-factor, required a long time for full clarification of their true implications and hence discoverers and expounders of the laws can claim almost equal credit. The following names are the most important in the history of thermodynamics.

Benjamin Thompson-Count Rumford	(1753-1814)
Sir Humphry Davy	(1778-1829)
J. P. Joule	(1818-1889)
J. R. Mayer	(1814-1878)
W. Thomson (Lord Kelvin) ..	(1824-1907)
G. H. Hess	(1802-1850)
H. L. F. Von Helmholtz	(1821-1894)
Sadi N. L. Carnot	(1796-1832)
B. E. Clapeyron	(1799-1864)
R. J. E. Clausius	(1828-1888)
J. W. Gibbs	(1839-1903)
J. H. Vant Hoff	(1852-1911)
H. L. Le Chatlier	
W. Nernst	(1864-)
M. Planck	(1858-)

The First Law

The fact that all friction produces heat was known for a long time; but the first person to pronounce it in a scientifically accurate manner is Count Rumford. A teacher, a scientist, a soldier, a philanthropist, that is a formidable array of titles which faithfully picture Benjamin Thompson, the

Yankee teacher, who became a Count. He founded the Royal Institution of London, which stands as a perpetual gift to science and the world. Benjamin Thompson was born in Woburn, Massachusetts, in 1753. His father died when he was only a year and a half old, and shortly after, his mother married again and young Benjamin lived with his step-father. He had almost no formal schooling beyond learning the three R's and had to get himself apprenticed to a merchant for a living. Thence-forward he was self-taught except attending lectures, in 1771, on experimental physics at Harvard College, to which he walked every day from his home in Woburn, a distance of twenty miles. In the following years he worked as a teacher in Rumford, afterwards called Concord, where the eminent philosopher and assayist Emerson later lived. When his fame as a teacher spread he married a prominent young lady of Rumford who, having wealth and social position, helped her husband to achieve some of his other ambitions. The teaching profession, therefore, lost a valuable member. The American War of Independence took place at this time. Rebellion and Aristocracy do not well harmonize and Benjamin Thompson who sided with the British had to leave for England. But before he left, he was appointed a Major of a regiment and showed his military skill. In 1778 while a refugee in England, we find him deeply interested in the improvement of fire-arms, the testing of explosives and inventing a new code of marine signals. His notable works in these directions led to his election as a Fellow of the Royal Society in 1779. A teacher-scientist with military leanings, Lieutenant-Colonel Benjamin Thompson, left England in 1783 for a continental tour in the course of which he came in contact with the Elector of Bavaria who invited him to become Major-General of Cavalry and Privy Councillor of the State of Bavaria with a palatial residence in Munich to live in. The King of England in releasing Colonel Thompson from his own service made him a knight with full honours. As a military and civil servant of the State, he reorganized the Bavarian army, immensely improved the condition of the industrial classes throughout the country by providing them with work and instructing them in the practice of domestic economy, and he did much to suppress mendicancy. The multitude of beggars in Bavaria had long been a public nuisance and a danger. In one day he caused no fewer than 2600 of these outcastes and depredators in Munich and its suburbs alone to be arrested by military patrols and transferred by them to an industrial establishment which he had already prepared for their shelter. In this institution they were both housed and fed and they not only supported themselves by their labours but also earned a surplus for the benefit of the State revenues. The principle on which their treatment proceeded is stated by him in the following memorable words:

" To make vicious and abandoned people happy, it has been supposed necessary first to make them virtuous. But why not reverse this order? Why not make them first happy and then virtuous?

Of course, the people of Bavaria were grateful and when the Elector became Vicar of the Holy Roman Empire he made Benjamin Thompson a Count who took his new name from the town of his youth, and became Count Rumford (1791).

In 1795 Count Rumford returned to England where reports of his work and accomplishments had preceded him, for he was now a popular scientist. While in London he became known as the first man to advocate home economics and dietetics.

In 1798 his outstanding work was presented to the Royal Society and published in his shortest manuscript (20 pages) under the caption " An Enquiry Concerning the Sources of Heat which is excited by Friction." Up to this time there had been a controversy on " the existence or non-existence of igneous fluid." There was a firm belief in a substance called " Calorie " which was defined as a fluid heat which flows from a hotter to a colder body. Count Rumford very conclusively disproved this theory as he worked on the boring of cannons for the Bavarian army. He noticed during the boring work that the metal turnings were hot enough to heat water to boiling. Then through a series of very interesting experiments, which individually excluded different variables, he concluded:

" It is hardly necessary to add that anything which any insulated body, or system of bodies, can continue to furnish without limitation, cannot possibly be a material substance; and it appears to me to be extremely difficult, if not quite impossible,

to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in these experiments, except it be *motion*."

Thus was laid the foundation of the convertibility of one form of energy into another, a partial exposition of the First Law of Thermodynamics.

In 1799 he, in conjunction with Sir Joseph Banks, projected the establishment of the Royal Institution. It received its Charter of Incorporation on January 12, 1800, and Count Rumford became its first journalist, and himself selected Sir Humphry Davy as scientific lecturer there. He was the founder and the first recipient of the Rumford Medal of the Royal Society. He was also the founder of the Rumford Medal of the American Academy of Arts and Sciences and of the Rumford Professorship in Harvard University.

In 1805 he went to the Continent again. His first wife, his senior by 14 years, died in 1792. Now a widower for thirteen years, he married the wealthy widow of Lavoisier. This marriage was not a happy one, the widow of the discoverer of the Law of Conservation of Mass could not pull on well with the partial founder of the First Law of Conservation of Energy, so they separated. Count Rumford retired to Auteuil, France. Here he lived a happy and restful life with his flower gardens and books until the year 1814 when he died.

Though born of humble Yankee parentage, Thompson had all the instincts of an intellectual aristocrat. He was a natural leader, but never too removed to see the benefits that his money, his knowledge of science, and his leadership could give to humanity.

The lives of the other founders of the First Law are not as romantic or eventful as that of Count Rumford.

The work of Rumford was further extended by his nominee Humphry Davy in the Royal Institution. The name of Sir Humphry Davy (1778-1829) is familiar to all with any knowledge of chemistry. He made many discoveries but the greatest of them all was his discovery of Michael Faraday. Born of modest parentage, he was early in life, because of his father's untimely death, compelled to take charge of the family. By dint of indomitable courage and energy he rose to the highest eminence in the scientific world. He had all the gifts of a popular lecturer on scientific subjects. With his laughing gas, newly discovered alkali metals, safety lamp, etc., his lectures used to draw the biggest audience including members of the fashionable London society. So he was one of those who contributed considerably towards the popularization of scientific knowledge at the parting of the 18th century and the 19th in England. At the height of his fame he married a wealthy society lady, a relation of Sir Walter Scott. Young Michael Faraday, then a book-binder's apprentice, was encouraged in his scientific studies by the eminent Sir Humphry Davy and was later appointed as his assistant in the Royal Institution. Faraday is one of the best scientific experimenters, living and dead. In his experiments he could "see" the invisible, as he used to say that he could see the lines of force round a magnet. In spite of his very modest mathematical training he drew conclusions which baffled Maxwell. He had wonderful power of intuition and was truly a "Seer" in science. He had a saintly character and was the most lovable of all the scientists. Under the influence of his aristocratic wife Davy quite often humiliated Faraday and grew jealous of him as the fame of the latter spread far beyond insular England. The great Davy thus unwittingly exhibited his feet of clay. We have strayed away from our point but who can avoid paying homage to Faraday in dealing with the history of sciences?

"In 1799, Davy showed that when two pieces of ice were rubbed together water is produced. It was admitted by all that water contained a larger amount of caloric fluid than ice. Now supporters of the caloric theory asserted that heat is generated in friction because the substance produced by friction has less capacity for heat than the original substance. But the substance produced in Davy's experiment (water) contains more heat than ice, hence the caloric theory became untenable. Davy's experiment proved the greatest stumbling block for the caloric theory.

"But the valuable work of Rumford and Davy was soon forgotten and it was only about forty years later that the First Law of Thermodynamics

gained general publicity through the researches of Joule in England, Mayer and Helmholtz in Germany, and Colding in Denmark." (Saha and Srivastava).

Julius Robert Mayer (1814-1878) has been claimed by many, specially by his German colleagues, as one of the discoverers of the First Law, but his claim to this honour has been shown to be baseless by Lord Kelvin, P. G. Tait and G. G. Stokes. According to them, Mayer entirely ignored the grand fundamental principle laid down by Sadi Carnot—that nothing can be concluded as to the relation between heat and work from an experiment in which the working substance is left at the end of the operation in a different physical state from that in which it was at the commencement. Mayer has also been called the discoverer of the theory that heat consists in (the energy of) motion, but in the teeth of this statement we have Mayer's own words:—"We might much rather assume the contrary—that in order to become heat, motion must cease to be motion." From all these controversies it seems that Mayer had a somewhat vague notion about the convertibility of heat into mechanical energy but it is certain that the true nature of the relation did not reveal itself to him. His experiments for the determination of the relation were indirect and that is why he missed the real significance. This controversy reminds one of a still bitter academic quarrel between the compatriots of Sir Isaac Newton and of the philosopher Leibnitz regarding their claim for the priority of the discovery of calculus long after both these great men were dead.

Mayer focussed the attention of the scientific world in this direction by reviving the problem but failed to make accurate formulation of his ideas, and it was left to J. P. Joule (1818-1889) to carry out very accurate measurements establishing the relation between heat and mechanical work. Joule was another self-taught British scientist. His most important scientific contributions are (*i*) the determination of mechanical equivalent of heat and (*ii*) the energy-changes during the expansion of gas, better known as Joule-Thomson Effect. The first confirmed the ideas of Rumford and Davy, and the second refuted the contention of Gay-Lussac that temperature remaining constant, the internal energy of a gas is independent of volume. Joule read his paper on "The Calorific Effects of Magneto-Electricity and the Mechanical Value of Heat" at the British Association Meeting at Cork in 1843. In 1847, Thomson (afterwards Lord Kelvin) first met Joule at the Oxford Meeting of the British Association. A fortnight later they again met in Switzerland and together measured the rise of the temperature of water in a mountain torrent due to its fall. Joule's views on the nature of heat greatly influenced Thomson's mind with the result that in 1848 Thomson proposed his absolute scale of temperature which is independent of the properties of any particular thermostatic substance, and in 1851 he presented to the Royal Society of Edinburgh a paper on the dynamical theory of heat which reconciled the work of Sadi Carnot with the conclusions of Count Rumford, Sir Humphry Davy, J. R. Mayer, and J. P. Joule and placed the dynamical theory of heat and the fundamental principle of the conservation of energy in a position to command universal acceptance. It was in this paper that the principle of dissipation of energy briefly summarized in the Second Law of Thermodynamics was first stated.

The forms of energy dealt with in the generalizations mentioned above were chiefly thermal and mechanical and it was left to Hermann Ludwig Ferdinand von Helmholtz (1821-1894) to give the first law its final shape embracing all forms of energy. As the name implies Helmholtz was a German and a full-fledged university professor. It is an interesting historical fact that in England culture of both arts and sciences grew outside the universities up to the middle of the 19th century and in some cases even later. In Germany, on the other hand, with her centuries-old network of universities, culture even to this day, originates in and spreads from the universities.

Helmholtz was born at Potsdam, near Berlin. His father was a teacher of philosophy and philology in the Gymnasium, while his mother was a Hanoverian lady, a lineal descendant of the great Quaker William Penn—the founder of the State of Pennsylvania in U. S. A. Delicate in early life Helmholtz became by habit a student. He showed

mathematical powers but these were not fostered by thorough training mathematicians usually receive, and in after years his attention was directed to higher mathematics by force of circumstances. As his parents were poor, and could not afford to allow him to follow a purely scientific career, he became a surgeon of the Prussian army. In 1842 he wrote a thesis in which he announced the discovery of the nerve-cells in ganglia. This was his first work, and from 1842 to 1894 scarcely a year passed without several important, and in some cases epoch-making, papers on scientific subjects from his pen. He lived in Berlin from 1842 to 1849, when he became professor of physiology in Königsberg; then he occupied the chair of physiology at Bonn, from there he moved to Heidelberg. Finally in 1871 he was appointed professor of physics in Berlin. In this post with which was coupled in 1887 the directorship of the Physico-technical Institute at Charlottenburg, he remained till his death in 1894.

Helmholtz was a versatile genius and in some respects may be compared with Leonardo da Vinci in the wide range of his interests and contributions. His researches in physiological optics and acoustics, the theory of colours, and sensations of tone, were epoch-making discoveries and inventions opening out new worlds to the students of medicine. For the later years of his life his labours may be summed up under the following heads: (*i*) on the conservation of energy; (*ii*) on hydro-dynamics; (*iii*) on electro-dynamics and theories of electricity, (*iv*) on meteorological physics; (*v*) on optics and (*vi*) on the abstract principles of dynamics. In all these fields his contributions were of great importance. In 1871 he announced that the velocity of the propagation of electromagnetic induction was about 314,000 metres per second. Faraday had shown that the passage of electrical action involved time, and he also asserted that electrical phenomena are brought about by changes in intervening non-conductors or dielectric substances. This led Clerk Maxwell to frame his theory of electro-dynamics, in which electrical impulses were assumed to be transmitted through the ether by waves. G. F. Fitzgerald was the first to attempt to measure the length of electrical waves. Helmholtz put the problem into the hands of his favourite pupil, Heinrich Hertz, and the latter finally gave an experimental demonstration of electro-magnetic waves, the "Hertzian Waves". The life of Helmholtz was uneventful in the usual sense. He was a man of simple but refined tastes, of noble carriage and somewhat of austere manner. His life, from first to last, was one of devotion to science, and he must be ranked, on intellectual grounds, as one of the foremost men of the 19th century.

