

DEPARTMENT OF EXPERIMENTAL EVOLUTION.*

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The present year has marked an advance in that cytological, chemical, and morphological studies on mutation and pigmentation have moved far along converging lines. From several points of view new light has been gained on the nature and control of sex. The studies on human heredity have made substantial progress.

DETAILED REPORTS ON SCIENTIFIC WORK.

ORIGIN AND CYTOLOGICAL BASIS OF MUTATIONS.

One of the most striking results of the year is a demonstration, more complete than has been made hitherto, of the conclusion that has long been held in a semi-speculative way, that the chromosomes of the cell contain materials that determine the direction of development of the organism and the details of its structure. The demonstration has been made in this wise: Usually a given species has a definite and constant number of chromosomes in all individuals that are capable of reproduction. But in *Oenothera lamarckiana* and its mutants the number is variable. This fact was early demonstrated in our cultures of the evening primrose by Miss Anne M. Lutz. Thus she found 14 chromosomes in the tissue-cells of the form *lamarckiana*, 15 chromosomes in the form *lata*, and 28 chromosomes in the form *gigas*. Thus, each of these characteristic forms of the primrose, separated by marked differences of form and size, has its special condition of chromosomes. The conclusion can hardly be escaped that each special condition of the chromosomes determines the peculiarities of the form of the adult body; and, in general, within cultural limits, what the organism shall develop into is determined by its germ-plasm.

Miss Lutz's studies throw light specifically on the mutability of the evening primrose. They indicate that the primrose is mutable just because in it the mechanism for exact division of the determiners, at the ripening of the germ-cells, is imperfect and irregular. The reason for this irregularity is, in part, an inequality in the number of chromosomes that have come from the two parents, so that there are one or more unpaired chromosomes whose fate in the maturation of the sex-cells is undetermined and variable and, consequently, results in variable combinations of determiners, and so in variable progeny. The suggestion arises that "mutation" is always induced by some irregularity in chromosomal division—a condition that may, prob-

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ably, be initiated by the hybridization of the two forms with an unequal number of chromosomes.

PIGMENTATION.

Of all the morphological characters of organisms the pigment is one of the simplest and its manufacture would, it is to be expected, lend itself most readily to modification by chemical and other means. Thus it is known that sunlight influences (even in the human skin) the formation of pigments, and that animals removed from the influence of sunlight, such as those that live in caves, in grottoes, or within opaque shells, develop little or no pigment. It has often been gratuitously assumed that they had lost the power of manufacturing materials for pigment, but experiment shows that this is not always so, for, subjected to sunlight, pigment appears. It was hoped that in our artificial cave pigment-production would be inhibited in some animals as in the caves, and this proves to be the case. The salamander (*Amblystoma*) larvæ that have hatched in the cave and are now a year and a half old are still "white"—they have no more pigment than many cave species of long standing. Nevertheless, pigment production is not wholly inhibited. The mud minnows (*Umbra limi*) which have been kept in the cave for nearly 2 years are showing a progressive reduction in amount of pigment. Other material in the artificial cave gives promise of especially interesting results. These studies have been made by Dr. Banta.

In our studies on the inheritance of plumage color in poultry it early developed that there are two kinds of whites, namely, whites which when mated with pigmented birds give pigmented offspring, and whites which when mated with pigmented birds give only unpigmented offspring. Indeed, these two kinds of whites, recessive and dominant, are now recognized as widespread in nature. The white of sheep's wool is another dominant discovered by us. According to modern methods of interpretation, recessive whites are those whose lack of pigment is due to an absence of one or more of the factors necessary to pigment production. And dominant whites are to be explained on the assumption of some additional factor. What that additional factor might be has been unknown, and Dr. Gortner has been seeking for it. Now black pigment, "melanin," is produced by the oxidation of tyrosin in the presence of an oxidizing ferment, tyrosinase. It was suggested by Spiegler, before Dr. Gortner began his work, that the dominant white was due to a superoxidation of the melanin. If this conclusion were correct it should be possible to isolate the melanin—only it should be *white*. Dr. Gortner soon showed that Spiegler's conclusion was wrong. The "white melanin" from sheep's wool is only the insoluble portion of the keratin and is not pigment at all. It seemed probable, consequently, that the dominant factor in white wool is an *inhibiting factor*, which prevents the pigment-forming elements, though present, from combining. This explanation remained pure hypothesis until tested, and this test Dr. Gortner, working with

