

complex example is given by crossing black polled with red horned cattle, which in the first generation yields all black polled animals, but in the second generation a very mixed progeny arises. If the factors for the black-red and the polled-horned pairs are transmitted in the same manner, but *independently of one another*, then the second generation will consist of four classes: black-polled, black-horned, red-polled, and red-horned in the ratio of 9:3:3:1. This ratio has not been verified on a comprehensive scale for the cattle cross, but it has been worked out in all details in several cases for smaller animals. That horned-blacks and polled-reds appear in the second filial generation means that there has been a "break up" of the parental types, and the new classes arise through re-combination of the two pairs of factors in which the original parents differed.

Many of the characters of animals owe their manifestation to the presence of one or other definite factor transmitted according to a definite scheme. If these factors are not divisible under normal conditions they must be transmitted through the germ-cells as definite entities producing their full effect in each successive generation. Therefore, if these factors are relatively permanent, and follow a fixed scheme of distribution in heredity, it is obvious that the characters of living things can be brought under accurate control by the breeder. This factorial theory of heredity has been tested and proved to hold good in a large number of cases, and the problem now engaging the attention of research workers at Cambridge is to find whether it can be applied to those cases where at first sight there appears no suggestion of clear-cut alternative pairs of characters.

The last two papers of the series under notice deal with some of the experiments carried out on these lines. One of the most extensive analyses was designed to investigate the inheritance of weight in poultry. Two standard breeds were chosen; for the larger bird the Gold-pencilled Hamburg, and for the smaller one the Silver Sebright Bantam, the latter being, roughly, three-fifths of the weight of the former. The first-cross birds were intermediate in size, but in the second generation there was a very wide variation. The majority of birds were between the weights of the original parental birds, but a few were larger than the Hamburg, while a few were smaller than the Sebright. Nilsson-Ehle, working on wheat and oats, was the first to give an explanation of such cases, and the closeness with which the theory fitted his results left little doubt of its being a true interpretation. Essentially, his theory is that a similar effect may be brought about by more than one factor, though such factors are independently transmitted. Accordingly, if there are several similar factors, A, B, C, D, etc., which influence the weight

of poultry, then a bird possessing none of these factors will be the smallest type. When it contains A, it will be rather larger; when it contains A and B, it will be larger again, and so on until the largest bird is reached which contains the full collection of the weight factors.

This theory was found to cover all the observed facts, and although it is not suggested that weight is dependent solely upon such factors, yet it seems probable that even such complicated characters can be interpreted in terms of definite factors. On the other hand, very different results were obtained in experiments on rabbits, where the large Flemish was crossed with the small Polish rabbit. In this case the  $F_2$  generation contained no animals at all approaching the size of the original Flemish, and no explanation of this can at present be offered. Further experiments on rabbits were concerned with the inheritance of coat patterns, and the analysis of the continuous series from self-colour to almost white provided an interpretation in terms of the factorial theory.

Another interesting series of analyses dealt with the peculiar form of inheritance known as sex-linked heredity. This can be illustrated by the Hamburg-Sebright cross used for the weight experiments. The Hamburg was a gold-pencilled and the Sebright a silver, and the experimental work showed that silver and gold form an alternative pair, silver being a simple dominant to gold, but in the hen the transmission of the factor for silver is sex-linked. The silver hen is never pure for the silver factor; half of her eggs are "silver" and half are "gold"; moreover, she transmits the silver factors to her male-producing eggs and the gold to her female-producing eggs. A large number of birds have been bred from the mating of silver hen and gold cockerel, but there has not been one exception to the rule that the cockerels all come silver and the pullets all gold. This sex-linked type of inheritance is found in several other characters in poultry, and it may prove of economic importance, for by making use of suitable crosses the breeder of poultry for egg-production can be sure of rearing nothing but pullets through the earlier, and more costly, stages.

Further experiments dealt with the inheritance by cocks of henny feathering, while others were concerned with the characters of egg-colour and broodiness in poultry. These had to be curtailed considerably owing to war conditions, although some interesting results were obtained.

Although all these analyses may prove to be of economic value, yet it must be remembered that the "main object of the work at Cambridge is the elucidation of the principles that underlie the phenomena of heredity," and when these have been revealed the application can be left to those who will derive profit from it.

### A Petrological Microscope.

WE have received for examination from Messrs. R. and J. Beck an example of their "Standard London Petrological Microscope," which they have recently designed for the use of students. It embodies some of the recommendations of a committee of the British Science Guild, which carefully considered the subject (*Journal of the British Science Guild*, November, 1916, pp. 28-30). The microscope, which is strongly built and stands firmly, has the following distinctive features:

The analyser is a form of the Abbe prism, devised

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by Mr. E. M. Nelson. It is placed immediately below the upper lens of the ocular, and slides laterally in and out of position. This arrangement, while it does not appreciably contract the field, has the advantage that it allows a quartz wedge to be inserted between the nicols in the focus of the ocular, with the result that the colour bands are sharply defined, as is also the dark band indicating the position of compensation. It is stated that in certain circumstances a faint second image of the cross wires can be seen, but it is scarcely noticeable, and causes

no inconvenience. The analyser can be rotated about the axis of the microscope, and is provided with clicks in the positions of crossed and parallel nicols. There is an arrangement by which it can be rotated alternately through small equal angles in opposite directions, from the position of crossed nicols, thus affording an accurate means of determining whether the exact position of extinction of a mineral has been arrived at.