As already mentioned, it was Helmholtz who for the first time in 1847 in his famous paper "Über die Erhaltung der Kraft" brought together all forms of energy under the Law of Conservation. Curiously enough to denote energy he used the word "Kraft", which means force. He cited all kinds of energy forms as were then known and showed their quantitative relations, and asserted that any kind of energy can be converted into any other possible variety and thus the total can neither increase nor decrease. This all-comprehensive idea of Helmholtz seemed so revolutionary to the scientific world of the time that his paper mentioned above was refused publication by the editors of Poggendorff's *Annalen der Physik* to which it was sent.

Later works on the First Law of Thermodynamics were either refinements of experimental data or its application to all possible natural phenomena.

The Second Law

The Second Law of Thermodynamics is of more intangible and elusive character for proper comprehension than the First Law. But its origin in the mind and method of Sadi Carnot dates earlier than the first establishment of the First Law. It is a matter of wonder how great minds can derive conclusions with quite insufficient data taking big jumps in their imagination over unfathomable chasms. Their process of reasoning is quite often not palpably logical from the current knowledge of the time. It requires equally great minds to construct the bridges for ordinary students to follow in their foot-tracks. Sadi Carnot's work was rendered understandable by Lord Kelvin just as Gibbs' work was so rendered by Ostwald later.

Sadi Nicolas Leonhard Carnot (1796-1832) comes of a family well known in France for the last 150 years. His father, a military man and an engineer of repute, had to take active part in the French Revolution; as a member of the Committee he signed its decrees and was thus at least technically responsible for the acts of the Reign of Terror. He was elected one of the five Directors in November, 1795. Sadi Carnot's younger brother L. H. Carnot was a litterateur and a student of philosophy but later took to politics and was elected Senator for life. M. F. S. Carnot, the son of this younger brother was the fourth president of the third French Republic. All the other Carnots, greater than our hero in their own lands and in their own times, are now forgotten, but to the greater world Sadi Nicolas Leonhard Carnot has become immortal.

He was educated in the École Polytechnique and in 1874 at the age of eighteen got a commission in the Engineers with prospect of rapid advancement in his profession. But Waterloo and Restoration led to a second and final proscription of his father and, though not himself cashiered, Sadi was purposely told off for the merest drudgeries of his service. Disgusted with an employment which afforded him neither leisure for original work nor opportunities for acquiring scientific instruction he presented himself for examination for admission to the staff corps (etat—major) and obtained a lieutenancy. He then devoted himself with astonishing ardour to mathematics, chemistry, natural history, technology, and even political economy. He was an enthusiast in music and other fine arts. He became Captain in the Engineers in 1827, but left the service altogether in the following year. His naturally feeble constitution further weakened by excessive study broke down finally in 1832. An attack of scarlatina led to brain fever, and he had scarcely recovered when he fell a victim to cholera of which he died in Paris on the 24th of August, 1832, at the early age of thirty-six. The only work he published was that on his "Cycle" (1824). This contains but a fragment of his scientific discoveries, but it is sufficient to put him in the foremost rank, though its full value was not recognized until pointed out by Lord Kelvin in 1848 and 1849. Fortunately his manuscripts have been preserved, and extracts were appended to a reprint of his published paper by his brother L. H. Carnot in 1878. These show that he had not only realized for himself the true nature of heat, but had noted down for trial many of the best modern methods of finding its mechanical equivalent, such as those of J. P. Joule with the perforated piston and with the friction of water and mercury. Joule-Thomson's porous plug experiment is also suggested.

In the history of sciences it is quite often found that art precedes science. Conversion of heat into work was known and applied long before the true nature of either was realized. The steam-engine, a machine for the conversion of heat into mechanical work in which the working substance is water and water-vapour, has a long and checquered history dating back from 130 B. C. which is briefly as follows:—

(*i*)	Hero's apparatus (Alexandria, 130 B. C.)	
(*ii*)	Battista della Porta	(1601)
(*iii*)	Edward Somerset, Marquis of Worcester	(1663)
(*iv*)	Thomas Savery	(1698)
(*v*)	Denis Papin	(1705)
(*vi*)	Thomas Newcomen	(1705)
(*vii*)	James Watt	(1763)

In Watt's days it was found that only 5% of the heat could be converted into work and the rest of it was rejected as heat unutilizable under the circumstances. The question arises whether the waste is unavoidable, whether it was due to the faulty construction of the contrivance (the steam-engine) for conversion; even at the present time with the best type of steam-engines the efficiency of conversion does not exceed 18%. Carnot devoted himself at the early age of 28 to the solution of this problem and proved that this low efficiency is inherent in the nature of the problem of conversion of heat to work. He proved that the efficiency of a heat-engine is a function of the temperature of the source of heat and that of the surroundings.

Novelties (for these times) of Carnot's proof consisted in the following:—

(*i*) Introduction of a cyclic process, the working substance being brought back to its original condition with the same energy-content.

(*ii*) No Particular working substance was assumed.

(*iii*) An ideal engine with no loss due to mechanical defects.

(*iv*) Complete reversibility—infinitely slow process—an idealized hypothetical working condition.

(*v*) Isothermal and adiabatic expansion and contraction; calculations of work and heat involved in these processes.

(*vi*) Tacit assumptions of conservation of energy and fixed relation between heat and work.

With the help of his ideal engine working in a cycle under reversible conditions Carnot calculated the theoretical maximum efficiency of conversion of heat into work under given values of temperatures; he showed that all reversible engines will show the same efficiency and no other engine any higher than this. Thus was laid unknowingly by Carnot the foundation of the Second Law of Thermodynamics. Carnot was ignorant of the true nature of heat at the time (1824) when he published his theorem of efficiency and followed the old caloric theory in his speculations but came to the right conclusions. It was Clapeyron who showed that Carnot's arguments and results remained intact when the kinetic theory of heat was introduced.

Importance of Carnot's theorem was not recognized at the time of its publication and it required a genius like that of Lord Kelvin to discern, explain, and proclaim it to the scientific world. The importance of temperature developed in this theorem in determining the efficiency of the conversion led Clausius to enunciate the second law in the following form,—" Heat cannot of itself pass from a colder to a hotter body."

Rudolf Julius Emmanuel Clausius, (1828-1888) like most German professors was of migratory nature. It is a peculiarity of the German students that many of them move from university to university before they settle down in any one for the research work for the doctorate. Professors too offer their services to the highest bidder and change their allegiance accordingly. Clausius occupied the professorial chair in physics at Zürich, Würzburg, and Bonn. He was more a mathematician than an experimenter, his most important work being in molecular physics. The kinetic theory of gases owes much to his labours, Clerk Maxwell calling him its principal founder. It was he who raised it, on the dynamical theory of heat, to the level of a theory and he carried out many numerical determinations in connection with it, *e.g.*, of the mean-free-path of a molecule. By his restatement of Carnot's principle he put the theory of heat on a truer and a sounder basis and he deserves the credit of having made thermodynamics a science. He enunciated the second law in a paper contributed to the Berlin Academy in 1850 in the well-known form, " Heat cannot of itself pass from a colder to a hotter body." When confronted with the statement that there may be parts of the universe where heat may flow from a colder to a hotter body, Clausius declared—" Mein Satz gilt für eine Welt wie sie ist, und nicht für eine erdachte Welt." (My law holds good for the world as it is and not for an imaginary world). The declaration of Clausius may be made in the defence of all fundamental laws which are based on actual experience and observation. If only any real contrary phenomenon be observed in nature the fundamental law concerned breaks down and not otherwise, simply on the ground of any imaginary contradictory happening.

Thus were laid the foundations of the First and Second Laws of Thermodynamics which were quickly followed by the explanation of their implications and applications to all kinds of natural phenomena. A host of scientists devoted themselves earnestly in this work and were rewarded with brilliant results. It is not possible in this short article to name them all in order of sequence and importance and we shall satisfy ourselves with a short description of the life and work of one of the brightest luminaries in this galaxy of stars—Josiah Willard Gibbs (1839-1903).

America in the early days of Gibbs did not loom large in the scientific world. The sum total

of her contributions to pure science was meagre both in quality and quantity. The atmosphere for research was neither congenial nor encouraging, and this fact, therefore, adds more to his credit. Interchange of ideas, battle of wits, helpful criticism and suggestions all go to develop the latent powers in a man whether he be a scientist, an artist, a literateur, or a philosopher. All these were comparatively lacking in the surroundings of Gibbs working as a professor in a provincial town in the then academically undeveloped America.

Josiah Willard Gibbs' father, bearing the same name, was professor of sacred literature in the Yale Divinity School. The son, the scientist, graduated from Yale College at the age of 19 in 1858. For the next five years he studied there, got the doctorate degree in 1863 and was appointed a tutor to teach Latin and then natural philosophy. In 1866 he with his sister went to Europe, visiting Paris, Berlin, and Heidelberg one after the other and attending lectures by Magnus, Kirchoff and Helmholtz. He returned to New Haven, the seat of Yale University and two years later in 1871 was appointed professor of Mathematical Physics in Yale College, a position which he held until the time of his death.

He published his first two papers (*i*) Graphical Methods in the Thermodynamics of Fluids and (*ii*) A Method of Geometrical Representation of the Thermodynamic Properties of Substances by Means of Surfaces in 1873 in the *Transactions of the Connecticut Academy*. These two were followed in 1876 and 1878 by his most important work, " On the Equilibrium of Heterogeneous Substances," in two parts. The last is considered generally, and probably rightly, his most outstanding contribution to physical science and is unquestionably among the greatest and most enduring monuments of the wonderful scientific activity of the nineteenth century.

Gibbs was inclined to the use of geometrical illustrations which he employed as symbols and aids to the imagination, rather than the mechanical models which have served so many great investigators. Mechanical models do not in all respects agree with the phenomena they represent, and Gibbs' extremely logical mind was dissatisfied with such discrepancies and he, therefore, had recourse to the geometrical representation of his equations. Before his time, in thermodynamic treatment, only the volume-pressure diagram was used, and it was he who for the first time used entropy and temperature as coordinates; this method has found very important practical applications in the study of the steam-engine. Next he applied with greater emphasis the volume-entropy diagram which properties are proportional to the quantity of the substance while pressure and temperature are not. From this he went over to diagrams in three dimensions (volume, entropy and energy) to develop the properties of the resulting surface, the geometrical conditions of equilibrium, the criteria for its stability or instability, the conditions for co-existent states, and for the critical state. The exceptional importance and beauty of this work by hitherto unknown writer was immediately recognized by Maxwell, who, in the last years of his life, spent considerable time in carefully constructing, with his own hands, a model of this surface, a cast of which, very shortly before his death, he sent to professor Gibbs.

His third paper, that on the equilibrium of heterogenous substances he begins with the following well-known statement of Clausius:—" Die Energie der Welt ist constant. Die Entropie der Welt strebt einem maximum zu." (The energy of the World is constant. The entropy of the world is tending towards a maximum). In this paper the most important step is taken of introducing as variables in the fundamental differential equation, the masses of the constituents of the heterogeneous body. It is impossible to narrate the importance of this work here and it may suffice the purpose to state that Le Chatelier compared it with the Law of Conservation of Mass enunciated by Lavoisier. There is perhaps a little exaggeration on the part of Le Chatelier which is to be expected from a Frenchman in the enthusiasm of the moment, but this also shows his magnanimity, for Lavoisier is his compatriot.

The importance of these papers specially of the third was not known and recognized for a long time for two reasons—(1) Natural modesty of Gibbs induced him to publish the papers in the *Transactions of the Connecticut Academy*, a provincial journal

little known in America and still less to the outside world; (2) The mathematical forms and the rigorous deductive processes make the paper very difficult reading to any one, not to speak of the chemists. At the present time, however, the great value of its methods and results are fully recognized by all students of physical chemistry. It was translated into German in 1891 (*i.e.*, 25 years after its publication) and into French in 1899 by Le Chatelier. It was explained in a more easily understandable form by Ostwald, the *doyen* of physical chemistry in the last quarter of the nineteenth century. In its simplest form a part of it is known to all students of chemistry as the " Phase Rule " which has served to classify and explain, in a simple logical manner, experimental facts of much apparent complexity.

Gibbs' other works were on statistical mechanics, vector analysis, astronomy, etc., all of them being of mathematical nature of a very high order.

Gibbs did not propound any new fundamental law of nature and did not excel in intuitive faculties like Faraday or Carnot. His was a logical mind trying to explain and expand the laws of nature mathematically and drawing inferences from them. This abstruseness of his intelligence is due to his training and environment. He came of the New England Puritan stock; his early specialization was in classical languages and mathematics, he suffered from indifferent health and lived a bachelor's life. Under the circumstances, he, an intellectual and a mathematician, cannot but be extremely logical—he never came in intimate relation with the illogical half of the human race. Being a bachelor, and not being compelled to satisfy a child's curiosities and to listen to its prattles, Gibbs' writing became extremely abstruse and incomprehensible to ordinary understanding.

The Third Law

The First Law of Thermodynamics deals with the conservation of energy, and arose out of conversion of work to heat the Second Law with the reverse problem of conversion of heat to work, and the Third Law, sometimes also called Nernst's Heat Theorem, is concerned with entropy and means of evaluating it at absolute zero. One form of the statement of the theorem is:—"Every substance has a finite positive entropy, but at the absolute zero of temperature the entropy may become zero, and does so become in the case of perfect crystalline substances."

