INDIAN SCIENCE CONGRESS, BENARES, 1941

Summaries of Addresses of Presidents of Sections

1

MATHEMATICS AND STATISTICS

President: DR. M. R. SIDDIQI

FUNCTIONAL ANALYSIS AND MATHEMATICAL PHYSICS

A VERY important problem of Mathematical Physics is the unification of various theories connected with the different branches of this science. The task demands the creation of very powerful tools of mathematical analysis. Such tools have been developed since the beginning of the present century, and consist of the various topics in Functional Analysis.

The considerations of Abel and Liouville in the early part of the 19th century gave rise to a vast number of inversion formulæ for definite integrals which were later called "Integral Equations". Volterra, Fredholm and Hilbert developed since 1900 an extensive theory not only of the solution of integral equations, but also of the eigenvalues and of the Fourier-expansion in series of eigenfunctions as well as that of application to mathematical and physical problems. Integral equations have now become indispensable in many theories in geometry, analysis, and the whole domain of mathematical physics. The modern theories of ordinary and partial differential equations cannot be conceived without the theory of integral equations. Direct applications of this theory, without the mediation of differential equations have been made to statistics, kinetic theory of gases and the theory of radiation.

It is now recognised that evolution is not only of the non-hereditary character dealt with in classical mechanics and physics. These classical theories were based on the principle that the present state of a system determines all its future states. This determinism is a consequence of the conception that each action manifests itself only at the instant when it takes place, and leaves no heritage. This is the same thing as the assumption that the system does not conserve the memory of those actions which have affected it in the past. But all the phenomena of nature are not really produced in this way. There are a number of evolutionary phenomena in which heredity and memory play an essential role, and to which the theory of differential equations cannot be applied. The analysis proper to such phenomena is that of integro-differential equations.

When the theory of linear integral equations was built up in close analogy with a system of linear algebraic equations, it was natural to enquire whether the considerations could not be extended to non-linear integral equations. Such extensions have been made for solutions "im-kleinen" as well as "im-grossen", and Levi-Civita's problem of the propagation of two-dimensional surface waves of finite amplitude, Carleman's problem of the theory of heat radiation, the inversion problem in the theory of functionals, the equilibrium figures of rotating fluids, the dynamics of incoherent gravitating media, etc., can only be treated with the help of non-linear integral and integro-differential equations.

For the further development of functional analysis the introduction of the principle of passing from finite to infinite into the theory of determinants was of considerable significance. This made it possible to build up a theory of infinite systems of algebraic equations in complete analogy with the theory of finite systems. Thus originated the idea of functions of an infinite number of variables. Hilbert developed a systematic theory of infinite linear, bilinear and quadratic forms, and deduced from this the whole theory of solution and the theory of eigenvalues of integral equations. Hilbert's theory of infinite bilinear and quadratic forms provided also a very powerful method for the treatment of boundary value problems for ordinary and partial differential equations. A theory of infinite matrices and of principal-axes transformations was also developed which supplied the mathematical foundations for modern quantum mechanics. The geometry of Hilbertian space has been applied to formulate the generalised absolute differential calculus which includes Ricci's tensor calculus as a particular case.

Apart from Mathematics, functions of infinitely many variables have an important bearing on natural philosophy. If we consider a phenomenon as the effect of a finite number of causes, we are making only an abstraction because we are neglecting elements which are supposed to be very small compared to others which are taken to be preponderant. In this way we make only an approximative study of the phenomenon, for a full and complete study of which it would be necessary to pass from a finite to an infinite number of variables.

From a consideration of the variation problems, Volterra was led to 'functions of lines' which are now called "functionals". Functional analysis has developed along various lines corresponding to those of the theory of ordinary functions. It has penetrated deeply into the various branches of pure and applied mathematics. Everything concerning integral and integro-differential equations, investigations on functional spaces, the calculus of variations with its diverse applications in mathematical physics, questions involving effects of hereditary type—all these different subjects have now been unified in one general theory of functionals. Moreover, the functional method gives us a ready criterion for examining whether the various expressions for natural laws are in an invariant form agreeing with modern relativistic conceptions.