The "directions-image," showing interference figures, is obtained, not by the insertion of a "Bertrand" lens in the tube, but by placing a "Becke" lens over the ocular. This is decidedly preferable as it enables the optical effects of a small crystal or twin lamella to be isolated by first placing a diaphragm, with a hole of suitable dimensions, in the focus of the ocular, so as to hide everything except the object to be studied, and then putting the Becke lens into position. The diaphragm is so constructed that it allows of the insertion of a gypsum plate or quartz wedge immediately above it.

These arrangements render it unnecessary to cut into the tube of the microscope to allow of the introduction of the analyser and the Bertrand lens. This means less labour in construction, and therefore less cost.

It may be added that the upper lens of the ocular is adjustable, so as to admit of its being exactly focussed on the quartz wedge, the cross wires, or the perfora-

tion in the diaphragm, and there is also an adjustment of the Becke lens for the purpose of focussing the interference figures.

The polariser is conveniently placed in a swing-out below the stage. It has a slot immediately below it for the insertion of a diaphragm with a small circular or linear aperture for comparing the refractive indices of adjoining minerals by the Becke method, and other purposes.

When it is required to insert the condenser it is slid up into a cylindrical fitting in the stage. This is not very convenient, but we are informed that the firm is arranging to substitute a swing-out attachment, which it is believed will prove in every way satisfactory.

An interesting feature is the Sloan objective changer, which takes only two or three seconds to operate. Each objective is attached to a collar by means of two screws. When these are once correctly adjusted, the objective will always be found to be correctly centred immediately on insertion.

Among the accessories is a quartz wedge cemented to a gypsum plate, and graduated in intervals of fifty micromillimetres of relative retardation. This should render unnecessary the quarter-wave mica and Klein's plate, which are, however, still retained in the list of accessories.

It may be suggested that the fine adjustment should be provided with a milled head graduated to five microns on its circumference, even if it were only approximately accurate.

### Archæology in Mexico.

AT a meeting of the Royal Anthropological Institute on November 22 Mrs. Zelia Nuttall gave an account of recent archæological investigations in Mexico. As an introduction to her report Mrs. Nuttall referred briefly to the fact that after a period of quiescence of some centuries the great volcano Popocatepetl had again become active in 1920, and that its activity still continued.

During the last decade evidence that great volcanic disturbances had taken place at long intervals has been forthcoming. Two distinct types of figurines have been found in conditions which indicate that the topography of the valley has been changed and its inhabitants destroyed by great catastrophes antedating the arrival of the Nahuas or Aztecs.

Of these figurines the first, provisionally distinguished as the sub-gravel type, was brought to Mrs. Nuttall's notice in 1909, when specimens were offered for sale by Indians, and she herself discovered an example *in situ* under a gravel bed at Atzacapotzalco. They were delicately fashioned of fine clay, with slender bodies, long faces, smooth-hanging hair, some wearing chaplets. All presented a worn and polished surface. In the Valley of Mexico the gravel beds extend under the lava flow at the base of the extinct volcano Ajusco.

Under the lava bed, to which Dr. Tempest Anderson assigns an age of at least 20,000 years, Mrs. Nuttall in 1908, and afterwards Señor Gamio, head of the Department of Archæology of Mexico, have discovered a second type of figurine, to which the name "sub-lava type" has been given. This type is characterised by turbans and caps, evidently of fine stuffs or fur, and decorated with circular ornaments of stone or shell. They indicate that the southern part of the valley was inhabited by a race totally distinct from that of the "sub-gravel type" and the Aztec. The distribution of the clay figurines

is now under investigation. They have been traced as far as Guatemala.

Mrs. Nuttall also described the results of recent excavations at Teotihuacan, during which a small pyramid was opened up and reconstructed by Señor Gamio. A tunnel pierced at the height of 35 ft. to the centre of the pyramid revealed that it had been formed of mud filled with innumerable fragments of pottery vessels which had prevented the mud from cracking when it baked in the sun. A remarkable discovery was that of the remains of the ancient pyramid temple with a wonderful sculptured frieze which had been partly destroyed and then concealed by another terraced pyramid temple built in front. The sculptured serpents' heads and the masks of the water-god Tlaloc are of a form hitherto unknown. Associated with them are sculptured shells, principally the conch shell and the pecten or pearl shell. Not only is it remarkable that sea-shells should be represented in sculpture in the heart of the continent, but the association of the water-god with the ocean is entirely new.

In the discussion which followed Mrs. Nuttall's paper, Mr. Maudslay expressed the hope that it might be possible before long, by the elaboration of a system of stratification, to date Mexican antiquities. As Mexico appeared to have been untouched by outside influence, the study of its antiquities afforded evidence of the highest value for the study of the development of the human mind acting by itself. Mr. T. A. Joyce emphasised the importance of the evidence relating to the figurines, and pointed out that the British Museum had acquired a figurine of similar technique from Ecuador. Prof. Elliot Smith expressed the opinion that, contrary to what had been stated by Mr. Maudslay, Mexican antiquities showed clear evidence of influence from outside, and in particular from Asia. Mrs. Nuttall's work showed that this culture must have crossed the Pacific.