The theorem arose out of a quest to find out the conditions which lead a chemical reaction to completion. A system under a definite set of conditions reaches equilibrium, *i.e.*, runs to completion of the reaction at its minimum free-energy-content under the circumstances. Berthelot did not make a clear distinction between free energy and the heat of reaction and was of the opinion that only exothermic reactions run quickly to completion. Lord Kelvin was misled by this opinion and unfortunately chose the Daniell cell which has a very low temperature-coefficient of the electromotive force, for verification of Berthelot's assumption. This view of the relation between heat of reaction and free energy was corrected and put on the proper thermodynamical basis by Gibbs and Helmholtz. It is easier to measure the heat of reaction than to measure the free-energy from electromotive force because many reactions cannot be run electro-chemically. Therefore some method of calculating the driving force of a chemical reaction from purely thermal data has long been sought. There are equations theoretically derived, which show that the change of free energy in a reaction may be expressed as a series of terms, every one of which is obtained from measurement of heats of reaction or of specific heats except the one involving I, the constant of integration. Le Chatelier in his *Memoir* of 1888 integrated the free-energy equation and explained the importance of this integration constant. Unfortunately, owing to the inaccessibility of the journal in which his paper was published, his study of the integration constant was for a long time overlooked until 1906 when his methods were revived by Nernst in his work on the so-called chemical constants.

Gibbs-Helmholtz equation expresses the relation between free energy and heat of reaction and this involves the temperature-coefficient of the electromotive force. T. W. Richards (1902) experimentally studied the free energy and heat changes in a number of galvanic cells and showed that in a great many cells the two quantities approach each other rapidly as the temperature is lowered and that in the neighbourhood of absolute zero of temperature

the change in heat capacity and the change in entropy become negligibly small. Thus except for the fact that these cells involved solutions Richard's experiments very nearly imply the generalizations which were later to be embodied in the Third Law of Thermodynamics. Vant Hoff (1904) discussed Richards' experimental results and obtained the following rule which may be regarded as a corollary of the Third Law:—When two forms (solid or liquid) of a substance exist the one with the larger specific heat is the one which is stable at higher temperatures. Richards' extreme accuracy of whose experimental results could never be questioned, did not believe in Nernst's Heat Theorem and in his lecture classes (1911-12) he used to say " Nernst does not understand what he speaks about." Theories were never Richards' forte. Priestley discovered oxygen yet stuck to the phlogiston theory, and Lavoisier explained the role of oxygen in the phenomena of combustion.

All these attempts to secure information regarding free energy from other than equilibrium data were brought to a focus in the important paper of Nernst (1906), " Uber the Berechnung chemischer Gleichgewichte aus thermischen Messungen." Herein he announced the general principle that in any chemical reaction between solid or liquid substances temperature-coefficients of the heat of reaction and of free energy approach zero at the absolute zero of temperature. As a corollary to this for any reaction in such systems the change of heat capacity and of entropy both approach zero asymptotically at the absolute zero of temperature. So with the constant values at absolute zero as the starting point one can determine the absolute values of heat capacities and entropies of systems under the limited conditions at any other temperature and state, and the integration constant evaluated.

The Third Law has not yet found such wide theoretical and industrial applications as the First and the Second.

Nernst is happily yet in the land of the living; his greatness as a scientist is recognized by all, but he has not been able to inspire love and affection from the general body of scientists except from amongst his colleagues and students. He never suffers from an excessive sense of modesty. His traditional introduction to his course of lectures on thermodynamics used to begin with the words " The First Law of Thermodynamics rests on the shoulders of many; the Second Law, on the shoulders of a few; the Third, on the shoulder of one—mine."*

This article is meant to be an humble but earnest appeal to all teachers of science not to lose the historical background of the subject they teach. Science is logical and the history of the development of every science indicates the working of the restless inquisitive human mind in its peerings into the secrets of nature. The lives of the great Masters will infuse the spirit of reverence in the young learners and will inspire them into greater strivings. A knowledge of the different ages and the leaders thereof will impart a sense of proportion and will help the students to be men of culture; and the aim of all education is first and foremost to turn out cultured gentlemen and then specialists.

*Very few scientific men will subscribe to the claims made by Nernst, on his own behalf. The Third Law was vaguely seen by Le Chetalier and Richards, but undoubtedly it was Nernst who stated it clearly, and proceeded to prove it on systematic experimental and theoretical basis. But neither the proof, nor the statement can be said to have reached finality except *before the rise of the quantum theory*, and completion of our knowledge of atomic structure. The works of Sackur, Tetrode and Stern, of Bose, Fermi and Dirac should not be forgotten. The Third Law, in fact, stands not on the shoulders of one man, but on those of many, as in the case of the first two—Ed., *Sc. & Cul.*

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human life. Thus South-Eastern Asia gave us " the hull-less barley, the millet, the soya-bean, and many fruit-trees." The regions round the Mediterranean produced "the hard wheats, the large-seeded flax and leguminous plants, the beet, the olive and the fig." Abyssinia specially was the home of these, as also the ordinary barley, emmer, certain beans and forage plants. From Central and South America came " the maize, potato, tobacco, New-world cottons and the like." Lastly, it is held that the original home of rice is to be looked for in the Phillipines.

It is also established that the crop plants must have originated in mountainous countries. The first step in civilization was not taken in any low-lying river-valley covered with dense vegetation as obstacle to be cleared by man. It began on more open ground on the slopes of hills where wild wheat or barley grew. Thus though civilization is supposed to have started from its original centres in the valleys of the Indus, the Euphrates, and the Nile, we must go farther back in time, and higher up in spaces to discover and locate the very earliest phase of these great agricultural civilizations, which were really secondary growths. Civilization started on hills and later spread down to the plains and river-valleys.

Thus biology and plant genetics must make us revise established notions regarding the original home of mankind or the Aryans, and the origins of civilization. The different sciences, biology, archaeology, anthropology and, even geology, are all pointing to the common conclusion that India was at once the cradle of the human race and of its civilization. She offers the most fruitful field of studies in pre-history. Quite recently the Yale Cambridge Expedition from U. S. A. visited different parts of India in search of materials for the early history of Man and reported that the North-Western Punjab and the Sind valley are specially rich in pre-historic and palaeontological materials, while they got the best collections of primates in the Siwalik, post-Siwalik, and Salt range areas, pointing to the conclusion that the evolution of man, probably took place somewhere in the Himalayan foot-hills of N. W. Punjab and Kashmir, where was previously found the Sivapithecus jaw, an early indication of Man. The authorities of the Expedition (Dr de Terras, Mr Paterson, Mr D. Sen and others) hold that "the Palaeontologist and the Pre-historian would one day show that India was the cradle of pre-historic civilization, if not of humanity." To this we may add the earlier conclusion of Elliot-Smith that " the common ancestors of anthropoid apes and man probably occupied northern India during the Miocene Epoch " (*Early May*--a lecture delivered at the Royal Anthropological Institute) and the statement of Professor Lull,, the distinguished palaeontologist: " We have to go to the region north and south of the Himalayas to find peoples whose facial characteristics best resemble those of Cro-Magnon Men, while their stature and bodily build are best displayed by the Sikhs " (' *The Antiquary of Man* ' in the Evolution of Man series edited by Bartsale). The geologist Barell also recorded earlier his conclusion that " Man and the Himalayas arose simultaneously, towards the end of the Miocene Period."*

* Read before the Second Session of the Indian Historical Congress.

Synthesis of Natural Products

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A Natural product can be defined as a substance that occurs in nature, animate or inanimate. The substances occurring as minerals are not strictly within the scope of this article, although there are mineral substances like petroleum which are of organic origin. The importance of the study and synthesis of natural products arises from their economic importance. Substances like indigo, alizarin etc., have been of great economic importance to this country but after their artificial preparation this country has been out of the picture altogether. The substances that have physiological interest are also of no less importance. The production of quinine, strychnine and other physiologically important alkaloids, digitalin and other cardiac aglucones have both economic and other interests. The synthetical production of a natural substance has a tremendous political significance also. Before the War, the foreign policy of England used to be, to a great extent, dictated by the consideration of the textile interests. In the post-War world, petroleum and rubber are two important considerations of the foreign offices of many countries of the Occident. It is stated that England could have realized the whole amount of the interest she had to pay to America by imposing an export duty on rubber. Henry Ford experimented on the production of rubber in tropical America so that his gigantic industry could be independent of outside supplies. If the synthetic production of rubber became a commercial proposition in peace-time conditions much of the international animosity on this score would be avoided. The question of petroleum is even more fraught with danger. The rivalry in the Middle and Near East is in a large measure bound up with this question. The researches on low temperature carbonization of coal have been intensified so that a peaceful solution of the petroleum problem can be achieved. This has been successful to a certain extent but still a lot remains to be done.

There is some confusion with regard to the use of the words " artificial " and " synthetic." The low-temperature tar of hydrogenation of coal would give a product capable of replacing petroleum, but would not be chemically identical with it. Therefore it should be better designated as " artificial petrol." Similarly hydrogenized fat would simulate butter in some respects, but its difference from natural butter can be demonstrated in a variety of ways; for example, it will show a characteristic difference of fluorescence under ultraviolet light. But the synthetic specimen of an alkaloid would be chemically and physically (also physiologically) identical with its natural analogue.

The idea to produce natural products in the laboratory is as old as the science of chemistry. Chemistry owed its birth to the desire of men to produce gold artificially. But the synthesis of natural products had the obstacle of the theory of vital force to overcome. Wohler's demonstration of the fact that substances of organic origin can be produced in the laboratory removed the last obstacle to progress. Are we not similarly handicapped even today? It is believed that synthetic chemistry will not be able to synthesize protoplasm, the unit of life. Most people believe that life on this planet had an extra-terrestrial origin. Is it outside the bounds of possibility that a suitable juxta-position of the constituent elements of protoplasm will not result in an assemblage showing properties we associate with living matter?

Synthetic chemistry has revolutionized the industrial fabric of a country. In 1868, Graebe and Libermann synthesized alizarin. In 1870, Germany (of much smaller dimensions than the present) was importing 750 tons of alizarin, the colouring matter of madder. But in 1900, she was exporting 2,000 tons per annum. If we consider the case of indigo, it is even more striking. In 1897, India exported 20

million dollars worth of indigo (6 million kilos). In 1880 Baeyer synthesized indigo for the first time in the laboratory. The cost of the synthetic material would have been about thousands of dollars per pound. At any rate, the original method of Baeyer could never have been a commercial success. Did the German nation or the government tell Baeyer as we are told in this country everyday that they had no time for his intellectual recreation? Instead, five million dollars were spent on researches for evolving a workable method for the commercial manufacture of indigo. But the final clue to the successful production of phthalic acid needed for the synthesis of indigo came from 'academic sources' when the catalytic action of mercuric sulphate in the oxidation of naphthalene was accidently discovered. This illustrates the necessity of laboratory work, however unremunerative it may apparently seem. In 1897, Germany imported 50 million dollars worth of natural indigo, but in 1911 she was able to export 100 million dollars worth of the synthetic stuff to the outside world. India grew indigo on one and half million acres of land, but to-day India's production of natural indigo is negligible. Tyrian purple (the purple of the ancients) in olden days used to be prepared from a species of snails, murex brandaries. 12,000 snails gave a bare gram and a half of the dye. Its rarity and cost were responsible for its use being restricted to the wealthy and the rich. In many ancient lands its use was the prerogative to the royalty, and hence purple even to-day is regarded as the royal colour. This substance was shown by synthesis to be 6: 6'-dibromo indigo and its artificial production at a very cheap cost presents little difficulty. It is no longer used in dyeing because there are so many synthetic dyes that give better shades. The dyestuff chemists have synthesized innumerable dyes and have discovered the relationship between colour and constitution. The study of natural products has given the chemists a clue as to the mode of working of nature. It has given them an insight as to the building units nature employs in forming her diverse products. With this knowledge, the synthetic chemist has gone ahead and produced endless varieties not even contemplated by nature.

The study of a natural product is important even if its synthesis is not immediately possible. The case of quinine is an instance. Although it has not been possible to artificially prepare quinine every detail of its structure is known. Basing on the model of quinine, synthetic products like plasmoquin and atebrine have been prepared having certain advantages over quinine. Again in the field of local anaesthetics, cocaine has now been almost entirely replaced by substances prepared by its analogy and but for the illicit use of cocaine, it would have completely lost its importance.

The deficiency diseases, produced by the absence from food substances of accessory bodies termed vitamins, can in most cases now be combated by synthetic substances. Recently the synthesis of vitamin A has been announced. Two of the substances of the vitamin B complex have now been produced in the laboratory. Synthetic vitamin C is a commercial commodity and the structure of vitamin E is now known with certainty.

The secretions of ductless glands which profoundly affect our metabolic processes, have been investigated and in a few cases synthetically prepared. Harrington's brilliant work on thyroxine illustrates the perseverance needed for work of this nature. The final iodination for the production of thyroxine presented difficulties which found a solution from some very systematic work on halogenation done by Datta at Calcutta. In this connection it is worthwhile to stress the importance of systematic investigation. Our workers are sometimes subjected to the criticism that the research work they are carrying out is stereotyped and very often such painstaking work is held up to ridicule. Even the Director of Public Instruction of an Indian Province found it fit to refer sarcastically to work of this nature whilst addressing one of the leading learned societies of this country. To such men and others of this way of thinking, I would say in the words of Carlyle that "Work is Worship." Every systematic honest endeavour has its place in the scheme of things. The criticism of scientific work should not be based on the criterion of its immediate benefits.