Dr. Banta, has made, with results that support the hypothesis. The experiments are as follows: To the water in which the eggs and larvæ of *Spelerpes bilineatus* (which are typically dark brown) are developing have been added certain phenols—substances that are known to inhibit the oxidation induced by tyrosinase. The result has been an almost complete inhibition of pigment formation. The larvæ, instead of being dark brown, are cream colored. The obvious conclusion is: tyrosin only in the body gives recessive *white*; tyrosin + tyrosinase give melanic pigment, that is, *dark brown*; tyrosin + tyrosinase + a phenol give dominant *white*. Further details are given in the following report of Dr. Gortner:

It was found, if phenols carrying the hydroxyl groups in the *ortho* or *para* position are treated with tyrosinase, that oxidation to a color results. If, however, to this mixture a small quantity of a phenol carrying the hydroxyl in the *meta* position be added—for example, a small quantity of phloroglucinol, orcinol, or resorcinol—not only does no oxidation of the *meta* compound occur, but the addition of the *meta* dihydroxyl phenol inhibits the action of the tyrosinase on those phenols which are easily oxidized to colors. A study of this reaction showed that the *meta* dihydroxyl compound neither united with the added tyrosin nor was it oxidized itself, but that the reaction in the test-tube was exactly analogous to that of an anti-oxidase, only in this instance the reaction was purely chemical, and not due to an enzyme. The suggestion was made that perhaps it is due to a reaction of this sort that the cause of dominance is due, *i. e.*, that the chromogen is changed by some reaction from a *para* phenol to a *meta* phenol; *e. g.*, tyrosin is changed from *para* hydroxyphenyl α -aminopropionic acid to *meta* hydroxyphenyl α -aminopropionic acid, thus preventing the black pigment from developing and producing a dominant white condition. It is of especial interest to note that Keeble and Armstrong (Proc. Roy. Soc. B., 85, p. 214), acting on the hypothesis that an anti-enzyme causes the dominant white condition, have recently proven that this hypothesis is correct for material from the Chinese primrose.

THE ORIGIN AND HEREDITY OF SEX.

It was early seen that the new methods of studying heredity would throw light on the question of the determination of sex; and indeed great progress has been made in this and other countries by the combination of the investigations of cytologists and breeders. It is now generally recognized that a certain chromosome usually distinguishable from its fellows and which is, essentially, unpaired and so is carried by only half of the progeny of any pair of parents, determines that its bearer shall be of a given sex. The other half are of the opposite sex. This sex-determiner carries with it other characters than merely those that are combined with sex; and these are the sex-limited or sex-linked characters. The hunt for sex-limited characters has yielded many surprises. In the last few years the Director has studied a case of a sex-limited character in poultry and found that the color of the margin or "lacing" of the neck, or "hackle" feathers, is sex-limited; and that, when crosses are made between races with red and those with white

hackle, the daughters show the color that their father has. The reason is that this is a character linked with the sex chromosomes and the daughters get their sex chromosome from their father only, while the sons get a sex chromosome from each side of the house. Occasion was taken, in printing these results, to review cases of sex-limited inheritance in birds and to bring all results into accordance with a simplified formula. Dr. Shull has discovered a sex-limited character in his *Lychnis* cultures—the first case to be observed in plants. Here a narrow-leaved condition is in the offspring of hybrids found only in male plants.

Plants are usually unsatisfactory for the study of sex-limited characters because they are so often hermaphroditic. In some species, however, as noticeably in the cockle, *Lychnis*, males, females, and hermaphrodites occur side by side in the same culture field. The females are usually sharply differentiated from the others, but the males are only extreme cases of abortion of female organs in an hermaphrodite. Many sperm, indeed, carry the determiner for hermaphroditism, the others that for femaleness; but the eggs ordinarily carry only the determiner for maleness. It now appears, however, that some eggs do carry the determiner for hermaphroditism; and it was hoped to get a union of eggs and sperm which should be positively homozygous in respect to the determiner for hermaphroditism, that is, should have it double-derived from both parental germ-plasms. Such a product should be the ancestor of a pure hermaphrodite strain. But, so far, Dr. Shull has met with disappointment. Always there arise eggs that do not carry the determiner for hermaphroditism, but femaleness only.

Usually, we expect that half of the offspring in all forms shall be females; but we know exceptional cases where, as in plant lice and rotifers, female children only are born for many generations. In *Lychnis*, also, expectation is not fulfilled; for the sex-ratio of the female sex varies all the way from 4 per cent to 97 per cent in different families of large size; and making all counts, it appears that the females constitute about 62 per cent instead of the expected 50 per cent.

