

of the last spermatogonial division. The chromatin nucleolus retains a clavate form through the early and late periods of growth and this form is retained till the metaphase of the first spermatocyte division is reached. It is suggested that the behaviour of the chromatin nucleolus of *Labidura riparia* resembles that of the chromatin nucleolus of *Oecanthus* described by Makino.

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**A Cytological Study on the Liver of the Rat
with Special Reference to the Intracellular
Blood Canaliculi, Inter- and Intra-cellular
Bile Canaliculi, Mitochondria and Golgi
Apparatus.**

EDITH M. JAY (*Jour. of Morph.*, 1934, 56, No. 2, 407-421) makes an interesting con-

tribution to the cytology of the liver and interprets the so-called 'intracellular blood canaliculi' described by Schafer and his pupils as artefacts produced by the differences in the osmotic pressure and the mechanical pressure employed in administering the injection masses. She further demonstrates that a permanent system of intracellular bile canaliculi described by the earlier authors does not exist and that the short knob-like intracellular projections from the intercellular bile canaliculi possibly represent the passage of the secretion into the intracellular canaliculi. Though the presence of glycogen effectively hinders the processes of impregnation, her observations on the Golgi apparatus and mitochondria confirm those of Cramer, Ludford and others.

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Irrigation Research in the Punjab.

THE investigations that are being carried out in the Punjab have as their objects the improvement of design of irrigation works, the reduction in the costs of maintenance of channels, the control of the rise in water-table and the prevention of soil deterioration under irrigation. In order to carry out these investigations the following Sections of the Research Institute have been established—Hydraulic Section, Physics Section, Chemical Section, Land Reclamation Section, the Statistical Section and Mathematical Section. A brief account of the work of each of these sections will indicate the lines of work that are being pursued.

1. HYDRAULIC SECTION.

The essential features of a canal headworks in the Punjab are a weir across the river to obtain command of the land and the head regulator of the canal. One or more bays of the weir are provided with under-sluices for purposes of regulation. The weir consists usually of an upstream apron, the crest, the down-stream glacis, and below this the block protection. If the weir fails, the whole of the irrigation in the canal system may fail. It is of the greatest importance, therefore, to design a weir so that it will stand up to the strains imposed upon it. Experience has shown that weirs may fail due to the floor not being heavy enough to withstand the unbalanced head. The pressure under the floor of the weir may be greater than the pressure on the floor. If this is the case and the floor is not strong enough, the floor may be lifted with disastrous consequences. The pressures under the floor as influenced by various forms of design have been studied and, as a complement to this, methods for controlling the flow on the floor have been investigated.

The methods for investigating the flow under a work have already been described.¹ The tanks used in these experiments have been adapted

to study the pressures and it is now possible to place a model of a work in the tank and determine accurately the pressure that will be experienced on any portion of the floor. Fig. 1 is an illustration of a model of Khanki Weir, Bay 4.

In order to examine the condition of flow over the weir a scale model of a section of the weir was constructed in the flume and the effects of the different conditions of flow actually experienced on the work were examined. In order to render a work safe, it is essential that the velocity of flow in contact with the floor should be as low as possible. The methods that have usually been adopted to secure this have had as their basis the destruction of energy. The subject was examined from an entirely new point of view in the Punjab Laboratory. If the high velocity water could be thrown to the surface and a low velocity water be made to travel along the floor, the problem would be solved since a high velocity water at the surface could do no damage. It has been found that by placing arrows a short distance below the crest of the weir and raised control blocks at the end of the floor, the flow along the floor is extremely slow. Determinations of the velocity of flow show that the arrows throw the high velocity water to the surface and the raised blocks check the flow of the bottom water. Under these conditions no standing wave, as usually understood, is formed. Instead a wave which has only a forward motion is produced. In order to distinguish this wave from the standing wave it has been designated "forced jump". Fig. 2 shows the design adopted for the down-stream protection of Khanki Weir.