There is a growing feeling in this country that all we need is an army of men versed in the processes of technical chemistry and pursuit of pure sciences could be stayed till the country is in a

better position. To my mind divorce of technical chemistry from pure chemistry would be like teaching a boy how to solve extras in geometry without giving him a thorough grounding of the book propositions. There is a talk that higher education should be made self-supporting, and whatever higher education there is should pay its way. If that principle had been adopted in Europe we can well imagine what would have been the state of their sciences to-day. It is often said that the present system of higher education has failed in this country and it should be replaced. It is easy to make this kind of statement. At any rate, such statements can hide a lot of "shortcoming" for the time being. But a little reflection will convince any one that during the short spell of two decades since the inauguration of the present system of research degrees, our universities have produced quite a number of outstanding scientific workers who would have been a credit to any country. When a boy I was given a small plot of ground for gardening. Often, a few days after planting a tree I would pull it up to see if it has taken roots. I had no garden left in a short time. This habit of pulling a thing up by the roots to see how it is thriving if applied to our educational system can produce nothing but disaster.*

*A popular lecture delivered under the auspices of the National Institute of Sciences of India at Bombay.

Chance in aid of Scientific Researches

Scientific discovery can be divided into three phases: birth of the idea, its control or experimental verification and its practical realization. Only the last two points are susceptible of being presented in a public exhibition. But the first phase cannot be rendered concrete. The knowledge of the latent process of scientific discovery, the qualitative and quantitative laws of the creations of ideas have not yet been elucidated. Do they really exist? We know nothing. The marvellous work of thought escapes us totally and its analysis permits us at the most to predict certain regularity in the formation of the idea. There exists a profound analogy between scientific research and the work of the artist in the first phase of the process of creation. Some examples will suffice to illustrate the same:

Leonard de Vinci,—mathematician, physicist, astronomer and artist; Blaise Pascal—illustrated mathematician, physicist and philosopher; Borodine —Russian chemist and reputed musician; Wilhelm Ostwald—philosopher and physicist; Kurbatow—chemist and historian.

Long since chance is no more regarded as a unique source of discoveries but one can cite numerous happy cases where it has played an important role. Let us recall the discovery of saccharine by Fahlberg, that of thiophene by V. Meyer and the determination of the catalytic role of the oxides of nitrogen in the manufacture of sulphuric acid by Clement and Desormes. It is also a pure chance which led Verguin to the discovery of fuchsine and Perkin to that of mauveine during his researches on the synthetic preparation of quinine. It is by the breaking of a thermometer during the sulphonation of naphthalene that Saoper of the "Badische" prepared unintentionally phthalic acid which gave a formidable impulse in the industrial synthesis of indigo. Owing to a crack in the vessel the nitroglycerine contained in it impregnated the porous earth in which Nobel packed his vessel. The explosive character of this earth did not escape the notice of the inventor and dynamite was born. The discovery of iodine and bromine were facts of pure chance. The latter element was isolated by Balard in 1826. It is reported that Liebig who had remarked on the brownish red vapour without attaching much importance to it, ironically said, "It is not Balard that discovered bromine but bromine discovered Balard." We will conclude with another anecdote on the role of chance. During a ball given by Charles X at the palace of Tuillaries the candles

which illuminated the hall gave rise to extremely irritating vapours and necessitated the evacuation of the salon. Balard, the royal chemist and director of the factory of Sevres, asked his son-in-law, young Dumas, to ascertain the cause of it. The vapours were formed of hydrochloric acid arising out of the fixation of chlorine used in the bleaching of the candles. Dumas was able to demonstrate that organic compounds are susceptible to combine with the halogens and thus to announce his unforgettable theory of substitution.

One can analyse the role of necessity, immediate want and struggle for existence in discovery. It is sufficient to recall that France owed industry of sugar from beet and Leblanc's process of manufacture of sodium carbonate to the continental blockade.

Another phenomenon worth noticing is the simultaneousness of scientific discoveries. It is not an exceptional fact that two or more persons foreign to one another happen to announce the same scientific truth or to resolve the same practical problem at the same time. This phenomenon is virtually universal and very frequent. The memories of Darwin and Wallace on natural selection were both read on the 1st of July, 1858, at the Linnean Society of London. Cros and Ducos of Hauron exposed their processes of colour photography on the same day in 1869 at the French Society of Photography. Cailletet and Pictet discovered at the same time the liquefaction of gases. Restricting oneself in the domain of chemistry, one can still cite the discovery of oxygen by Priestly, Scheele and Lavoisier; of chloroform by Soubeiran in France, Liebig in Germany, and by S. Guthire in the United States. Mendeleef and Lothar Mayer in the same year came to announce the Periodic Table—classification of Elements by the increasing order of atomic weights. American Hall and French Heroult within the interval of one or two months perfected the industrial manufacture of Aluminium. Nilson discovered Scandium and Clive was late by a few weeks in announcing the discovery of the same. Crooks in England and Laney in France independently discovered Thallium.

Only one plausible and satisfactory hypothesis can be applied to this simultaneity. Discoveries mature at a given period. Society poses to the savants a certain number of problems which are expressions, of a practical or intellectual need born of previous discoveries. In the domain of pure science, the problems are suggested by the degree of advancement of a particular culture. This culture is determined by the teachings of masters, organization of laboratories, previous publications and finally by the general evolution of the society considered.

In the domain of applied science it is acted on, above all, by the industrial demand. The dominant factors here are utilitarian instinct, desire of well-being, competition, the lowering of the cost of production, etc. But this determinism is not the only factor of the simultaneity of discoveries. One must equally take into account the necessary succession of great scientific discoveries. Borrowing the formula of Mentre one could say that infinitesimal calculus cannot be born before analytical geometry —Newton before Kepler.

P. B. S.

Chemistry of Sterols and the Alleviation of Human Sufferings

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THE knowledge of the chemistry of sterols and related compounds (cholan chemistry) has during the last few years, undergone such drastic and far-reaching changes through the continuous experimental works of Wieland, Windaus, Ruzicka, Diels, Rosenheim, Butenandt, Fernholz and their pupils, that it forms to-day not only an interesting but the most important branch of physiological chemistry.

Sterols have been found to possess various kinds of biological activities and to have close structural relationship with other physiologically active substances such as bile acids, vitamin D, sex hormones, saponins, cardiac glycosides and cancer producing substances. From the knowledge of the structural similarity between sterols and these substances of biological importance it has also been possible to prepare them from sterols in the laboratory in large quantities. In one word, it can be said that recent developments in this line, have contributed much towards the progress of medicinal science and towards the alleviation of human sufferings.

What Sterols are.

Before proceeding further it is necessary to touch upon a brief account of the nature, occurrence and classification of sterols. Sterols, the unsaturated solid alcohols (steros=solid) of high molecular weight are regular constituents of oils and fats, both of animal as well as vegetable origin. These are neutral and comparatively stable substances and occur partly in the free state and partly esterified with higher fatty acids. Sterols with respect to their origin can be divided in three main classes:—(1) animal sterol (zoosterol) (2) fungus sterol (mycosterol), and (3) plant sterol (phytosterol). The important sterol occurring in the animal body is cholesterol ($C_{27}H_{46}O$) which was known since the eighteenth century, (Conradi, 1775) as the chief constituent of human gall stones. It has been so named from its occurrence in bile (choles=bile). It is the characteristic sterol of higher animals and is present in all cells of human organism and in large quantity in the brain, nervous tissue, in suprarenal cortex and in egg yolks. The solid matter of the brain contains as much as 17% of the substance. It also occurs in lanolin, the wool fat of sheep, as esters of higher fatty acids and in the feathers of birds as an ester of cilicic acid.

Ergosterol, the most important mycosterol and the so-called mother substance of vitamin D, was for the first time isolated in the year 1889 by Tanret from ergot, the fungus of rye. It has also been found in the yeast and animal body. It is present in the skin to the extent of about 1/600 of the total sterol. The present formula $C_{28}H_{44}O$, has been suggested only in the year 1932.

Stigmasterol, the characteristic plant sterol, was isolated from soyabean by Windaus in the year 1906 It has been found to be present also in beet oil, coconut oil and cocoa butter. The present formula $C_{29}H_{48}O$ has been developed in the year 1930. The sterol, as will shortly be shown, is the mother substance of female sex hormone luteosterone.

Several other sterols such as zymosterol, fucosterol, lanosterol, agnosterol, calosterol, cerevesterol etc. have been isolated from various sources, but details about their internal structure and physiological activity have not hitherto been known.

Functions of Sterol

Sterols were formerly believed to be merely waste products of metabolism. But it is now held

that they have got some protective function and save the body cells to some extent, against the entrance of certain poisons such as the snake venom which has a property of dissolving red blood corpuscles. From the occurrence in the bile and from the knowledge of its structural similarity with bile acids it is also (though not found definitely) that bile acids, which as will shortly be seen are of great importance to the system, owe their origin to the naturally occurring sterols.

Bile Acids and their Functions

Bile acids are the important constituents of bile and generally occur as sodium salts in conjugation with the amino acids, taurin and glycin (*e.g.* taurocholic acid and glycocholic acid). Other bile acids present in the human bile are deoxycholic acid and cheno-de-oxycholic acid which are of considerable importance.

Important functions of bile salts are (*a*) stimulating the secretions of bile, deficiency of which causes serious digestive disorder and (*b*) forming the so-called water soluble "Choleic acids" from some of the water-insoluble compounds.

Wieland and Sorge found (1916) that de-oxycholic acid which is an important constituent of the human and cattle biles formed co-ordination compounds with fatty acids excepting formic acid called "Choleic acid." Stable addition-compounds are also formed with cholesterol, with certain aliphatic and aromatic hydrocarbons, certain alkaloids and also with esters, ethers and phenols. Thus water-insoluble substances including fats and higher aromatic hydrocarbons can be brought into aqueous solutions in the form of sodium salts of cholic acid. Wieland and Sorge suggested that the dissolving power of the bile may be due to the "Choleic acid principle." But it must be pointed out that only de-oxy-cholic acid as opposed to other bile acids can form choleic acids and *help facilitating* absorption.

Sterols and Bile Acids

The view that sterols might have some genetic relationship with the bile acids has been developed since the year 1879 when Lachinov gave some hint about the point. The structural resemblance between sterols and bile acids, was first verified experimentally by Windaus and Neukirchen who were successful in converting cholestane the saturated hydrocarbon corresponding to cholesterol into allo-cholanic acid (a bile acid derivative) and corpostane into cholanic acid. Works of Wieland and Jacobi threw further light in this point. They succeeded in reversing the process. They started with ethyl cholanate (a bile acid ester) and through the action of Grignard's reagent and subsequent oxidation with chromium trioxide, found corpostanone—24, and from this they obtained corpostane, the saturated hydrocarbon corresponding to corposterol, by reduction of the CO-group.

Vitamin D and its relationship with Sterols

Vitamin D which in the form of solution in oils is now so vastly used as an antirachitic medicine for infants suffering from rickets and as an important calcifying factor during the period of pregnancy and lactation has also a close genetic relationship with the class of substances called sterols.

McCollum and co-workers in the year 1922 put forward the idea that vitamin D was distinct from vitamin A. Till the investigations of Schultz and Zeigler the generally accepted view was that cholesterol was the precursor of vitamin D.

It was soon revealed that the selective absorption shown by cholesterol was due to the presence of minute trace of a contaminant in it, and pure cholesterol, obtained by reconversion from the dibromide, could not be made to develop antirachitic activity. This led to the search for the "impurity" that was the precursor of the antirachitic factor and in the year 1927 Windaus and Rosenheim almost simultaneously announced that this impurity might be ergosterol. This declaration gave an impetus to the workers in the line of sterols; and subsequently investigation of a larger number of sterols and their derivatives pointed to ergosterol as being the specific pro-vitamin D.

Since this relation between ergosterol and vitamin D had been established, the sterol chemistry became a subject of considerable physiological importance. Attempts were then made to isolate

the chemically pure vitamin D; and within a few years, through the investigations of Askew *et al* on the one hand and of Windaus and his co-workers on the other, crystalline vitamin D (called calciferol by Askew and vitamin D_2 by Windaus) was isolated. By ultraviolet irradiation of ergosterol a number of isomerides were formed, but none other than calciferol has got any antirachitic property.

Different Varieties of Vitamin D

Some biological evidence however soon came to be prevalent against the view that ergosterol is the only source of vitamin D. By feeding chicks and children with cod-liver oil it was found that activity of this oil against rickets was about 25-100 times more than an equivalent number of rat units of calciferol. Waddel soon pointed out that though the irradiation product of crystallised cholesterol could not cure rickets in rats, it had a much more greater potency in curing rickets in chicks than an equivalent rat unit dosage of calciferol.

Only recently the idea about the problem of conversion of a sterol into an antirachitic factor, has been revolutionised. Windaus, Lettre and Schenck have found that a sterol irrespective of the molecular weight, can be made to develop antirachitic activity, provided it possesses two ethenoid linkings in the rings, in the same position as in ergosterol. It has been found that 1 mg. of irradiated 7-dehydrocholesterol prepared from cholesteryl acetate is equivalent to 8000 international *antirachitic units.*

Thus it is seen that the idea about the origin of vitamin D has recently been changed through the works of Windaus and his associates. It has been found very recently that just like 7-dehydro cholesterol, 22-dehydro ergosterol also can produce on irradiation a substance possessing high antirachitic potency and showing the same characteristic absorption maximum at 265 m, as vitamin D_2 and D_3. This goes by the name vitamin D_4.

Through the advancement of knowledge in the line of the chemistry of sterols it has not only been established beyond doubt that sterols irrespective of their molecular weight can act as the precursor of vitamin D, but it has also shown new ways and means for the relief of suffering humanity.