A third study of sex was made by the Director in collaboration with Professor Arkell, until recently in charge of the New Hampshire experiment station at Durham, with which this station has been cooperating. This study had to do with the horns of sheep. As is well known, in some races (Merinos) the males are usually horned, the females hornless, and this fact has been explained on the ground that the testis secretes a substance (which the ovary lacks) that stimulates the formation of horns. A difficulty lies in the fact that in other races of sheep, as in most sorts, both ewes and rams are horned, and in other races neither sex. So the data gathered from the sheep-breeding experiments of both stations were gone over and it appeared that the facts were not opposed to the conclusion that the horns of sheep likewise are inherited as sex-limited characters. A note was published in Science to that effect, and in consequence of a criticism of this conclusion

urged by our colleague, Dr. Castle, the germ-gland has been removed from a horned ewe lamb and from a horned ram lamb. It is also planned to make studies on castrated rams on farms near by. The experiments seem worth while in order to bring under a general rule the outlying case of horns in sheep.

SEX STUDIES IN POULTRY.

A fourth series on this subject treats of the interrelation of sex-glands and somatic coloration. Poultry, like birds in general, are markedly dimorphic in coloration. Mr. Goodale removed the left ovary (which alone normally functions) from a duck that was 12 weeks old. This bird continued to develop female plumage for more than a year, but finally acquired so much of the plumage of the male as to be easily mistaken for such. Autopsy revealed the fact that the removal of the ovary was complete and the right gland was also lacking. The only oviduct was the normal left one and that was in a juvenile condition. Thus this bird that had gained the male plumage was an unsexed female. Another case of even greater interest, also worked out by Mr. Goodale, is that of a Brown Leghorn female from which the left ovary was removed when the bird was less than a month old and which assumed most, but not all, of the characters of the male. When the bird was about a year old an autopsy was made and, in place of the removed ovary and on the right side also, there was found a small organ, sections of which showed a mass of cells that were undifferentiated and very different from those of the normal testis. Both vasa deferentia were present, but not functional, and a well-developed but juvenile oviduct was present on the left side. Mr. Goodale has repeated this experiment, which seems well calculated to demonstrate the essentially hermaphrodite nature of the female fowl.

From some Brown Leghorn males of the age of three weeks testes were removed by Mr. Goodale. All developed the usual secondary male characters of plumage and spurs. The comb, on the other hand, developed far less than on the hen of the same race, so that the small comb of the capon can hardly be considered a female character. The crowing and mating instincts also are lacking.

Spurred Hens.—Spurs are secondary sex characters of cocks. Occasionally they are found even on young hens. In order to learn if the tendency to hen-spurring is inherited, three such hens were mated, by Mr. Goodale, to a cock that belonged to the same strain as one of the hens. Though the progeny are still too young to show spurs, the positive result has been gained that a hen with spurs need not differ, in point of fecundity and full development of maternal instincts, from ordinary non-spurred hens.

SEX IN MOLDS.

To broaden our knowledge of the phenomena of sex, Dr. A. F. Blakeslee, botanist at the Storrs Agricultural Experiment Station, well known for his researches in sex of the molds, has been granted leave of absence from

that station to carry on his work here as Research Associate. At present he is working to discover which of the sexual races of the mucors, provisionally designated by the terms (+) and (—), is actually male and which female. The effect of varying external conditions upon the sex, the form and physiology of the individual races, and their influence in inheritance will be tested. He reports that of the mucors he has under cultivation 8 hermaphrodite species and the paired strains of some 22 dicecious species, besides individual unmated races of a considerable number of other species.

HEREDITY OF OTHER CHARACTERISTICS.

Heredity of Flower and Foliage Colors.—Dr. Shull reports interesting studies in two species. In *Lychnis* the announcement of the discovery of a “dominant white” was premature, as the second hybrid generation proves that this white was a recessive white which was mated to unsuspectedly impure stock. The hopes expressed in the last report of being able to secure purebred purple-flowered strains from the reddish series have been realized. A “homozygous” or purebred “tinged white” strain has been produced; a number of different grades of greenness in foliage have appeared, indicating distinct biotypes; and variegated forms have arisen whose inheritance is being studied. The component color elements involved in the Shirley poppy have been isolated and some colors have been produced which are not visible in the original stock.