An examination has now been made of the prototype after the weir, according to the new design, has been in operation for one flood season. It has been found that the form of flow over the weir is identical with that predicted from the model experiments and that the greatest settlement of the loose blocks has been 0.5 foot, while the majority have not settled more than

¹ *Curr. Sci.*, 1934, 2, 367-370.

0.2 foot. This will result in a large reduction in the cost of maintenance of the weir since large scour holes down-stream had to be filled annually with stone at considerable expense.

One further important result of these investigations is worth noting. Before these studies were made, it was impossible to obtain informa-

tion be determined. The design of Bay 8 of Khanki Weir which is to be reconstructed during the Cold Weather of 1934-35 has been based on these laboratory experiments. Further work on the same subject is in progress with the object of adapting arrows and raised control blocks to canal falls.

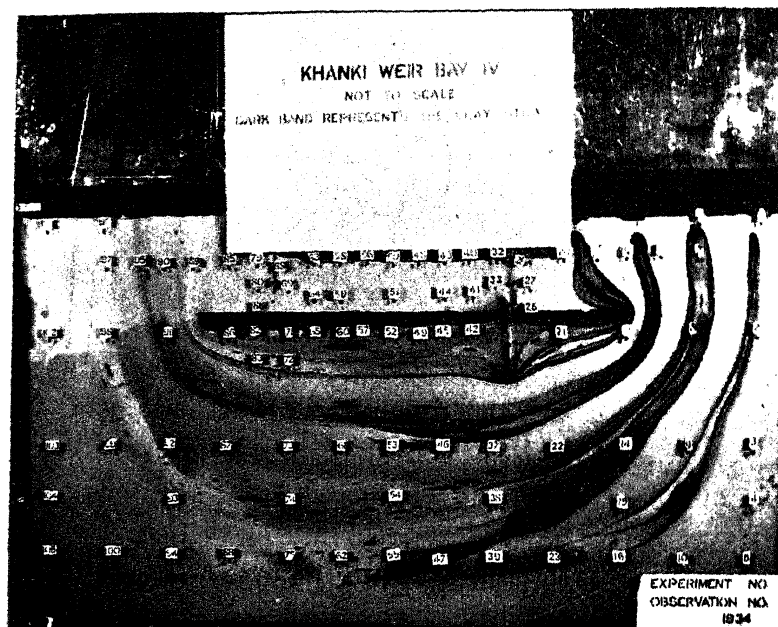


Fig. 1.

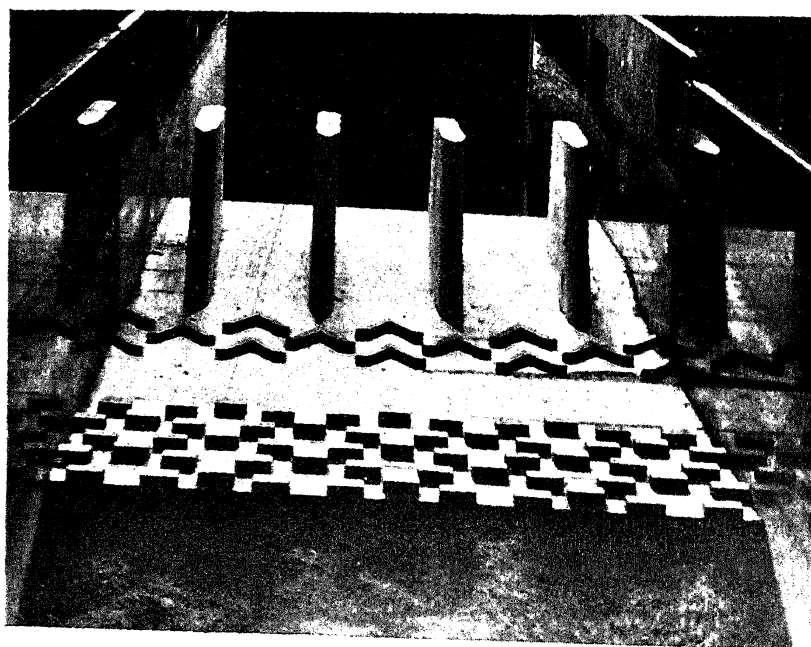


Fig. 2.