Recently, a general analysis has been developed in which the concrete variables of the infinitesimal calculus have been discarded, and

relations are studied between two elements of any nature whatsoever. This new analysis proceeds by making an abstraction of all those concepts which are common to several known and allied theories. These are then generalised by removing from them any particular properties that are related to the concrete elements on which they are based. This has given rise to the general theory of "functional operators" which has now become an essential part of many of the most important domains of mathematics. In it we see the methods of classical mathematics blending harmoniously with those of modern mathematics, bringing about a certain unity in different branches sufficiently remote from each other. A really profound insight into many important branches of mathematics such as the theory of functions, integral and integro-differential equations, calculus of variations, theory of sets, topology and theory of dimensions is possible only with the help of functional operators.

Modern theories of physics make much use of the operator calculus. Thus, apart from classical mechanics and electro-dynamics, the subject of quantum mechanics in its modern developments is based entirely on the theory of linear operators. This theory plays the same part in quantum mechanics as tensor analysis plays in relativity mechanics. Quite recently the quaternionic operators have been applied to relativistic quantum mechanics.

Functional analysis has developed extensively during the last few years, and has penetrated deeply into mathematics, mechanics, mathematical physics, statistics, biology and sociology. It is one of the most powerful tools of research in contemporary mathematics.

6

BOTANY

President: Dr. S. Ranjan

THE RESPIRATION OF PLANTS IN LIGHT

IN the case of non-green leaves of croton containing carotinoid pigments and the flowers of *Bougainvillea* and *Nerium*, the respiration rate in light appreciably increases. The respiration rate of a green leaf in light also increases, but due to photosynthesis the respiration rate is to a greater or lesser degree marked. Therefore to find out the true rate of respiration of a green leaf in light is to study the dark respiration after a period of illumination. The respiration rate of this dark period at first increases up to a point and then decreases. If this falling curve is produced backwards to the point when light was cut off or to the zero hour of darkness, then the respiration curve of darkness will show an L-shaped fall. The high point touched at the zero hour of darkness is the respiration rate in light while in darkness the respiration rate steadily falls off. This steadily falling off respiration curve is similar to the "floating respiration" of Blackman which is nothing else but the "after effect" of light. The following scheme for light respiration is suggested.

$$\text{Carbohydrates} \xrightarrow{\text{Hydrolysis}} n(\text{Glucose})$$

Primary reaction (Photochemical or thermal)

$$2\ \text{Glucose} + h\nu \longrightarrow \text{Glucosé} + \text{glucose}$$

Secondary reaction (Thermal)

$$\text{Glucosé} + \text{En} \longrightarrow 2C_3H_6O_3 + q$$

$$2\ \text{Glucose} + q \longrightarrow \text{Glucose} + \text{glucose}$$

$$\text{Glucosé} + \text{En} \longrightarrow 2\ C_3H_6O_3 + q$$

and so on.

N.B.—En = Engyme.

q = hV + the difference of the energy between $C_6H_{12}O_6$ and $C_3H_6O_3$.

hV = is the photonic energy (h is Planck's constant, V the frequency of light).

The above scheme of reactions suggests at least two reactions involved in respiration.

(1) The primary reaction which is both thermal and photochemical and (2) Secondary reaction which is purely thermal. Further support is given to the above scheme of reactions by the work on the temperature effect upon respiration in light. It has been found that in the case of Eugenia leaves—which is a tropical plant—the maximum rise in the respiration rate in light is at 27° C. This increase decreases with higher or lower temperatures. Now, according to the above scheme let us suppose that in the chain of reactions $A \rightarrow B \rightarrow C$ the first reaction, *i.e.*, A to B is Photochemical and B to C chemical. The rate of B to C will depend upon the rate A to B.