Heredity of Pitcher-leaved Ash Trees.—In studies in heredity with plants, garden or domesticated varieties have been largely employed and the characters studied have largely arisen under culture. But this is quite natural, since only the cultivated plants are best known; however, it has been raised as a criticism of modern studies. Studies are now being made by Dr. Shull on a striking character that occurs in a group of ash trees found in the forest near by, namely, the cornucopia-like folding of the terminal leaflet. He has bred trees having this character to themselves and to “normals” and has got from the first kind of cross some seedlings that already show the foldings; but none from the second kind of cross.

The Aberrant Inheritance Ratio of Bursa.—In continuation of his studies on this subject Dr. Shull finds that of the two hypotheses formulated to account for the unexpected inheritance ratios in the second hybrid and later generations of the cross between the flat capsuled and the elliptical capsuled bursas, the first is confirmed, the other must be rejected. The triangular capsule is independently produced by two different determiners, and the theoretical ratios of 15:1 in the F_2 generation and of 15:1 and 3:1 in the F_3 generation are to be expected. The hypothesis of the relative inefficiency of the *heegeri* type of fertilized egg is rendered untenable by the fact that families have appeared with an excess of *heegeri* offspring. The deviations from the expected ratio of 15:1 is accounted for on the hypothesis of a selective fertilization producing the observed excess of triangular capsules. The hypothesis is to be tested.

Variation and Hybridization in Evening Primroses (Oenothera).—The series of cross and self fertilized strains of *Oenothera lamarckiana* and certain of its derivatives have been continued by Dr. Shull, and special attention has been given to the offspring produced by several mutants from *O. gigas* and *O. rubrinervis*. A striking variegation in which the leaves have a yellowish-green central region surrounded by a dark-green margin is found to be slightly inheritable. The first plant of this sort was found last year. During the past season a second type of variegation has appeared, which is probably closely related to that first discovered, but has the central region of the leaf dark-green and the margin yellow. The latter kind of variegation has appeared on three different individuals of quite independent origin, and in two of the three plants the two sorts of variegation occur on different portions of the same plant. It is anticipated that this second type of variegation will differ very materially from the first in the extent to which the offspring will be affected.

Reciprocal crosses among three biotypes of *Oenothera cruciata* and between these three biotypes and *O. lamarckiana* have yielded a remarkable series of F_1 hybrids, the reciprocal families being in every case unlike, and many of the progenies being polymorphic. The latter consist of two or four distinct types. In several of the combinations a uniform progeny results when one of the biotypes is the seed-parent and a dimorphic or tetramorphic progeny when the other is the seed-parent. An interpretation of these anomalous results may be found only by carefully following each of the hybrid types through the second and probably later generations.

Relation between Heredity and Environment in Corn.—Dr. Shull has produced purebred strains of maize that vary greatly in quantity of yield. If a high-producing and a low-producing strain be crossed, the second hybrid generation gives offspring that show great variability in yield. Now, while under good conditions and poor conditions the *absolute* yield is different (environmental differences), under both conditions there is the same *relative* variability in the yield among the progeny of this F_2 generation (hereditary differences).

Inheritance of Light Reaction in a Parthenogenetic Species.—The theory that selection within the "pure line" is without effect should, obviously, apply to parthenogenetic species. And it is important to know if it holds for physiological characters as well as morphological. So Dr. Banta set himself (November 1911) to the task of testing the hypothesis that selecting within a "pure line" of daphnids the most and the least sensitive to light will not result in producing more or producing less light-sensitive strains. These lines have now (August 31) entered from the twentieth to the twenty-third generation. The material is favorable, inasmuch as the organism is prolific and new generations appear in rapid succession. Under the most favorable conditions a brood of young is sometimes produced by an individual when only 7 days old; and one and the same female may produce successive broods

at intervals of from 3 to 8 days, until from 4 to 8 broods appear of from 6 to 30 young each. At the last test the individuals of the strain originating in a sensitive mother reacted to light more quickly, and with more uniformity, than did those of the other strain.

Large vs. Small Feathered Chicks.—Certain strains of chicks have gained large quill feathers at 10 days after hatching, while these feathers are then relatively slight in other strains. A study of crosses between these two strains during two generations warrants the conclusion that well-developed wings and tail at 10 days is a condition recessive to ill-developed, though dominance of the great-feathered condition is by no means complete. (Goodale.)

Plumage Coloration in Ducks.—Data are being collected on inheritance of various white spots and "plain" head, black, heterochromidia, irides, red breast in the male, and spotting, not white. (Goodale.)