Sterols and Sex-Hormones

Another interesting feature is the structual similarity between sterols and the secondary sex hormones. A hormone $C_{19}H_{30}O_2$ (androsterone), which controls the secondary sexual characters in the male, has been isolated from male urine by Butenandt and Teschering. Within a few months the startling discoveries by Ruzicka, Goldberg and Brungger, have not only served to support the constitution of androsterone but have formed a bridge over sterols and the most physiologically active substances like hormones, and have brought forward a stimulus for the investigations of the chemistry of sterols. The authors have succeeded in converting cholestanyl acetate into an active isomeride of androsterone and epi-dihydro cholesterol into androsterone, by method of oxidation with chromium trioxide.

From the time it was supposed that ergosterol was the only pro-vitamin D, the importance of other sterols and their derivatives, was lessened to a great extent. But the works of Ruzicka and his co-workers (*loc. cit.*) in the year 1934, have renewed interest in the subject by showing that inactive sterols and sterol-derivatives can also be made to acquire physiological activity only through some chemical treatments.

The point has further been elucidated through the synthesis of the active principle of corpus luteum hormone luteosterone ($C_{21}H_{30}O_2$), almost simultaneously by the German scientists Butenandt and Fernholz, from a naturally occurring well characterised plant sterol named stigmasterol.

The scarcity of sex-hormones both male and female has thus been removed and the trouble in isolating those substances from urine, testes, ovaries etc. has been done away with. People suffering from insufficient or abnormal supply of these secretions of sex glands will now have the fortune of getting an adequate supply of sex-hormones, which can be manufactured from sterols.

Interconversion of Sex-Hormones

An astonishing result has recently been obtained in Butenandt's Laboratory where, Dannenberg has

CHEMISTRY OF STEROLS AND THE ALLEVIATION OF HUMAN SUFFERINGS

succeeded in converting the male hormone androstandione ($C_{19}H_{28}O_2$) which has been isolated from testes into a female one (1:2 androstendione) only by insertion of an additional double bond in 1:2 position. This new substance has the power of causing complete oestrus in a castrated mouse when injected but cannot cause comb growth of capon which is the characteristic property of the former one.

An interesting substance has also been reported to be formed from a male hormone de-hydro androsteron ($C_{19}H_{28}O_2$). This compound has been termed as androstendiol ($C_{19}H_{30}O_2$) and has the peculiar power of showing bi-sexual properties *i.e.*, of causing comb growth of capon and oestrus formation of castrated female mouse.

Whether some such transformation takes place in the animated beings are questions still to be solved.

Sterols and Saponins

It has been shown that saponins, the glucosides present in the plants which have the property of acting as emulsifying agents as soap solutions and thus causing oils and fats to be absorbed easily. have close structural resemblance with bile acid and hence with sterols. Zigogenin ($C_{27}H_{44}O_3$) has been converted to aetio-allobilianic acid ($C_{19}H_{31}O_4$).

Sterols and Cardiac Poisons

Though the compounds classed as cardiac poisons (Uzarigenin, Strophanthidin etc.) were unknown to the natives they made use of the crude extract of the plants in which these occur, as their arrow-poisons.

The active principles have now been isolated in the purified condition and have been and are being used as medicines to cure cardiac weakness and irregularities.

That these substances are also members of the *sterol group has been proved by the formation* of actio-allo cholanic acid ($C_{20}H_{32}O_2$) from uzarigenin ($C_{23}H_{34}O_5$).

Sterols and Carcinogenic Substances

Through the light of the modern research it has been established beyond doubt that cancer is not produced by any organism but it is formed by a peculiar method of cell division and destruction of the tissues at a greater speed.

In the year 1933 Cook and Dodds of the Royal Cancer Hospital, London and Wieland and Dane of Germany announced almost simultaneously that methyl cholanthrene ($C_{21}H_{16}$) obtained from a bile acid, 12-Keto cholanic acid, is a very active cancer producing substance.

Now as the constitution of this product has been known and the mechanism of working of this carcinogenic substance has also been ascertained to a certain extent we can hope that through the advancement of the knowledge in the branch of the chemistry of sterols and related compounds, science will soon find out means how to prevent its formation and to effect its cure.

Conclusion

Thus it is seen that the recent observations regarding the production of antirachitic substances from sterols other than ergosterol, transformation of more than one sterol to the highly active sex-hormones of both types male as well as female and conversion of sterol and sterol derivatives to bile acids, carcinogenic substances etc. have added greatly to the interest in the subject and have led to the search for new sterols and sterol derivatives in the plant and animal kingdom.

Nobel Laureate in Physics for 1938 —Professor Enrico Fermi

R. C. Majumdar
Bose Research Institute, Calcutta.

To Dr Enrico Fermi, the most outstanding Physicist of Italy has been awarded the Nobel Prize for Physics this year for his "*Discovery of new elementary radioactive substances engendered by Irradiation of Neutrons and other researches on the reaction created by neutrons.*" Born in 1901, Fermi got his preliminary education in Italy and later on in Germany under Prof. Max Born in the University of Göttingen. He is at present serving as Professor of Physics in the University of Rome.

Fermi's first work of importance was an extension of Saha's theory of Thermal Ionisation which he worked out in 1924 in collaboration with Prof. Urey of America. The work which brought Fermi to the forefront of Physicists is the discovery of Fermi Statistics, (the law of velocity-distribution of electrons in thermal equilibrium) a work which was inspired by that of Prof. S. N. Bose of the Dacca University. To quote the words of an eminent physicist, "the two statistics pertake of the nature of the two world-regions from which the two physicists hail. In Bose's system there is no limit to the number of particles herding together just as we find with Easterners. In Fermi's there is a very strict Law, and herding is strictly regulated as in all western countries." Bose's Law is found to be true for light-corpuscles, and the particles with an even mass number; Fermi's is found to be correct for electrons, protons, and particles of odd mass number. The ideas thus introduced were responsible for throwing light on many important problems in Physics. On the basis of this theory Prof. Sommerfeld of Munich was able to explain the puzzle of electrical conductivity of metals and a number of workers following the illuminating work of Prof. Fowler of Cambridge were able to throw much light on the constitution of those wonderful stars called "White Dwarfs" in which "matter of the size of a rupee weighs more than a ton and requires a heavy crane to lift it up" (Eddington). In 1928 Fermi was successful in calculating the Potential field inside a complex atom by assuming that the electrons inside it obey his newly discovered statistics and this work threw much light on the distribution of elements in the periodic table. This method of calculation of statistical field by Fermi was responsible for many important developments in atomic as well as in nuclear Physics during later years. Another important work of Fermi consisted in deducing a theoretical formula for the evaluation of the magnetic moment of nuclei from a knowledge of hyperfine structure-separation of the energy levels of atoms. In 1929 he successfully developed a general quantum theory of electromagnetic field in which charges were present. He also brought to the fore-front the inherent defect in such a formulation. He showed that the general field could be separated into two parts—transverse and longitudinal; the former one behaved just like the ordinary rediation field of Maxwell-Dirac, showing the characteristic properties of a particle under Lorentz-transformation and was responsible for emission, absorption, etc., whereas the latter one, the longitudinal part of the field gave rise to the electrostatic interaction (Coulomb field) between charged particles and therefore contained terms which became infinite. They represent the self-energy, *i.e.*, the energy of the static field of a point charge. No satisfactory solution has yet been found to this fundamental difficulty of infinite self-energy as pointed out by Fermi in 1929-31. A similar theory of Quantum electrodynamics in a more general form was also independently developed by Heisenberg and Pauli.

Shortly after this Fermi turned his attention

to the problem of Radio-activity on which was focussed the attention of the scientists all over the world. When Heisenberg was seriously busy in building up the nucleus with Protons and Neutrons, instead of Protons and Electrons as assumed earlier, Fermi came forward in 1934 with a theory of β-ray (electron) disintegration from the radio-active substances, which has far-reachng consequence in our understanding, not only of the nuclear phenomena, but also of the nature of the physical world. The outstanding difficulty with the β-ray disintegration was to realise how the electrons emitted by a nucleus which has got perfectly well defined quantum levels, could have a continuous distribution of energy amongst themselves. This discrepancy led Bohr to advocate the sacrifice of the energy-conservation Law for nuclear process, whereas Pauli was not prepared to give up this time-honoured law of Physics and asserted that during β-ray disintegration a new kind of particle was simultaneously emitted along with the electron and carried away the balance energy. This new particle is called *neutrino*, a particle having no charge and practically no mass. In 1934 Fermi constructed a very ingeneous theory of β-ray disintegration based on the hypothesis of Pauli, in which the law of conservation of energy holds good, and explained, at least qualitatively. the form of the energy distribution curve of the emitted electrons. He thereby assumed the virtual existence of a "field," which caused the transition of the nucleus from its neutron to proton state with the emission of electron anl neutrino. In describing the interaction of this field with the nuclear particles Fermi introduced a constant term having the dimension of length. The process is analogous to that of the omission of a quantum from a Bohr-atom in its transition from a higher to a lower state under the influence of the electromagnetic field. With the help of the Fermi-field Heisenberg was able to explain the phenomenon of "shower" produced by cosmic rays. Fermi's theory also explained, as shown by Wick, the anomalous magnetic moments of the proton and the neutron, which are about three times and -2 times the nuclear Bohr magneton respectively instead of and zero nuclear magneton as expected from Dirac's theory of elementary particles. His theory has thus opened a new path for studying the baffling problem of constitution of the nucleus and the laws prevailing amongst its inhabitants. But Fermi's theory goes further. The new constant introduced by Fermi is of a great fundamental nature. As already emphasised by Heisenberg, this fundamental constant of Fermi is expected to revolutionise our knowledge of the physical world just like the constant c, the velocity of light revolutionised the conception of space and time (Einstein's theory of special Relativity) and the constant h, the Planck constant, brought a revolutionary change in the conception .of Wave and particle (Uncertainty prniciple-Wave mechanics).

All these works are on theoretical physics. Now what is very amazing in Fermi is that all on a sudden one finds him working in the laboratory, busy in bombarding the Nucleus of atoms with Chadwick's Neutron which has no charge but a mass nearly equal to that of the Proton. This experiment of Fermi yielded results of fundamental importance and has become now very celebrated. The idea of bombarding nucleus with heavy electrically charged Alpha particles and causing artificial nuclear transformation was first successfully carried out in practice by Lord Rutherford in 1919. By bombarding Nitrogen nucleus with the fast Alpha particles of RaC he observed that the protons were ejected, the original nucleus being converted to a heavy isotope of Oxygen. His work was soon followed by his students in Cambridge and by Bothe, Curie and Joliot and others on the continent, who made a systematic study of the artificial radioactivity caused by bombarding the nucleus of different elements with the *Alpha particle* obtained from different sources. In course of these investigations Curie and Joliot observed in a number of cases the emission of positive electrons after the source of the bombarding Alpha particle was removed. This sort of radioactivity as induced by the nuclear reaction behaves very similar to the ordinary radioactivity of the radioactive elements and is called *Induced Radio-activity*. Now Fermi perceived that the *Neutron*, since it has no charge, would penetrate straight within the nucleus without being stopped by its surrounding electrical forces and would therefore be the most powerful projectile for attacking the nucleus or the heart of the atom. Though the first neutron disintegration was obtained

NOBEL LAUREATE IN PHYSICS FOR 1938

by Feather by bombarding Nitrogen with neutrons, when alpha particle was emitted, it was, in fact, Fermi's systematic investigations with neutron bombardment, which have opened a new avenue in the field of nuclear physics. Fermi's experiments with Neutrons may be divided into two groups—namely, those performed with fast neutrons (about 10 MeV), which are emitted, for example, from a radon+beryllium source, and those with neutrons slowed down to thermal energies (*i.e.* to energies of gas molecules at room temperature, which are about a few volts only) by passage through a hydrogen-containing material.

Fermi's discovery of induced radioactivity in 1934 by neutron bombardment gave a vigorous impetus to physicists for the development of Nuclear Physics. By bombarding many elements with fast neutrons, Fermi observed emission of electrons when the source of neutrons was removed, activity being thus induced in the bombarded elements. The new radioactive isotopes thus produced have the atomic number either less by one or two units or identical with that of the original nucleus. Fermi also found that in many cases the neutron was directly captured by the nucleus without emission of any nuclear partcles, the excess energy being emitted in the form of γ-radiation. This sort of radiative capture of the incident neutron is generally expected for the case of heavy elements, where the potential barrier is sufficiently high to prevent the charged particles to leave the nucleus. The most outstanding discovery by Fermi and his co-workers in this connection is that of a new radio active element obtained by irradiating uranium with Neutrons. They observed several periods of induced activity and proved by means of chemical test that the active bodies must be transuranic elements, their atomic number being greater than 92. The researches of Meitner and Hahn have confirmed the existence of some of these elements; one of them is probably Eka-Re (Z=93) and the other product an Eka-Os (Z=94), and still another Eka-Pt (Z=96).

The climax came, as remarked by Bethe, when the Rome group *i.e.*, Fermi and his coworkers discovered the so-called 'water effect' *i.e.*, when they observed that the activity of the simple capture process of the neutrons by many elements was enormously increased when the source and the irradiated element were surrounded by a hydrogen-containing material, like paraffin or water. This was explained by Fermi as due to the slowing down of the neutrons by collisions with hydrogen atoms. The bombardment of Nuclei by slow neutrons showed another very remarkable effect, namely selective absorption of these neutrons. The neutrons which produced strong activity in one element were found to cause no appreciable activity in others. These capture reactions induced by slow neutrons are very fundamental in investigating nuclear structure. Infact the discoveries of these reactions with slow neutrons by Fermi, together with those of the resonance levels of the nucleus have led Prof. Bohr to formulate his recent theory of nuclear reactions.