In dark at 20° C. both A to B and B to C are slow and the rate of respiration is consequently slow. If light is given A to B gets accelerated while B to C remains slow. Thus the reaction is limited by the rate of B to C.

At 27° C. the rate of respiration augments in light because B to C is no longer limiting.

Now as the activation of the reacting metabolites in the primary process can be brought about both by light and temperature, then if the temperature is greatly in excess a large number of molecules will already be in an activated state and with light the increase in activation will be proportionately less. Thus the increase in respiration proportionately decreases in light beyond 27° C.

The increase of the primary process or the increase of respiration in light will only take place, if the respiring organ is coloured. Colourless plants like fungi or the roots of plants show no increase in respiration in light, for the simple reason that light of the necessary frequency is not absorbed.

On this scheme the falling respiration curve of leaves which is called the floating respiration by Blackman is really the 'after effect' of light. Because the energy q given out in the reaction is enough to activate a second molecule of sugar and light energy after the first reaction, the value of hV will not be required. Theoretically the reaction once commenced in light shoud go on at the enhanced rate in darkness, but due to the gradual dissipation of energy q the respiration in darkness comes down to a slower rate.

8

ENTOMOLOGY

President: Y. RAMACHANDRA RAO

SOME OBSERVATIONS ON THE PERIODICITY OF LOCUST INVASIONS IN INDIA

IN the broadest sense of the word, a "Locust" is a grasshopper capable of appearing in large swarms and causing considerable damage to crops. While there is little difference in general appearance and structure, the grasshopper lives a solitary life scattered in small numbers all over the area, whereas the locust tends to congregate together both in the younger stages as hopper bands and in the adult condition as flying swarms.

There are three most important locust species in India: (i) the Migratory locust; (ii) the Bombay locust; and (iii) the Desert locust. The first is found in its solitary phase all over India; but there are indications that it can occasionally assume gregarious habits and become a destructive pest; the second is endemic in the region of the Western Ghats and usually visits the neighbouring districts of the Bombay Presidency. Its swarms invade also, Kathiawar, Central India, Central Provinces and parts of Madras and sometimes extend as far as U.P., Bihar and Bengal. Since 1910 this locust has not, however, occurred in a serious form. The third is the locust *par excellence* of India and is usually found in the desert regions of N.W. India, but during years of mass multiplication, may invade, upto Assam in the East, and right up to the northern districts of Madras in the South. This species has the ability to pass through two or more generations in rapid succession in a single year and assume the dangerous swarming condition under favourable circumstances. As this species has been the subject of special investigations in India since 1930, much information has been gathered in respect of its periodicity and various other factors.

When locusts appear they are seen at the same time in many parts of India either breeding or migrating, the extent of spread being considerably greater in years of high multiplication; during the intervals between locust cycles, few locusts are noticeable anywhere in India. During the recent swarm-free period, 1932–39, investigations financed by the Imperial Council of Agricultural Research, were in progress, regarding mainly, the habits, ecology and distribution of the nongregarious locusts found in the desert areas; these locusts are found to react to changes in the environment exactly in the same way as the gregaria phase locust; their breeding is similarly dependent on favourable rainfall and they migrate over long distances at the change of seasons from one rain belt to another and goes through at least two generations a year, one in winter-rain areas and the other in summer-rain areas. The main difference would appear to lie in the crowded life lived by the gregaria locust and in the high intensification of its activities under the influence of mass psychology. In the present state of our knowledge the change in status of an apparently innocuous, obscure, and sparsely distributed resident locust of the desert, into a highly dreaded pest, capable of appearing in vast hordes and dealing wholesale destruction to crops, would appear to be due mostly to its reaction to a complex of meteorological factors favouring its breeding under crowded condition.

The general sequence of events during a year of locust swarm activity may be roughly classified under (1) over-wintering, (2) spring breeding, (3) summer breeding. And the causes for the breakdown of the infestations are most probably, (1) failure of the swarms produced in the eastern areas in summer to reach the winter-rain zone and (2) failure, or very low seasonal rainfall tending to diminish greatly the extent of breeding and multiplication.