Hybridization of Butterflies.—Prof. John H. Gerould, of Dartmouth College, is continuing his experiments in hybridizing butterflies in association with this department. He reports that his attempts to hybridize *Papilios* were checked by certain technical difficulties but that he was quite successful in getting hybrids between two species of the cabbage butterfly, *Colias*, and he has fertile eggs laid by the hybrids.

STUDIES IN HUMAN HEREDITY

Through the continued support of Mrs. E. H. Harriman, to which has been added during the past year that of Mr. John D. Rockefeller, your Director has been put in a position not only to continue the work of the Eugenics Record Office, with its loyal staff, but to bring several of its studies to publication. Two of these deal with the detailed history of the matings and progeny of "degenerate" rural communities. They have important social bearings, and, from the scientific point of view, test the theory of inheritance of "feeble-mindedness," epilepsy, "shyness," indolence, and lack of self-control in the sex sphere. They discuss the relative rôle of "blood" and culture in such communities, using three criteria: (1) a comparison of the sets of children from two successive consorts of one parent; (2) a comparison of the behavior in later life of sibs who have been "placed out" or adopted in good homes with those who have remained under home culture; (3) a comparison of the behavior of the descendants of those who have moved to a distant State with cousins who have remained behind. By all these criteria the indelible impress of family traits under whatever conditions of culture is striking.

To facilitate the work of collecting data and of indexing them at the Eugenics Record Office, it became necessary to prepare a list of human "traits." This consumed a good deal of time, as apparently nothing of the sort had been attempted before. It will be an easier task to make the improvements and additions that future experience may require.

Inheritance of Human Skin-color.—As an apparent case of blending, the inheritance of skin-color in crosses between whites and negroes has commanded much attention. With the aim of extending studies published some years ago, a field worker of the Eugenics Record Office was sent to Bermuda to collect data; and later the Director of this Department visited Jamaica and secured cooperation for studies upon some 80 families. All determinations of skin-color are made quantitatively by means of the "color-mixer." Altogether data on over 125 families have been secured, with clear evidence that the skin-color of negroes depends upon two gametic factors for black pigment. This conclusion immediately explains all of the observed gradations of skin pigment in "colored" persons of all grades; demonstrates that wholly white-skinned persons may arise even in the second generation from negro parents, and proves that skin-color is no exception to the law of segregation of determiners in the germ-cells.

STUDIES ON TERATOLOGICAL VARIATIONS.

Teratological conditions are relatively so rare that there have been few studies made upon the laws of their occurrence, degree of development, and inheritance. Dr. Harris is dealing with large numbers for such studies. He has examined about 500,000 seedling beans and nearly 200,000 fruits of *Passiflora*. The abnormalities found are being studied and analyzed.

QUANTITATIVE STUDIES OF SELECTIVE ELIMINATION.

Material progress in this subject has been made by Dr. Harris, working with various flowering plants. Working with the physiological characters of fertility, fecundity, and seed-weight, and asymmetry, he has used them to study unfitness for survival. He finds that small and large seeds have about the same chance of developing to maturity in the field, but in neither case is the chance so good as for the seeds of more intermediate weight. He sought an answer to the question: Have abnormally shaped seedlings an equal chance of developing to maturity with normals? This involved the examination of over 200,000 seedlings and the planting of 5,030 normals and 4,217 abnormals. The answer was: There is a relatively high elimination of the abnormals. In further studies it is hoped to test the relative elimination of each type of abnormality.

INFLUENCE OF STARVATION OF PARENTS UPON CHARACTERISTICS OF PROGENY.

Dr. Harris has published in the June (1912) number of the *American Naturalist* a first study on this subject, based on many thousands of bean plants. Beginning with very similar seeds, of as nearly as possible similar potentialities, he planted some in poor soil and others in good soil; gathered the seed from the two lots, and, the next year, planted them side by side in a different, fairly fertile field. In another set of experiments two generations

were starved and well fed respectively before being grown in the comparison field. The conclusion is: there is no conspicuous influence of the different treatment of the ancestry upon the number of pods produced per plant.

EXPERIMENTS ON FEEDING EXTRACTS OF "DUCTLESS GLANDS."