tion upon which the designs of the floor could be based. Since it is now possible to determine the pressures under the floor and also the profile of the water surface on the floor, the unbalanced head can now be evaluated and the position that this will occupy on the floor can be stated. As a result the thickness of the floor can be calculated and the area requiring reinforcement can

Another important investigation now in progress in the Hydraulic Section is the study of the silt in canals. The Physics Section has collaborated in this investigation by designing a Siltometer which can be used for deriving the distribution curve of the bed silt. If silt accumulates in the bed of a channel, the channel must become wider in order to carry the designed

supply. This widening of the channel entails a large expenditure to protect the banks. The object of the investigation is to study the relation of the silt type to the hydraulic data of the channel. Observation sites have been established on a number of channels and the hydraulic data that has been collected is being examined in conjunction with the characteristics of the bed silt at the site.

The silting of the Upper Bari Doab Canal has been thoroughly examined both at observational sites and on models. As a result a silt ejector has been designed and constructed for dealing with the silt. This ejector is now returning to the river about thirty per cent. of the silt entering the canal. Extensions of the ejector are to be made with the object of controlling the remainder of the silt. As a result of this silt control maintenance costs will be considerably reduced and the re-modelling of channels will become unnecessary.

2. STATISTICAL SECTION.

The research work of the Statistical Section has been mainly concerned with the investigation of the factors responsible for the rise in water-table in irrigated areas in the Punjab.

The data for the work are the records of well levels, the rainfall, the canal discharges and the areas commanded. Fortunately the level of water in the wells has been recorded from a considerable time. The first area investigated was that commanded by the Upper Chenab Canal in which water-logging is a serious problem. It has been shown that the variation in the level of the water-table is directly related to the amount of the monsoon rainfall. Fig. 3 shows the relationship between the rise in water-table between June and October and the monsoon rainfall.

It has also been demonstrated that there is no significant relation between the amount of irrigation water that the land receives and the rise in water-table. From the data it has been shown that the greater the amount of irrigation water that the land receives the less is the rise in water-table between June and October. This is due to the fact that in years of low rainfall there is a keen demand for canal water, while in years of high rainfall the demand for water is relatively small. Since it has been shown that the monsoon rainfall is the factor determining the variation in the water-table, the foregoing result as regards irrigation is to be expected. Before the investigations of the causes of the rise in water-table had been carried out, canal closures were tried as an anti-water-logging measure. These have now been discontinued as they have been shown to be of little value and interfere with agricultural operations to a harmful extent.

Since the monsoon is a characteristic of the climate of the Punjab, objections to the above conclusions have been raised on the ground that water-logging was not a serious problem before the advent of the canals. The reason for the monsoon rainfall now causing water-logging is that the canals and distributaries frequently block the natural drainage lines and the land in these drainages is now cultivated thus preventing any run-off. Government has now accepted this view and has sanctioned a programme of drainage development over a period of five years. The importance of drainages as part of any scheme or irrigation development has now been recog-

nised and attention will be paid to this in all future projects in the Punjab.

As a result of these investigations, the Statistical Section has been called upon to examine alterations in alignment of channels and in water supplies from the point of view of water-logging. In addition to this major problem, the results obtained from the silt observation sites and the pressure observation on models of works are dealt with.