In the study of the ecology of the solitary phase, the main problem is to determine the conditions in which groups of solitary individuals become transformed into gregarious swarms. Since eggs are generally laid under crowded condition, the hoppers hatching therefrom, tend to get crowded and form incipient hopper bands later developing into the primary swarms of fliers. Such situations as these where phase transformation is brought about, are termed "outbreak centres".

The sequence of events in the origin of a locust cycle appear to be (1) heavy and well-distributed rainfall in the winter-rain areas causing the formation of outbreak centres with incipient swarms; (2) the conveyance of these swarms into the desert area at the right time for monsoon breeding; (3) occurrence of heavy and well-distributed monsoon bringing about concentrated and continuous breeding in the desert leading to the building up of large swarms.

The importance of taking adequate and timely measures in checking the initial outbreaks cannot be overemphasised. The best way of dealing with them would be to locate the centres of outbreaks and destroy the incipient bands of hoppers before they develop wings and leave the area.

The influence of the fluctuation of sunspot activity on locust incidence has been recognised by many authorities and this phase of locust investigation comprises a fascinating study.

Although a considerable advance has been made in a study of locust epidemiology there are still various gaps in our knowledge of locusts, especially in regard to problems of a fundamental nature and it is hoped that necessary funds for their investigation, while the material for study is available during the present swarm period, will be forthcoming.

12

PHYSIOLOGY

President: DR. B. B. DIKSHIT

SCIENTIFIC STUDY OF SLEEP

IN his Presidential address delivered before the "Physiology Section" of the 28th session of the Indian Science Congress held at Benares in January 1941, Dr. B. B. Dikshit, PH.D., M.R.C.P., M.B.B.S., D.P.H., records "Some observations on sleep" in the hope that his observations may urge young physiologists to pursue investigations of the familiar but, in some respects, baffling phenomenon of sleep. He notes that "most of the literature on sleep is in German, some in French and comparatively little in English" (P-2). In the opening section, Dr. Dikshit sums up a few observations on the physiological changes in sleep with reference to circulation, respiration, muscular movements and secretion of sweat. That sleep is a "parasympathetic phenomenon" is next noted. Sir Henry Dale had pointed out in 1934 that there is an intimate relation between parasympathetic and acetylcholine. If so, the question has to be posed and problem solved whether "acetylcholine is the sleep-producing hormone". Dr. Dikshit then briefly refers to the "Chemical theory of sleep", to "sleep centre" localized and identified in the third ventricle of the brain, to "cortical" and "sub-cortical" theories of sleep, and enumerates certain experiments conducted with a view to identification of the substances that act as sleep-producing hormones. Dr. Dikshit inclines to the view that a majority of considerations would point to *acetylcholine* being pre-eminently the sleep-engendering hormone. What is the action of acetylcholine on sleep-centre? Does it exist normally in the brain? Is there a special mechanism to control its action? Does its pharmacological action agree with the physiological changes observed during sleep? Is there accumulation of it in the sleep centre? These and allied questions are answered next and the concluding section is devoted to a discussion of methodological procedure and results obtained so far. Three important conclusions emerge from Dr. Dikshit's presidential pronouncement: (1) The sub-cortical centres are responsible for sleep. (2) There is a sleep-centre in the hypothalamic region. (3) Acetylcholine may be claimed to be a sleep-producing hormone and it activates the sleep-centre.