Fermi is only 37 years of age and has built up a fine school of Physicists about him. He was elected many years ago a member of the Society of Lincei, the oldest and the celebrated scientific Society in Italy." The Society is so-called because its members are supposed to possess an extra vision which enables them to see through walls of ignorance, like the mythical Lynx which can see through material obstacles. Fermi is a noted Alpine climber. He has got friends in scientific circles all over the world."

The Message of Muscles and Nerves

Basu Kumar Bagchi

PHYSIOLOGY investigates the function of living structures including nerves and muscles; it has done that for centuries. But not until about the end of the 18th century did it know that nerves and muscles can "talk", *i.e.*, can give electrical "messages" which accompany their chief functions but which are not their chief functions in the body economy.

When Mr. Galvani of Italy and his good, helpful wife accidentally discovered in 1786 that the leg of a dead frog hung with a copper hook from an iron ballustrade gave a spasm the moment it touched the latter, they came across a unique phenomenon. The significance of it in all its bearings is not realized even to-day. The phenomenon was the electrical manifestation of living tissues brought out in this case by contact with dissimilar metals. Thus, amidst crude surroundings, electrophysiology, a cousin of physiology, was born. To-day most sensitive radio valves with delicate electrical appliances costing hundreds, even thousands, of rupees and amplifying the tiny currents in the living tissues as much as 2 million times to make them recordable, constitute the equipment of some of the modern electrophysiological laboratories. Galvani would gape in astonishment if he could be resurrected and see all this. In the last fifteen years or so Europe and America have made remarkable progress in electrophysiology. But in India, barring the great work of the late Sir J. C. Bose and his co-workers, advanced electrophysiological research has been conspicuous by its absence.

In addition to its own planning of ingenious experimental techniques, electrophysiology has had to depend to a great extent for its advance upon the development of increasingly sensitive and accurate electrical recording machines. Schweigger (1811) devised the first galvanometer to indicate electrical changes. Oerstead's galvanometer (1821) was much better than Schweigger's. Nobili's astatic needle galvanometer (1827) was first used for measuring the electrical properties of frogs' muscles which were thought to be due to what was then called "animal electricity"—a very unfortunate and confusing term. There was a regular scientific war over this affair of animal electricity between Galvani and Volta and their followers. Galvani thought electricity, or rather animal electricity, was in animals but not in metals. Volta thought it was in dissimilar metals causing animals in contact with them to react electrically, but not in animals. As Waller pointed out later "Both assertions are correct and both denials are incorrect," we now know animal currents exist and so do metal currents.

The famous du Bois-Reymond discovered in 1848 many important electrical properties of animal tissues such as the negative electrical current, called injury or rest current, which occurs when the upper surface of a nerve is connected by a wire to any of its cut-ends. We shall skip the brilliant researches of J. Muller, Helmholtz, and others only mentioning that Helmholtz first discovered the rate of speed of nerve impulses, which is 88 to 99 ft. per second for a frog's motor nerve. This speed is infinitely slower than that of electricity. Quite a surprise at that time! Lippman's capillary electrometer (1872) enhanced the accuracy of electrical recording. Einthoven's string galvanometer (1901) although more sensitive than Lippman's instrument has had quite a bit of inertia. Then followed different types of oscillographs more advantageous than the string galvanometer and considered fairly good for ordinary purposes even to-day. However the inertia-less cathode ray oscillograph of the modern type (first made by Braun in 1890), the most accurate of all reproducing without distortion electrical oscillations as high as 200 million per second, has proved to be one of the greatest boons to scientific workers of to-day including those who want to know what nerves and muscles have to "say". But even that would [illegible]

been inadequate if it were not for the amplification devices used with it which modern electrical engineers have placed in the hands of electrophysiologists.

One of the greatest physiologists of all time is Sir C. S. Sherrington of England, a Nobel laureate. He has done more than any other single man in modern times to prove the integrative action of the nervous system. Sensory nerves convey into the spine and brain information of the world or inner part of the body impressed on the sense organs; motor nerves convey "orders" from the spine and the brain in response to the information received, to the muscles and glands; the nervous system selects, integrates, co-ordinates and elaborates the information and the responses in accordance with environmental demands and its own internal patterns. These are its functions. It is a vast and most intricate telephone and controlling system in one. Muscles are, in a sense, slaves to the nerves. Muscles move bones, make postural changes, knead and carry forward food, pump and push blood, inflate and deflate lungs, make us blush and pale, and do many other things, but all these functions are made possible mainly through the influence of the nervous system, their master, especially in higher animals. Where mind comes in is a point that is beyond the province of orthodox physiology.

An interesting problem of modern electrophysiology is to record and analyse the electrical messages that nerves and muscles give out when they discharge the above-mentioned functions. You cannot only listen to them on the loud speaker but see them right before you as they flash on the screen amplified by the wonderful machines of to-day. These electrical messages come from the nerve impulses. But what are the nerve impulses? Nerve impulses going over a nerve or a nerve fibre are not exactly like the odinary flow of electricity or electrons through a metallic wire, yet they are similar in many respects. Professor Adrian of Cambridge, a Nobel laureate, and others, have maintained that they are like discontinuous "bullets from a firing machine gun" and not like a continuous stream of water running out of a hose. They are more or less akin to a burning fuse of a fire-cracker. In technical language they are the progressive, step-by-step depolarization of the semi-permeable membrane of the nerve fibres—a sort of moving exchange of ions or charged electrical particles between the inner and outer surfaces of the nerve fibres. Further, an extremely gradual impact of a certain type of stimulus will not start a nerve impulse, and after an effective stimulus starts it a second stimulus of equal value, administered within one thousand of a second of the first or even within ten thousands of a second as in the case of some slow-conducting nerve fibres, will not evoke a nerve impulse—(the nerve or the nerve fibre remains refractory) *i.e.*, cannot then be whipped into any activity.

From the results of experiments on animal nerves conclusions have been drawn in regard to men's which are not very far from the truth. Suppose some one touches your skin quickly and lightly (say with a 10 gm. pressure). The touch will cause a temporary deformation of your touch organ on the skin which acts like a trigger and starts a series of nerve impulses running over the nerve fibres connected with it. The nerve impulses will race quickly along over the fibres in steps of anywhere from 10 to 100 per second (technically called frequency) until they reach your brain and you have the sensation of touch. The strength of the steps (the nerve impulses) is always the same according to the all-or-none law in the sense that the nerve impulses appear either with maximum strength or do not appear at all: they cannot appear half way. But the number of steps per second may be more or less, that is the frequencies of nerve impulses may be fast or slow. Suppose some one presses your skin increasingly harder. Two things will happen. First, the more intense the touch stimulus, the greater is the number or touch organs and nerve fibres called into play. Second, the impulses will take many more steps per second (*i.e.*, will have a much higher frequency) in going to the brain, over each of the nerve fibres and the more intense will be your touch sensation. So modern scientists believe that the intensity of a sensation is proportional to the number of nerve impulses per second (Adrian). That is true provided there is nothing to distract your mind and provided you feel the different intensities of a sensation, which you of course do but which are so difficult to measure scientifically.

Now suppose again that a coin is placed on your palm and kept there for a few seconds. At

first there will be a burst of impulses, say 100 to 200 per second, over the nerve fibres connected to the palm, then the impulses will become less and less until they are irregular and scarce. And the excitatory process of your touch organ becomes less and less too. This is the phenomenon of adaptation. Psychologically also you begin to get accustomed to the "feel" of the coin. Thus, although far from solving the body-mind problem, electrophysiology, by discovering the minute electrical behaviour of active nerve fibres, is at least making that big old "gap between stimulus and sensation a little narrower."

Erlanger, Gasser and others of America have further analysed the nerve impulses by their electric message picked up from the surface of a nerve. From the electrical message they can roughly estimate the speed-capacity and function of some of the nerve fibres of which a nerve is composed and which in reality send these messages. The electrical message can be instrumentally converted into visible forms of five distinct types with their characteristic timing and strength, each type having been given a name. An alpha message looks like a very tall spike flashing on and then off within about half of one thousand of a second; beta hangs on the side of the alpha like a hump; gamma, following it, is a small saw-toothed projection. These three together are called *A*. Then follow *B* and *C* messages which look like two very low elevations in outline. These messages are slower than the alpha, flashing on and then off over an active nerve in a few thousandths of a second. Some of the fattest of the nerve fibres, such as of a frog's sciatic nerve (in its leg) containing 854 medullated nerve fibres, each with a diameter of from 13 micron to 18 micron (a micron being one thousandth of a millimeter) have when stimulated a strength in their *A* message to the extent of from 2.5 millivolts for alpha down to .1 millivolt for gamma (one millivolt being one thousandth of a volt). These fattest nerve fibres are the fastest of all, able to carry nerve impulses in the shape of alpha, beta and gamma over them at a speed of from 140 feet to over 300 feet per second. That includes the speed of mammalian nerves. The messages *B* and *C*, however, are very weak; they are whispers, as it were, of very thin nerve fibres, 5.5 to 2.4 micron in diameter. Some of these thin fibres carry nerve impulses over them slower than a fast running dog, 2 to 14 feet per second. The truth has been mathematically expressed thus: the conduction rate of nerve fibres varies not as their diameter but as the square of their diameter (Erlanger).

Now though it has not yet been possible to relate all the nerve fibres of various thicknesses to their functions in terms of their electrical message some facts like the following have emerged. Most of the motor nerve fibres which carry "orders" down from the brain and the spine give only the alpha message, some slow ones only *B* or *C* message. Some of the sensory nerve fibres which carry the cutaneous information (information from the skin) up to the spine and the brain do not give the alpha message; they give only beta, gamma and *B* messages. Some of the small-diametered fibres flash only *B* and *C* messages. They mediate involuntary activities, they also slowly carry the information of pain. In fact the information of pain is not carried by any other type of fibre. Physical pain is not simply dependent upon sense organs, or the head and any and every type of nerve fibre connecting the two as was formerly thought. A fairly specialized line has to transmit pain information before it can be felt as pain in our consciousness.

Let us come to some work done on intact human beings. Take human muscles. When you move any muscle or muscle group such as the biceps, nerve impulses travel down from the brain over motor nerve fibres of the brain and the spine to it. Each of the motor fibres is connected with 120 to 160 muscle fibres and is called a motor unit. When you move a muscle many such motor units "fire" electrically, putting their message on the record in the form of many up and down (diphasic) lines. If you think of moving the same muscle group without overtly moving it the electrical message will come soon, perhaps from one motor unit, then from more, and so on until the record is a mass of electrical lines. If somebody else moves the same muscle group for you (which is passive movement), the electric "dance" will be less than when you moved it yourself, and if you are very much relaxed while it is moved for you, the electric dance will be still

less or even absent because your "righting reflexes" in connection with that muscle group will then be less or absent. In a disease involving muscular weakness (myasthenia gravis) the diseased muscles give peculiar irregular electric messages of unequal strength. If we had room we could mention results of many more researches.

In the last few years another very promising phase of electrophysiology, which is tied up with psychology, has opened up. Dr Berger of Germany first published his results concerning this in 1929, which were later confirmed by Prof. Adrian. It is possible now for the first time in the history of science to pick up electrical pulsation from any intact human brain. These pulsations or beats (about 10 per second) are going on spontaneously in every brain and are modified more or less almost immediately by vision, hearing, touch, smell, concentrated attention, thought, images, emotional upset, sleep, slight muscular movement, hypnosis, etc. Some time ago I reported results which I obtained in connection with sleep. Brain potentials assume different patterns at different stages of sleep. In Iowa, Harvard and 10 or 12 other laboratories of the world fascinating investigations are going on along the brain potential line. Epileptics can be spotted out by their peculiar brain wave patterns long before they are medically diagnosed as such. To-day researches are being made in the Boston City Hospital to locate brain tumors by this method. Problems of mental disease, mental deficiency, all sorts of psychological and biological problems are lending themselves to this type of investigation. Medically, biologically and psychologically brain and muscle potential work has a bright future. An advanced form of electrical recording for such purposes would be a great asset to scientific investigation in this country.

Our Automatic Breathing Control

For weeks even for months, the unborn child in the mother's womb makes distinct rhythmic respiratory movements, but these movements are not breathing, in that they do not expand the lungs and keep them expanded. If a lamb is delivered by Caesarean operation without disturbance of the placental circulation and is kept in a warm bath resembling its normal prenatal environment, the respiratory movements continue, but they still are not breathing.

The baby unborn and the fetal lamb maintained in conditions closely paralleling those before birth are both freed of the necessity of breathing. Once birth has occurred, however, if the creature is to survive, breathing must and does commence. What makes this difference?

Professor Yandell Henderson of the laboratory of applied physiology at Yale answered, in a paper read before the Connecticut Academy of Arts and Sciences, that a function deficient in the fetus is quickly developed at birth and then continuously maintained through life. Of critical importance for respiration, circulation and metabolism, this function is that of muscle tonus—a condition of mild steady activity.

The inflation which normally exists in living lungs is a function of the tonus maintained in the respiratory muscles. From birth to death the lungs are never deflated, because the diaphragm is never completely relaxed.

At birth, tonus is induced in the muscles by the coming into action of the motor centres of the spinal cord. The relation of these centres to the presence of tonus is demonstrated by the fact that if spinal anesthesia reaches the motor neurones, a depression of tonus results, which produces in the body a diminution of respiratory metabolism, stagnation of the blood in the tissues, failure of the venous return to the heart, and relaxation of the respiratory muscles producing partial deflation of the lungs. The extreme form of this state, which may follow serious physical injuries and major surgical operations, is termed shock.