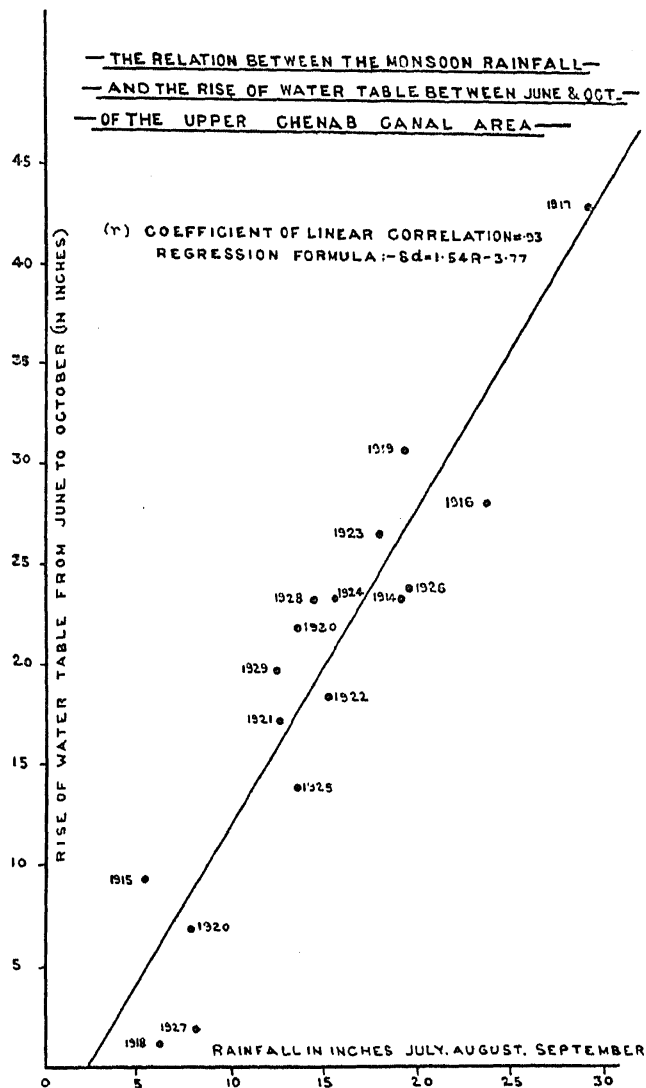


Fig. 3.

3. CHEMICAL AND LAND RECLAMATION SECTIONS.

The Irrigation Research Institute is unique in that it not only studies the design of works and the running of channels but also deals with the effect of the water on the land irrigated. One of the major irrigation problems in the Punjab is the deterioration of land under irrigation. As the Punjab is an agricultural province any deterioration in the soil must mean a reduction in revenue. Further, while there is sufficient water in the Punjab rivers for the present irrigation, it is doubtful whether it would be sufficient for land reclamation, a process that would have to be undertaken if land were allowed to deteriorate on a large scale. In the case of the Punjab, land deterioration may be defined as the replacement of the exchangeable calcium in the soil by sodium which results finally in the production of a soil in which alkalinity limits crop production. The soils of the Punjab plain are characterised

by an alkaline reaction and the presence of sodium salts in varying proportions. Under irrigation the tendency is for the salts present in the soil to circulate in the surface layers with the result that either the salt content or the alkalinity increases.

Extensive soil and crop surveys have been made recently and these have shown that when the pH value of the soil rises above 8.5, the crop yield tends to diminish and when the pH value rises above 9.0, rice is the only crop that can be grown successfully. When the pH value rises above 9.6 even rice cultivation is a complete failure. Large areas have already gone out of cultivation on account of the increase in the alkalinity and salt content of the soil. A much more subtle change is, however, also taking place in the irrigated areas. Since the soil usually contains small quantities of salts, base exchange reactions will take place. The rate at which these reactions take place will be slow and hence the deterioration may pass unnoticed until it has become acute. Recent work in the laboratory has been devoted to the study of these reactions. It is well known that calcium salts can react with a sodium clay to form a calcium clay. What does not appear to have been realised is that the presence of a calcium salt in the soil can *prevent* the reaction between a sodium salt and the clay. This discovery is of considerable importance as it at once points to the method for the prevention of land deterioration under irrigation. The periodical application of gypsum to the land under irrigation prevents the exchange reaction between the sodium salt and the soil and, hence, maintains the land in its original state of fertility. Since it has been shown that crop yields decline when the pH value of the land exceeds 8.5, gypsum should be periodically applied to land of this pH value to prevent further alkalinity being produced. As slow deterioration of this type may pass unnoticed it is essential to have periodical surveys of the irrigated areas so that the necessary steps can be taken to check soil deterioration before it becomes serious.