It may not be out of place, nor would it require any special pleading to observe that papers and presidential pronouncements, wherever possible of the Indian Science Congress, and of its different sectional ramifications, should occasionally at least endeavour to examine theories put forward in ancient Indian classics. The phenomenon of sleep affords undoubtedly the most fascinating subject of investigation, and Dr. Dikshit may have briefly surveyed the ancient Indian theories ignoring the fact that they of course were not formulations arrived after experimental investigation and laboratory analysis of the type now available. The Upanishadic theory of sleep may perhaps supply the clue to modern experimentalists. In the acute analysis of the state of sleep, perfect, undisturbed and dreamless sleep (*sushupti*) the Upanishadic thinkers have pointed out that the cortical centres are as much responsible for sleep as the sub-cortical so that for any theory or hypothesis to be complete, comprehensive, and inclusive of all the known facts and data, inclusion of both cortical and sub-cortical influences would be indispensable to account for sleep. That sleep is a parasympathetic phenomenon had been quite clearly realized by the Upanishadic thinkers. In their analysis, they pointed out that the entire *tout ensemble* of sensory-motor mechanism remains suspended during the time of sleep. (*Jnyana-karmendriya-uparati.*) But, then, only the *Chitta* is still active which renders possible personel identity and continuity of self-consciousness—such as "I had a sound sleep up till now". I wish Dr. Dikshit had made some brief reference to the theories of sleep advanced by the Ayurvedic teachers.

To many a teacher who is day in and day out confronted with the phenomenon of pupils falling asleep even during the first hour of the day undoubtedly as the result of a hurried meal and walking to the class-room, the problem of sleep must appear intriguing. On the contrary hundreds of students have complained to me that the soporific accents in which learned professors endlessly go on reading from the printed pages even without caring to face the audience straight, have invariably induced sleep in them however eager they might have been to "learn".

Is sleep at all necessary as a physiological necessity? The Yoga system has prescribed courses of practices by means of which sleep can be controlled. Certain practices lead to insomnia. To counteract it, other practices are detailed which plunge the subject in the bliss of deep, dreamless sleep. The ancient Indian thinkers had perfectly realized the value of sleep as a tissue-building reconstructive tonic.

The problem of sleep is by no means restricted to physiological treatment. It is psychological and its frontiers touch general philosophy. The Upanishadic thinkers saw that waking, dreaming, and sleeping should be viewed as triune or tripartite, so that abnormalities in one invariably found reflections and repurcussions in the other two. These problems deserve careful investigation. I commend Dr. Dikshit's address as an eminently able survey of the latest literature and theories on the problem of sleep.

R. NAGA RAJA SARMA.

13

PSYCHOLOGY

President: DR. I. LATIFF

PSYCHOLOGY AND THE FUTURE OF MANKIND

"THERE are only two alternatives; it is either re-education of man, or the catastrophy of his cataclysmic extinction. This presents to psychology its present task." In this rather alarmistic and challenging manner Dr. I. Latiff,

M.A., Ph.D., concludes his address delivered as President of the Section of Psychology and Educational Science of the 28th session of the Indian Science Congress held at Benares in January 1941. In the opening section, Dr. Latiff refers to the "tragedy that attends the march of human affairs", and records in pathetic strains that "mental disorders, crimes, political unrest, wars and unhappiness dog its steps at every turn" (P-3). In the second section, he complains that the "leading intellectuals" are ignorant of the real causes of these disorders. Quoting fairly extensively from the work of Samuel D. Schmalhausen, he points out that man's behaviour should be studied from the standpoints of psychology and psychiatry and not from those of sciences like economics. Incidentally he observes that the hostility to psychology should be directly due to many a skeleton in the cupboard of the mental-make of these distinguished modernists. In the *third*, Dr. Latiff goes on to explain that notwithstanding the claims and achievements of modern civilized man, there exists "behind the facade of rational conduct, a primitive mental structure which regulates his individual and social life" (P-8), and which is perhaps responsible for the manifold maladjustments of mankind. That the existence of the primitive savage elements in modern civilized mankind is not realized on account of Repression, and Projection, and that conventional morality and religion are nothing but neurotic manifestations are explained in the *fourth*. In the *fifth* concluding section, a strong plea is entered for the use of scientific psychology in effecting mental and emotional re-adjustments imminently incumbent on human society to-day. How can scientific psychology help? Firstly, instinctual demands should be gratified within reasonable limits without the imposition of irrational restraints. Secondly, Psycho-analytic treatment should be made available more generally than at present. The work, thirdly, must begin in the nursery. Psychological clinics for children should be started. Fourthly, parents and teachers should be educated along the lines of scientific psychology. Fifthly, carefully graded sex-education to suit the psycho-sexual development of individuals should be imparted. Finally, as vocation is influenced by unconscious motives, psychology and psycho-analysis should be pressed into service in selection of vocation.