Because of the importance of the testis in controlling the development of certain characteristics of the male sex, the question of possible control of bodily form or function by other glands which yield internal secretions becomes of importance. Dr. F. E. Chidester, of Rutgers College, started some investigations of this topic at the station during the summer of 1912. He fed rabbits and guinea-pigs both thyroid and thymus extract (desiccated) in daily doses of 0.4 to 2 grams. Even the smallest amount (0.4 to 0.6) of thyroid fed to pregnant rabbits caused extreme diarrhea and rapid heart action, and led to weak offspring, and soon killed even normal young nursed by the drugged mother. But feeding suprarenalin (0.5 to 2 grams daily) to non-pregnant rabbits was accompanied by steady increase of weight. Fowls similarly dosed with thyroid or thymus extract were not affected by diarrhea, palpitation of the heart, and falling of the hair like the rabbits.

STATISTICAL SUMMARY.

Poultry.—Of chicks 3,530 were hatched and of ducks 163.

Finches.—Of canaries about 80 were hatched, of which 50 survived infancy.

Sheep and Goats.—Twenty-six sheep were born and no goats.

Plants.—The number and extent of cultures grown in connection with Dr. Shull's investigations during the past year are indicated by the following table:

Name of species.	No. of families.	No. of individuals.	Name of species.	No. of families.	No. of individuals.
Agrostemma githago.....	1	18	Oenothera sp. ?	1	21
Bursa bursa-pastoris.....	3	262	Papaver commutatum.....	2	97
Bursa bursa-pastoris × heegeri F ₂	3	379	Papaver glaucum.....	1	132
Bursa bursa-pastoris × heegeri F ₄	65	13,009	Papaver glaucum × rhoeas F ₁	2	62
Camelina sativa.....	1	4	Papaver rhoeas.....	31	3,020
Fraxinus pennsylvanica.....	2	416	Papaver rhoeas × californicum F ₁	1	1
Lychnis cœli-rosa.....	3	74	Papaver rhoeas × commutatum		
Lychnis dioica.....	276	17,418	F ₁	1	14
Lychnis dioica × coronaria F ₁	2	4	Papaver rhoeas × glaucum F ₁	2	127
Lychnis haageana.....	1	31	Papaver somniferum.....	3	176
Lychnis noctiflora.....	4	293	Papaver somniferum × californicum F ₁		
Mecanopsis heterophylla.....	1	36	F ₁	3	141
Oenothera biennis.....	1	125	Papaver somniferum × commutatum F ₁	1	14
Oenothera cruciata.....	10	1,489	Papaver somniferum × nudicaule F ₁	1	1
Oenothera cruciata × lamarckiana F ₁	3	254	Silene antirrhina.....	1	48
Oenothera gigas.....	3	214	Silene vulgaris.....	2	48
Oenothera lamarckiana.....	21	1,285	Solanum guineense.....	1	16
Oenothera lamarckiana × cruciata F ₁	3	151	Solanum guineense × villosum F ₁	1	16
Oenothera lamarckiana × rubrinervis F ₁	1	85	Solanum nigrum.....	1	16
Oenothera lata × lamarckiana F ₁	1	85	Solanum villosum.....	1	16
Oenothera nanella.....	1	62	Vaccaria vaccaria.....	1	18
Oenothera rubricalyx.....	1	3	Zea mays.....	126	7,810
Oenothera rubrinervis.....	9	2,511			
			Total.....	599	50,002

STAFF.

The staff remains as last year, except that Dr. A. F. Blakeslee, of Storrs Agricultural College, has accepted an invitation to associate himself with the Station for one year to carry on work in mutation and sex-control. Dr. F. E. Chidester, of Rutgers College, worked upon the effects of feeding extract of the ductless glands on the development of mammals. During the summer Dr. Shull was faithfully and efficiently assisted by Mr. William F. Friedman in making scientific records and in pollinating Indian corn.

CONSTRUCTION AND EQUIPMENT.

The animal house which was started last year was duly completed and was occupied during the summer for breeding the small mammals required for certain physiological and chemical studies. The chemical laboratory was moved to the upper floor of this building, which has been fitted up for the purpose. Attention is again called to the crowded condition of the present building. At the suggestion of the Trustees plans have been prepared for completing this building, which is to take care of all our small animals, including the Whitman pigeons which are to come to us. Certain new directions of work require the control of conditions which can not be furnished in the present building. New needs arise with the development of our science which require additional equipment.

The other principal piece of construction of the year has been a new house for young chicks, relieving the greenhouse, formerly so employed, for plant work. This building, 80 by 20 feet, is built of concrete blocks covered with stucco, and provides for 15 runways. The work of fencing the station farm, using concrete posts, has been started.