The quality of irrigation water is a subject closely allied to that of soil deterioration. Investigations carried out in the Research Institute have shown that in the case of the best Punjab soils, base exchange takes place between the clay and a sodium salt when the latter is present to the extent of 60 parts per 100,000. It has already been shown that the presence of calcium salts in the water can prevent this exchange reaction. The quality of irrigation water has to be considered, therefore, not only from the point of view of total salts but also from the standpoint of the ratio of calcium to sodium ions in solution. Standards based on this ratio are now being used for classifying Punjab waters. This investigation is of considerable importance in connection with the use of drainage waters for irrigation and also in connection with the proposed development of tube-well pumping in the Punjab. In the case of drainage waters, it frequently happens that the drains have no outfall and hence the water has to be pumped into canals and distributaries in order to dispose of it. It is essential to control the amount of water pumped from the drains if the mixed waters are not to be harmful.

A further important point in connection with

the quality of irrigation water has recently been brought to light. The quality of the water is not only determined by the salts in solution, but also by the characteristics of the soil to be irrigated. It has been shown that the higher the pH value of the soil, the greater is the quantity of sodium ions in solution necessary to cause base exchange to take place. It follows from this that the higher the pH value of a soil to be irrigated, the higher can be the concentration of salts in solution without causing soil deterioration. A soil survey of the land to be irrigated is as essential as the examination of the water supply in deciding whether the water is fit for irrigation purposes in a particular area.

The complement to the laboratory investigations is the field work which is being carried out at the Chakanwali Research Farm. Rice is one of the few crops that can be grown on a soil with a high pH value. It is, therefore, the first crop to be taken during the reclamation of alkaline or salt land. It has been demonstrated, however, that rice plays a definite part in the reclamation process which consists essentially in removing the exchangeable sodium from the soil. Under the rice crop the carbon dioxide produced by the roots assists in the removal of the exchangeable sodium converting it finally into sodium bicarbonate which is removed in the drainage water. A considerable amount of information has now been acquired as to the types of Punjab soils that can be reclaimed and the types that cannot economically be brought under cultivation. The information gained has been of great value in connection with the soil surveys for project purposes. As the main factors limiting crop production on Punjab soils are alkalinity and salts a classification based on these factors has been reached which indicates their probable crop-producing power.

From the analytical results of the soil surveys, soil maps are prepared showing the soil classifications of the areas. For project purposes it is considered that if sixty per cent. of the land to be irrigated is not classified as directly culturable the project is unlikely to be financially successful.

4. PHYSICAL SECTION.

The Physical Section is a relatively recent addition to the Institute. The work of this section has been developed along two main lines: (a) the investigations of the characteristics of silt, and (b) the study of the seepage from canals.

The only satisfactory method of characterising a silt is by the distribution curve for particle size. The first work of the Physicist was to evolve a suitable instrument for determining the distribution curve. An ingenious Siltometer based on the principle of the optical lever was developed and is now adopted as the standard instrument in India for silt analysis. A series of observation sites on a number of canal systems were selected. The hydraulic data of the channels at these sites are taken daily and bed silt samples of the sites are also obtained. When a sufficient amount of data has accumulated it is hoped that it will be possible to determine a relation between the hydraulic data of the channel and some characteristic of the bed silt. At present from the form of the distribution curve it is possible to say whether the channel is silting or scouring, whether the channel has poor command, whether the channel has a stable bed or not and whether the channel

conditions are likely to improve or not. It is becoming more and more evident that one of the most reliable indications of the behaviour of a channel is the character of the silt as determined by the distribution curve.