I have fairly carefully perused the 25 pages of closely printed matter of Dr. Latiff's Presidential address, and I feel like old Khayyam that I have come out by the same door as in I went trite as the comment may seem. In the interests of disinterested scientific investigation it must be emphasized that as between non-recognition of the value and significance of psychology and psycho-analytic technique in the colossal task of re-education of mankind, and overdoing and making a fetish of psychology, psychiatry, and psycho-analysis, the latter is undoubtedly more dangerous. A million Freuds notwithstanding Religion cannot be so easily dismissed as an evolutionary manifestation of infantile or savage FEAR. Be that as it may, the manifold miseries and maladjustments to which modern mankind has fallen a prey, are not after all so much due to occasional eruption into consciousness of hidden primitive motives and instincts, as actually to very visible and manifest tendencies. Dr. Latiff makes mention of the well-known sadistic and masochistic tendencies, and I wonder what reception would be accorded to the psycho-analytic explanation or hypothesis if Dr. Latiff were to argue that Mr. Gandhi's *fasts* are mere manifestations of masochistic tendencies seeing that fasts are certainly a species of ascetic self-torture.

That is why Indian psychology while emphasizing the value of deep-seated tendencies, dispositions, complexes, primitive instinctual desires and motives (designated by the all-comprehensive *samskara*) rightly insists on an adequate analysis of openly expressed behaviorism and overtly operating motives and springs of action. Thus, there is absolutely no need for an onlooker like Wendell Willkie to attempt the impossible task of psycho-analysing the Fuehrer for isolating and identifying the war-guilt!! Overt behaviourism must quite suffice. Formation and crystallization of opinion cannot be arrested when one finds that a strong military nation simply because it is strong and powerful invades its weak neighbour. That must kindle the righteous indignation of all without any otiose and unprofitable attempt at psycho-analysis of the aggressor.

It is all so easy to talk of educating the parent and the teacher on the lines of scientific psychology. But, who is to educate the psychologist and the psycho-analyst? Can he like the King do no wrong? Of course these and allied questions genuinely germane to the subject selected by Dr. Latiff are not even touched on, but, that need not prevent one from commending Dr. Latiff's address as a fine performance.

R. Naga Raja Sarma.

14

ENGINEERING

President: Dr. C. C. Inglis

HYDRODYNAMIC MODELS AS AN AID TO ENGINEERING SKILL

SOME hydrodynamic models give accurate results, others yield results widely diverging from those of the prototype.

Geometrically similar models constructed for determining coefficients of discharge, standing wave relations, study of lines of flow at off-takes, and scour downstream of falls yield results with a fair degree of accuracy. But experiments conducted at Poona, on geometrically similar models to determine the coefficients of a high coefficient weir and to study the slab movement in the submersible bridges have not yielded similar results.

Usefulness of models with a mobile bed is well exemplified in the experiments on the flow round a bridge pier constructed in erodible sand in which "flow pattern" is the dominant factor. In 1938–39 Annual Report of the Central Irrigation and Hydrodynamic Research Station, it

is shown that scour, at pier noses, is due to the water, diverted by the pier, diving downwards towards the upstream toe of the pier. The action of scour is due to the 'flow pattern' and is scarcely affected by the upstream bed level.