—*Technology Review.*

NOTES AND NEWS

Legacy of our Civilization to the Futurian of 6939 A. D.

Today with all our advance of knowledge how eager we are to read into the past—to learn the life that existed on this planet of ours, say 5000 years ago, at Mohenjo-daro or at Babylonia or any other civilized place of those days. What has been spared from the all-swallowing bowels of time is often too inadequate to furnish any complete knowledge of the past. If the ancient man had only had the foresight—and the wherewithal—to preserve an accurate record of his life and times, what a vast expansion of our cultural knowledge would be available to us to-day! That being not so, we have got to depend on archaeology for whatever it can do for us in that direction. But what was not done by the ancients for us, we can do, with our technical abilities, for the future civilizations.

It was with this end in view that Dr Thornwell Jacobs, President of the Oglethorpe University, proposed in the *Scientific American*, November, 1936, "to provide for future historians an epitome of the life of an old generation—a generation in which *we* lived," so that, "for the first time in the history of a civilized land, future historians will have available a thorough and accurate record preserved for them." The original proposal by Dr Jacobs has undergone several modifications, mainly in the matter of the date of this legacy to the future and the place of deposit of the record. It was finally decided that the world's first "Time Capsule" would be deposited at the bottom of a 50-foot "immortal well" beneath the rising walls of the Westing-house Building at the New York World's Fair, 1939. "It has already begun its long journey into the future—a journey which, it is hoped, will extend through 5000 years of time,"—writes Mr D. S. Youngholm in the *Scientific American* of November, 1938.

The Time Capsule, as finally constructed, consists of an outer shell of Cupaloy, cast in sections, each to be threaded and screwed into the next and sealed with asphalt. The whole thing has been carefully planned and designed. The Capsule which is seven feet long and six and a half inches in diameter, includes more than 40 articles of common use in the present civilization, such as a fountain pen, a mechanical pencil, a watch, an electrical lamp, etc. All the rare objects of pride of our days will also be contained in it. Word will be left for future archaeologists in the form of a Book Record of very lasting materials, copies of which will be circulated all over the world with the expectation that some, which will survive, will give the required clue to the futurian for which it is meant. In case the futurian fails to follow the clue in determining the date of preservation, certain astronomical data, such as the number and dates of the solar and lunar eclipses of 1939, are given therein, as also the position of the planets and the angle of the Earth's Pole relative to the Star Polaris, which will be sufficient for them to calculate the time that will have then elapsed since 1939. Other matters of difficulty have been, as far as possible, obviated, and we all hope with the sponsors of the scheme that it will reach the proper hands 5000 years hence, and give the futurian an accurate estimate of the present-day civilization, feeling as we do that the good instincts of the human race will prevail in leaving it alone and undisturbed.

Rejuvenation by Sex Hormones

Experiments performed by Dr Neal E. Miller of the Yale University, on old men and on patients suffering from various types of glandular deficiency, revealed

Following this magnanimous proposal by Dr Anklesaria, the Government of Bengal is seriously considering the advisability of starting a college of pharmacy, and they have set up a committee of experts to investigate into the matter. The Committee consists of (1) Brevet Colonel R. N. Chopra, (2) Prof. B. N. Ghosh, (3) Mr J. L. Bell, (4) Dr B. Mukerji, (5) Dr Jitendra Chandra Aich, (6) Sir Upendra Nath Brahmachari and (7) One member to be nominated by Calcutta University.

The Committee will be required to report on the syllabus and course of study and the staff that would be necessary; on the total expenditure involved in the proposal; and the necessity and feasibility of legislation with a view to ensuring that only qualified pharmaceutical chemist should conduct chemists' and druggist' business. We hope that there will be little in the findings of the Committee which may prevent the establishment of a college of pharmacy, which, when opened, will remove a long-felt want of this province, and will also throw open new avenues of employment for the educated youths of this country, especially of Bengal.

The Indian Journal of Pharmacy

The United Provinces Pharmaceutical Association was started in 1935 with the objects, among others, of promoting "the cause of the science and art of pharmacy in all their different branches," and to give adequate training for the profession of pharmacy in U. P. Another object of the Association is to edit and publish such journals and books which will promote the cause of pharmacy in India. It is now announced, we are glad to learn, that arrangements are now complete for bringing out a quarterly journal from Benares, the present headquarters of the Association, under the title, The Indian Journal of Pharmacy, from January next. An editorial board has been formed and it will consist of (1) Prof. M. L. Schroff, as Chief Editor, and Messrs (2) B. B. Bhatia, (3) S. S. Joshi, (4) K. C. Pandya, (5) S. K. Sen, (6) S. K. Chaudhuri, (7) P. S. Varma, (8) G. P. Srivastava, and (9) B. P. Dube. The annual subscription has been fixed at Rs. 3/ (inland) and 6s (foreign). The members of the Association will, however, get it free of charge. We shall be eagerly looking for the first issue of the Journal.

The Seventh All-India Industrial Exhibition

For the last few years Delhi has been holding every year an important Industrial Exhibition under the auspices of the Association for the Development of Swadeshi Industries, and preparations for the seventh one, we learn, are now complete and will be held in the last week of February 1939, at the Peoples' Park, as usual, near Red Fort. Only *Swadeshi* products will be exhibited and sold in the exhibition excepting the foreign industrial machinery. The Exhibition plan, prospectus and any further information in connexion to the Exhibition, can be had from the Hony. Secretary of the Association, Chandni Chowk, Delhi.

Second Session of Indian History Congress

The Second Session of the Indian History Congress held last October at Allahabad has been described as a huge success. Several important resolutions were passed by the Congress at this session, and reference has already been made in our editorial article of this month at some great length to the one by Dr S. Krishnaswamy Iyengar which urged "that a Committee be appointed to examine the feasibility of preparing a scientific and comprehensive history for India with instructions to report at the next session of the Congress." Our leading article in this issue discusses the Resolution, and our comments have been made therein. There was some controversy over the word "feasibility" in the Resolution, which was finally adopted in its entirety, and a committee of the undermentioned persons, with powers to co-opt, was constituted for the purpose.

Dr D. R. Bhandarkar, Sir Jadunath Sarkar, Diwan Bahadur Dr S. Krishnaswamy Iyengar, Rao Bahadur K. N. Dikshit, Prof. Md. Habib, Rao Sahib C. S. Srinivasachari, Prof. K. A. Nilkantha Sastri, Prof. D. V. Potdar, Dr M. H. Krishna, Dr Surendra Nath Sen, Dr Balkrishna, Sri Jayachandra Vidyalankar, Prof. Sri Ram Sharma, Sir Shafaat Ahmad Khan, Mr R. V. Poduval and Mr B. V. Krishna Rao.

Another resolution adopted by the Congress runs as follows:

The Indian History Congress is strongly of the opinion that well-equipped record offices should be established by all the provincial Governments and Indian States at an early date to facilitate historical research. The Congress considers it essential that

adequate facilities should be afforded to all *bona fide* scholars of history in such offices."

The resolution was moved by Dr Balkrishna and seconded by Dr Sir Shafaat Ahmad Khan.

Preservation of Historical Treasures

In connexion with the Peace-Pact inaugurated by Dr Nicholas Roerich, the well-known painting artist, which aimed at the preservation of historical arts and treasures bearing evidence of the different stages of culture the world has passed through, from the dark stages of history, the History Congress next adopted a very important resolution moved by Dr Tarachand of the Allahabad University. Cases of vandalism have by no means been uncommon in the past, and the recent happenings in Spain definitely point to the urgent need of such a pact. It has already been adopted by twenty-one countries and a large number of learned societies and cultural associations have voluntarily bound themselves in honour to protect the historial treasures, the saving of which from the hands of war-hooligans is essential for the development and progress of culture. The resolution passed by the Congress reads as follows:

Resolved that the second Indian History Congress, held at Allahabad, approves of the International Pact for the protection of artistic and scientific institutions, historic monuments, missions, and collections, originated by Nicholas Roerich and records its support of the three Articles detailed below:

Article I—The historic monuments, museums, scientific, artistic, educational and cultural institutions shall be considered as neutral and as such respected and protected by belligerants. The same respect and protection shall be due to the personnel of the institutions mentioned above. The same respect and protection shall be accorded to the historic monuments, museums, scientific, artistic, educational and cultural institutions, in time of peace as well as in war.

Article II—The neutrality of, protection and respect due to, the monuments and institutions in the preceding Article, shall be recognized in the entire expanse of the territories subject to the sovereignty of each of the signatory and acceding states, without any discrimination as to the state allegiance of the said monuments and institutions. The respective Governments agree to adopt the measures of internal legislation necessary to ensure the said protection and respect.

Article III—In order to identify the monuments and institutions mentioned in Article I, use may be made of a distinctive flag (red circle with a triple red sphere in the circle, on a white background.)

The next session of the Congress will be held at Calcutta.

"The Radium Hound"

Radium, as is well-known, is a precious stuff. It is used in the treatment of cancer and some other diseases, and the amount used in such cases is so small that it stands the risk of being lost, as the patients can hardly realize the immense cost of the product. But the amount, when lost, may be in some cases recovered with the help of what is named the "radium hound" which is nothing but the electroscope or the Geiger-Muller counter, both of which are affected by the gamma radiation emitted by radium. The radiation counters are so sensitive that whole house can be searched for radium from the outside in cases of suspected theft. Radium causes severe burns if it is kept near an unshielded person, and the "radium hound" gives reassurance that the lost radium is not located where it will cause harm. We have it on the authority of the *Scientific Monthly* of October 1938 that Dr Robert B. Taft of Charleston, S.C., has compiled stories and statistics of radium theft and its recovery. Out of 107 records of losses, there are 59 complete and 11 partial recoveries. The most interesting case is the one in which the lost radium was recovered from the stomach of a pig, who devoured it along with the refuse of the hospital from which it had been lost.

An Electrodeposition Exhibit

The general public is quite familiar with many of the applications of electroplating today. Silver plated and chromium plated articles, for example, are well known. It is not, however, generally realized to what an important extent other electrodeposition processes contribute to the amenities of modern life. In the production of gramophone records, and in the photogravure process used for printing postage stamps and pictures, electrodeposition is a vital process. It also constitutes an important stage in the production of Treasury notes, and is used at the Royal Mint to form the steel dies employed in striking coins and

measurements of great accuracy are always possible. In the measurement of the conductivity of poorly conducting solutions it is necessary to take account of the conductivity of the water used and since the influence of the temperature on the specific resistance of liquids is very great, an accurate measurement of the temperature within 0.2° C is necessary for precise determination of specific resistance.

Sericultural Conference

A very important conference of sericulture took place in the third week of November with Mr F. I. Rahimtollah, President of the Tariff Board in the chair. The Conference was fully representative of the whole of India and was attended by the Directors of Industries of the various provinces interested in the industry, besides other important officials. Sericulture forms an important industry of the country, and there is yet ample room for developing it. Besides indigenous production of some 20,00,000 lbs. of raw silk India consumes 25,000,000 lbs. more which is imported from foreign countries, such as China and Japan. It is held by authorities on the subject that the whole of the country's requirements can be supplied by the Indian industry, provided adequate protection is given to it by the Government.

It is suggested that the Imperial Sericultural Institute should devote greater attention to the question of research and have the power to review the sericultural work done in the various provinces and States during the year, decide a programme of development work for the future, coordinate the work of the various provinces and States, and lay down lines of research work to be done, the results of which are to be made available to the whole of India.

The provincial representatives stated that since provincial autonomy had been introduced, the Ministers had taken much interest in cottage industries and were taking steps to safe-guard the interests of handloom weavers. So far as silk weaving was concerned, however, it was not receiving the same attention as cotton and wool. Mr Green, Director of Industries, Madras, suggested that the Central Government should assist the silk weaving industry in the same way as they were now doing in regard to the cotton industry, namely by a subvention.

Cost of the Manufacture of Synthetic Ammonia

In his article entitled "The manufacture of synthetic ammonia and nitrogenous fertilizers" published in the September 1938 issue of SCIENCE AND CULTURE, (pages 178-182), Dr N. G. Chatterji gave an estimate of the cost of production of synthetic ammonia, based on the information available at that time, chiefly from that of an exhaustive estimate made in 1926 by Prof. Tour of America who was in charge of a large synthetic ammonia factory in that country. The author has recently received more information regarding the latest type of plant. The following revised estimate of the cost of production of synthetic ammonia, has now been worked out by Dr Chatterji with great care and can therefore be confidently put forward as being fairly reliable for drawing up scheme by National Planning Committee.

Capacity of the Plant.—The minimum capacity of the plant recommended by experts from different countries is about 20 tons of combined nitrogen or 24 tons of ammonia per 24 hours, or 7,200 tons per year of 300 working days. The estimates are therefore for a 24 ton per day ammonia plant.

PLANT COSTS

1. *Ammonia Section*			Rs. 22.5 lakhs
(a) Water gas plant, purifier, Hydrogen conversion plant, CO_2 and CO washers &c.	6.8 lakhs.		
(b) Ammonia synthesis plant, Gas holders, &c.	11.2 lakhs.		
(c) Erection charges	1.6	„	
(d) Building charges	2.9	„	
Total	22.5	„	
2. *Power Section*		„	3.5 „
Total physical plant costs			Rs. 26.0 lakhs.
3. Overhead costs (during construction)		„	3.0 „
Total plant costs			Rs. 29.0 lakhs

Capital investment.

On plant	Rs.	29.00 lakhs.
Working capital	„	7.00 „
Total capital investment	Rs.	36.00 lakhs.

Fixed charges.

1. *On plant.*

Depreciation @ 7½ on Rs. 29.0 lakhs. Rs. 2.175 lakhs.