Seepage losses from canals are important for a number of reasons. Any loss by seepage is water-wasted; seepage may lead to water-logging in the neighbourhood of the canal and an allowance has to be made for seepage losses in determining the amount of water that must be supplied at the head of a channel to irrigate a given area. The study of seepage losses has been carried out both in the laboratory and in the field. The laboratory work has involved the study of the transmission coefficient of sands and soils. A relationship has been developed between the transmission coefficient and the distribution curve for particle size. It is now possible from the distribution curve to determine the probable transmission coefficient. The field-work has shown that soil type is the main controlling factor

in seepage losses. The presence of salt in the soil does, however, increase considerably the seepage losses in soils that would be impermeable as determined by the distribution curve.

The Institute has also carried out investigations for Government Departments other than the Irrigation Branch. The investigation of soil temperatures in connection with the capacity of underground cables, the examination of the causes of failure of plantations, the investigation of methods of increasing the fodder supply in *barani* tracts, and the study of forest soils are instances of the work that has been carried out.

From this brief account of the research work now being done, it will be seen that attention is mainly devoted to problems of immediate practical importance. Work of a more fundamental nature is being undertaken in all sections, but until the investigations into problems of immediate practical value have been completed, this side of the Institute's activities must be curtailed.

The Art of Chromium-Plating.*

By K. B. Parekh.

THE last decade has seen an enormous development in chromium-plated finishes applied to a variety of domestic and industrial articles. The merits of chromium as compared with nickel or silver plating have been thoroughly established, and there are at present in Great Britain more than 600 plants in operation. Perhaps the most striking characteristic of an electro-deposit of chromium is its stainless brilliancy and the ease with which the surface of chromium-plated articles can be restored to their original lustre, merely by wiping with a damp cloth. In addition, its extreme hardness and resistance to tarnish furnishes a plating that amply justifies the popularity it enjoys for numerous purposes.

Although chromium-plating was known eighty years ago the perfection in the art reached to-day is of comparatively recent origin. This is due to special difficulties of a technical nature involved in the process of chromium-plating, which could be solved only after a prolonged and intensive study of the problem.

Bloom, Piersol and others have contributed much towards the solution of the problem. In the case of chromium against other metals, the plating range is very critical, hence, current density, temperature, concentration of the bath, etc., have to be carefully controlled. Other difficulties of a special nature are connected with (1) choice of suitable anodes, (2) poor throwing power and (3) evolution of gases and porosity of the deposit.

Instead of the simple form of soluble anodes employed for every other form of electro-plating, chromium-plating calls for insoluble compound anodes whose composition also influences the success of the operation. Most suited anodes are those of lead-antimony alloy (lead : antimony :: 94 : 6).

At any given temperature the character of the deposit and also the cathode efficiency vary with the current density. On irregularly shaped articles the current density is never uniform. Consequently, in plating such articles it is difficult to obtain a bright deposit over the entire surface. The coating on the recessed part may be very thin or entirely lacking. This poor throwing power, however, is a decided handicap and has taxed the patience of those engaged in commercial chromium-plating. This has been overcome in practice by more or less empirical methods. Best results have been obtained by expedients that make the cathode current density more uniform such as, by increasing the distance between anodes and cathodes, using concentric or auxiliary anodes, or attaching a wire to the cathode which acts as a "thief" and takes away the excess current from points nearer to the anode.

In the usual chromium-plating bath, a considerable amount of hydrogen and oxygen are evolved and these carry along with them chromic acid in the form of a fine spray. These sprays can perforate the nasal septum and cause sores on the hands and feet of the workman. The chromic acid spray can be minimised to a certain extent by covering the bath with a layer of kerosene or paraffin oil. But in commercial plating, the gases are removed by adequate ventilation. As the chromium deposit occludes a large amount of the hydrogen, the plating is frequently full of pores and cracks if suitable precautions are not taken. Very thin coatings contain round pores. As the thickness is increased the porosity decreases, reaches a minimum and then increases with the thickness till large cracks are formed either in parallel or at random. Under the usual conditions of deposition there is a minimum porosity when the chromium coating is about 0.0002 inch thick. Further, due to the extreme hardness of deposit it is impossible to buff or burnish the articles so as to obtain a better finish as is the

* Abstracted from a lecture delivered before South Indian Science Association on 24th September, 1934.