Rigid vertically-exaggerated models, though with great care may be made to reproduce correctly conditions for a given discharge, may fail with longer or smaller discharges. Much patient 'trial and error' work spread over a number of years along with large data may enable prediction of conditions outside the verified range. But direct informations about scour and consequent changes in flow cannot be got. A rigid model of a 20-mile length of the Hoogly above Calcutta is being studied at Poona to determine lines of flow and places of scour bed action, as preliminary, to a more exhaustive investigation of bank-scour problem with semi-rigid or mobile part-models, using larger discharges.

Semi-rigid models can reproduce similarity much more accurately than the whole mobile models. But throughout the length of the channel conditions are imposed, the model being incapable of scour, its banks being rigid or changing its course thus precluding studies of future changes of river course and their consequent effects.

In the case of mobile channels, as a result of Lacey equations, slope exaggeration must equal vertical exaggeration for the same silt factor in model and prototype. A coarser silt increases the slope exaggeration whereas it decreases the vertical exaggeration. Choosing of correct silt conditions in a model is thus very essential. Hence channels can be more satisfactorily designed by the use of formulæ than by model studies.

Silt movement and hence the amount of scour and silting are always relatively much less, in a natural mobile model than in its prototype. With a low discharge, silt movement will occur in rivers whereas in a model it will not commence till a flow is a considerable fraction of the flood discharge. Use of finer silt in models though increases silt charge, has little effect on the velocity at which silt movement begins and ends. In the 1/300 Sukkur Barrage model, when regulated as at the Barrage, silt movement does not begin till the discharge exceeds half the normal maximum flood discharge. In many river problems, scour after floods greatly affects subsequent flow conditions and this scour is not correctly reproduced in models, leaving us to depend either on experience and judgment or to distort the model scales to effect silt movement at low discharges.

Bank slopes and rigid structures are exaggerated according to the depth exaggeration scale. Such exaggeration fails to reproduce correctly the "flow pattern" thus necessitating recourse to large-scale part-models, essential for studying bank effect.

To prevent distortion in plan, models are foreshortened longitudinally in the ratio of the vertical exaggeration, this foreshortening leading generally to distortion of the lines of flow or eddy pattern, due to inadequate length.

Long and short river models have specific advantages but in both these cases, great care must be bestowed on entry condition as on its correctness depends a reliable reproduction of the meandering course of a river. Generally models varying from geometrical similarity to various scales of vertical exaggeration would be needed to help proper understanding.

For several years, various scale experiments have been conducted with mobile models at Poona, to study effects of variation of slope scales, discharge scales, silt charge and vertical exaggeration. They have indicated the limitations of river model studies; a wide range of experiments with large models generally yield highly accurate qualitative results with some measure of quantitative accuracy. Conditions that have existed in the prototype under a known discharge and silt charge, can be reproduced accurately in a model and at best, mobile river model can serve as a valuable guide to the engineer.

C. GOPALAKRISHNAN.

CENTENARIES

Cooper, Astley Paston (1768–1841)

ASTLEY PASTON COOPER, a British surgeon, was born at Brooke Hall about seven miles from Norwich 23 August 1768. His father was a vicar; but his grandfather and uncle were both surgeons. He passed a spirited boyhood without much schooling. He learned classics from his father and his mother, who was an authoress of no mean repute, taught him history and grammar. He was thus neither overtaught nor overstrained in his boyhood. When he completed his sixteenth year, he was apprenticed to his uncle, surgeon to Guy's Hospital, and later to Henry Cline, surgeon to St. Thomas's Hospital. He specialised in anatomy and completed his course by spending seven months in Edinburgh, in close association with the most renowned surgeons of that place.

In 1789 Cooper was appointed demonstrator of anatomy at St. Thomas's Hospital and two years later he was promoted lecturer. He followed the Hunterian model which was scoffed at by the elders. The students accustomed to the teaching of such scoffers began to desert Cooper. After investigation Cooper found that it was due to their ignorance of Hunterian terminology and their lack of experience. To counteract these difficulties, Cooper adopted the plan of bringing before the class cases of disease and injury and further illustrating by morbid specimens and experimental results. This method he practised with great success throughout his teaching career of forty years.