2. *On invested capital.*

Interest, taxes, insurance, &c. @ 7% on Rs. 35.0 lakhs. Rs. 2.450 lakhs.

Total fixed charges Rs. 4.625 lakhs.

Hence, per ton of ammonia Rs. 64.

AMMONIA PRODUCTION COSTS.

Raw materials costs.

(per 24 tons of ammonia)

Electric energy, 42,200 K.W.H. @ 3 pies per unit.	Rs.	660
Coke, 33 tons @ Rs. 8/- per ton. ..	„	264
Steam, 50 tons @ Rs. 1.20 ton. ..	„	60
Cooling water, 625,000 gallons Feed water, 14,000 gallons } ..	„	18
Gas purifying mass, catalyser, chemicals, &c.	„	152
Total	Rs.	1,154
Or per ton of ammonia ..	Rs.	48

Hence,

		Per ton of ammonia.
1. Raw Materials and Energy ..	Rs.	48
2. General plant expense	„	17
3. Running maintenance	„	32
4. Overheads, contingency &c. ..	„	21
Total operating costs ..	Rs.	118
Total fixed charges ..	„	64
Total production costs ..	Rs.	182

Hence, for a plant of capacity, 24 tons per day,

Total production cost of synthetic ammonia is estimated to be about Rs. 182. per ton.

New Post of Director of Dairy Research in India

Following the recommendation by Dr N. C. Wright in his report on the cattle and dairy industries of India to establish a Central Dairy Research Institute, the Central Government who have accepted it in principle have come to the conclusion that as paucity of funds will not allow the setting up of such an institution, the appointment of an expert coordinating authority need not on that account be delayed. Applications have therefore been invited for the post of the Director of Dairy Research. It is stated that the appointment will be made towards the end of this year.

This officer will be instructed to devise schemes for the improvement of dairying generally in India and his expert knowledge will be at the disposal of any provincial Government desiring his assistance. He will also study the position in regard to the Central Institute, and Government do not propose to come to any decision as to its location or equipment until his advice has been received.

The majority of recommendations made by Dr. N. C. Wright about his survey of India's cattle and dairy industries problems call for action by the provincial Governments, and the Central Government in a recent communication to the provinces stated the importance of the utmost cooperation and coordination in the work done. In this connexion it has been shown that much time and energy might be wasted by duplication of experiments. Great importance is attached to the encouragement of mixed farming. This is also a matter for the provincial Governments but it is understood that the Imperial Council of Agricultural Research are prepared to make small grants to the Governments for experimental purposes and that the Government of India have under consideration the adoption of mixed farming experiments at Delhi and Karnal. Schemes of research on pasture improvement are also being considered by the Imperial Council of Agricultural Research. The Central Government have under consideration the possibility of holding a combined Cattle and Dairy Conference towards the end of next year when the progress made on Dr Wright's report will be reviewed and fresh schemes for the promotion of the industry will be examined.

Survey of Industrial Possibilities

We have several times in these columns urged upon the desirability of setting up a committee consisting of

specialists and experts for planning on a comprehensive scale a scheme of country-wide industrialisation for India. We are firmly convinced that without an efficient plan of national industrialisation India could neither raise her standard of living which is now so low nor could she attempt to solve properly the acute problem of unemployment. It is, therefore, just and proper that the Indian National Congress has recently appointed a National Planning Committee, which would devise ways and means to tackle the country's problem of national reconstruction, and the personnel of the committee is both strong and inspiring. It consists of Pandit Jawaharlal Nehru as President and Sir M. Visvesvaraya, Professor M. N. Saha, Sir Purushuttomdas Thakurdas, Mr Ambalal Sarabhai, Professor K. T. Shah, Dr Nazir Ahmed, Mr A. D. Schroff, Mr A. K. Shaha, Professor V. S. Dube and Prof. J. C. Ghosh with a non-member secretary to be furnished by the Government of Bombay.

The findings of the Committee will be presented before a National Planning Commission consisting of Ministers of Industries of the Congress provinces and also of other provinces and the States co-operating for the execution of the plan together with four representatives of commercial bodies and one representing the All-India Village Industries Association. The members of the Committee will be ex-officio members of the Commission.

Bengal, which is not a Congress province, has not lagged behind and, we are glad to announce, has set up a committeee of its own for similar purposes. It has a strong personnel consisting of Dr John Matthai, Director-General of Commercial Intelligence and Statistics as chairman and Dr J. P. Neyogi, Minto Professor of Economics, Calcutta University, Dr J. C. Ghosh, Professor of Chemistry, Dacca University, Dr S. K. Mitra, Ghose Professor Physics, Calcutta University, Dr N. N. Law, Mr M. A. Ishpahani, Mr Rajsekhar Bose, Mr B. M. Birla, Mr S. C. Mitter, Director of Industries (ex-officio) with Mr J. N. Sen Gupta, Secretary of the Bengal National Chamber of Commerce as secretary of the Committee.

Terms of reference of the Bengal Committee have recently been announced and they are, as will be found from the text given below that they cover practically the whole field.

(*i*) To examine the position of the existing large and medium sized industries in the province showing (*a*) which industries have reached a stage of full development and (*b*) which of them still hold out possibilities of further expansion and (*c*) in which directions there are still possibilities for the establishment and development of such new industries with a fair prospect of success.

(*ii*) To enquire into the difficulties and problems that confront the existing important large and medium-sized industries of the province and suggest measures for the improvement of their conditions.

(*iii*) To examine the location of existing industries and of industrial resources of the various divisions of the province and suggest means for securing the utmost diversification and the best geographical distribution of industrial activities throughout the province.

(*iv*) To advise what industries subsidiary to large scale industries have a fair prospect of success in this province and how far and by what methods such industries can be developed within the province.

(*v*) To advise on the measures which the Government can undertake to promote and develop large scale and medium sized industries within the province and, in particular to draw up a plan for the establishment and development of industries of national or economic importance including "Key" industries.

(*vi*) To examine the present position and working of small and cottage industries including those which are in the nature of a hereditary calling of any class or caste with special reference to:

(*a*) sources and terms of supply of raw materials;

(*b*) credit and financial facilities;

(*c*) marketing;

(*d*) improvement of productive technique.

(*A*) Recommendation should be made as how (*a*) may be improved and facilities as to (*b*), (*c*) and (*d*) may be provided.

(*B*) Recommendations should also be made about such of the cottage industries as are in a moribund condition with a view to effect their rehabilitation.

(*C*) To advise as to the possibility of starting new cottage and small industries in the villages.

(*vii*) To enquire and assess the results achieved by the various measures instituted by the Industries Department for the last 17 years and advise how far these measures have been actually effective in developing industries and how far they hold out material prospects for such development, and which of the measures should be discarded as of little or no practical value and what new steps should be taken to further the object in view.

(*viii*) And finally to make such other recommendations as pertain to State policy with regard to industrial development within the province.

We do hope that there will be ample grounds for co-operation between the National Planning Committee and the Bengal Committee, whose report on provincial resources should be a valuable asset in the deliberations of the National Planning Commission at a later date.

Scientific Research and State Aid for the Development of Industries in India

S. S. Bhatnagar
Director, University Chemical Laboratories, Lahore

We can see to-day the dim lights of a new dawn in the distant horizon of Indian progress. These faint radiations are not the vanishing streaks of our glorious past; they are the sure signs of a new birth full of promise and glory for the future. This dawn represents the birth of the Industrial Movement in India. The movement has been rather delayed, though its genesis could be traced to the years even before the War. The events of the War, however, gave a great impetus to the development of indigenous industries. Even the Government, whose lukewarm interest in industry had become proverbial, realized the importance of industrial expansion of India and we note that the Indian Industrial Commission appointed during the years 1916-1918 reported "that the experience of the War itself has been responsible for a new attitude on the part of both Government and leading industrialists. They realize that it is necessary to create in India the manufactures that are indispensable for industrial self-sufficiency and for national defence and that it is no longer possible to rely on free importation of essential articles in time of War."

The successes of the textile industry and the sugar industry furnish illustrations of the fact that, given adequate facilities, Indians are capable of handling big businesses intelligently and efficiently. Not only are these two industries in a flourishing state, but the electrical companies and the woollen industry, besides many others, have also done good business. These examples further bring home the fact that all Governments can really stimulate industries by the granting of subsidies, and loans from official banking institutions or by the imposition of protective tariffs. The Indian industrialists should not be slow to realize that the secret of success in this or any other industry lies in the economic utilization of all the bye-products of an industry and that this can be achieved only by contact with the uptodate methods and application of science. The businessman, proud of the initial success in a new undertaking, is apt to become a slave of tradition and the rule of thumb, and often begins to look with scorn upon scientific discoveries which he contemptuously calls 'theories.' An example of this may be found in the pre-War history of the British Industry. There was practically no intercourse and no co-operation between the men of science of that country and the leaders of industry. There were, here and there, a few enlightened industrialists who were interested in applying the methods of scientific research, but it became a reproach to British industry as a whole that it ran only in well-established grooves and refused to adapt its products to the requirements of the time, with the result that the continental products, particularly the German articles, gradually ousted the British goods from the market. This achievement of

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National Planning in Sweden

SIR James Grigg who has just laid down the high office of the Finance Minister to the Government of India had no faith in planned economy, a view which found ready support in bureaucratic circles in this country. As custodian of India's financial interests, he rarely departed from the traditional British principles of free competition in the production and distribution of goods; and the only advice which he could give to the Indian people during the extraordinary phases of the depression of 1931 was to tighten their belts and bring out their distress gold. Even the normal capital expenditure on railways and other civil works was considerably cut down; and at the end of his period of office he had the satisfaction that the credit of the Government of India had never stood higher before.

After a consideration of this orthodox but barren policy, which has resulted in a grave deterioration of the already low standard of living in India, it is a relief to turn to the pictures where Governments are making great experiments to alleviate the distress of their nationals. The question of depression or boom does not arise in countries like Soviet Russia, where all the major factors of production have been nationalised and lands, mines, factories, railroads and banks and even foreign trade have been made State monopolies. But today even in capitalistic countries outside Russia, *e.g.*, the U. S. A., Italy, and Germany, and even Britain not excepted, a large degree of State control over the factors of production is being enforced so as to radically alter the substance of private property even though the form of it may have been left intact.

The New Fabian Research Bureau has recently carried out direct investigations on the spot of the political, economic and industrial systems of Sweden and has presented a report,* which will be of extreme interest to all who believe that economic planning might be reconciled with a large degree of freedom of initiation and enterprise and we make no apology in presenting to our readers some aspects of this fascinating survey.

* *Democratic Sweden*—Published by the New Fabian Research Bureau.

LETTERS TO THE EDITOR

The isomers in question were already isolated by Desai and collaborators at a time when Chatterjee published his paper containing the statement "no definite isomers of the acids have been isolated and experiments are in progress to separate them".

In conclusion, it may be pointed out that the investigations on the isomers of cyclohexane and its derivatives are being continued by Desai and collaborators, and that if Chatterjee were to continue work on these lines, it would be mere overlapping which is undesirable.

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Matunga,
Bombay, 16-4-39.

[1] *J. C. S.*, 84, 1939.
[2] *J. C. S.* 1047, 1932.
[3] *J. C. S.* 416, 1159, 1676, 1936.; *Nature*, *138*, 548, 1936.
[4] *Nature*, *139*, 718, 1937.

The Isomers of 1-carboxy-4-, -3-, and 2-methylcyclohexane -1- Succinic acids

Dr Desai's reply to my letter[1] demands a rejoinder and I, therefore, like to record the following lines in response to his.

(*a*) The paper published by Desai in 1932[2] deals with the Formation and Stability of Spiro-compounds on the basis of the 'Valency deflexion hypothesis' of Thorpe and Ingold, and not on the separation of the isomers of cyclohexane derivatives of open chain acids. My first paper in the line was published in 1935[3]. In 1936, however, Desai published papers[4] which did not overlap my line. The experiments recorded there were to verify Dr Khuda's claim on the isolation of the isomers of methyl cyclohexane 1-carboxylic -1- acetic acids, in 1931[5].

(*b*) It was after Desai's communication of a note in 1937[6] that the overlapping actually occurred. Unfortunately it was after the inclusion of my detailed paper[7] on the subject, in the proceedings of the Indian Chemical Society. Desai's communication, however, to the *Nature* did not contain any experimental data although he claimed to have separated the isomers.

(*c*) In his detailed paper[8] in the Journal of the Chemical Society in 1939, Desai has adopted the very same methods of preparation of the compounds described by the present author as early as 1936[9]. The reference to my work made by Desai in the said paper has been, I am afraid, a bit inadequate.

(*d*) It may be that Desai began his work earlier but the credit of prior publication goes to the present author. It is unfortunate that Desai would continue these works though he can not claim priority of publication.

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Calcutta, 8-5-39.

[1] SCIENCE AND CULTURE, *4*, 599, 1939.
[2] *J. C. S.*, 1047, 1932.
[3] SCIENCE AND CULTURE, *1*, 435, 1935; *J. Ind. Chem. Soc.* *13*, 536, 1936.
[4] *J. C. S.* 416, 1159, 1676, 1936; *Nature*, *138*, 5[illegible]
[5] *J. Ind. Chem. Soc.*, 8, 277, 1931.
[6] *Nature*, *139*, 718, 1937.
[7] SCIENCE AND CULTURE, *1*, 788, 1936 and *J. Ind. Chem.* 127, 1937.
[8] *J. C. S.*, 84, 1939.
[9] *loc. cit.*

[No further correspondence on this subject published in these columns.—*Ed. Sc. & Cul.*]