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DEPARTMENT OF EXPERIMENTAL EVOLUTION.*

C. B. Davenport, Director.

The President of the Institution has suggested that in estimating the work of departments the unit should not be the year but the decade. It is now half a decade since work at the Station for Experimental Evolution was started, and this may be regarded as an opportune time for considering what this Station has accomplished and what may fairly be expected by the end of the first decade.

At the outset the investigators at this Station had not had extensive experience in breeding-work. Little such work was then done in scientific laboratories or departments of universities. A year or two was required to gain experience, but work rapidly increased to the maximum that each was able to handle properly. The material under observation and experimentation has included mammals (cats, sheep, goats), birds (poultry, canaries and other finches), fishes (to a very limited extent, with the cooperation of the State fish-hatchery), insects (including beetles, Lepidoptera, and flies), and flowering plants in great number. An extensive body of technical experience in the proper method of breeding these organisms has been acquired.

The problem of the "origin of species" has taken on quite a new form in the half-century since Darwin's epoch-making work appeared. Formerly individuals were thought of as a whole and the attempt was made to arrange them in varieties, species, genera, and so on. The basis of classification was, indeed, the possession of one or more common characteristics of form or function, but the characteristic was thought of merely as a convenient incident, of interest chiefly to the classifier. Today we clearly recognize that the whole problem of evolution is the problem of origin, nature, and relations of characteristics. The production of a new "species" is the production of a new characteristic; not necessarily new to nature, but in a new combination. He who by hybridization makes a new combination of characteristics that breeds true makes a new species, as truly as he who induces by physical or chemical means a characteristic that is both new to the species and breeds true. The difference in the two cases rests largely on the origin or source of the characteristic in the two cases.

Since characteristics are of primary importance in evolution, it is the business of this Station to consider them from all aspects, attention at present being directed principally to the following subjects:

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BIBLIOGRAPHY OF PUBLICATIONS RELATING TO WORK ACCOMPLISHED BY GRANTEES AND ASSOCIATES.

Under this heading it is sought to include the titles of all publications bearing upon work done under grants from the Carnegie Institution of Washington. In the list for the past year, as shown below, there may be some omissions, although it has been the endeavor to make it as complete as possible, and in some cases titles may be included which have only an indirect connection with such work. A list of the works published by the Institution during the year will be found in the President's report.

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THE ORIGIN OF CHARACTERISTICS.

Work on this topic involves the ability to produce them by changing the physical and chemical environment; but it also includes observing the conditions under which they arise "spontaneously" or by mutation. Data concerning the origin of characertistics have been acquired in the course of our studies. Several new qualities have arisen suddenly and *de novo* from parents of well-known pedigree, such as poultry with short mandibles, combless birds, birds lacking one toe on each foot, with two toe-nails to a digit, with no nail, without one or both wings, and without a tail. All of these new characters, excepting two that were not tested, were permanent acquisitions of the germ-plasm. Our associate, Prof. W. L. Tower, has tried, with much success, to control the origin of new characteristics in the Colorado potato-beetle and its allies. His results have been published in his work* "Evolution in Chrysomelid beetles of the Genus Leptinotarsa." In high temperature and dry air the germ-plasm of this beetle produced less pigment; in other cases it gave rise to an increased number of generations in the reproductive cycle, and was otherwise modified. For the immediate future we have planned a series of studies on the effect of cave conditions in modifying characteristics, to be in charge of Dr. A. M. Banta, who will become a resident investigator at this Station.

THE CHEMICAL BASIS OF CHARACTERISTICS.

In my last report I mentioned the discoveries of chemical differences in the proteins and hemoglobins of closely related species. There are strong theoretical reasons for believing that differences in the adult are determined by chemical differences in the egg. These chemical characteristics lie at the bottom of the morphological and physiological characteristics. During the past year we have sought to determine the chemical differences between the dominant white and the recessive white of poultry plumage. Dr. W. J. Gies, of New York City, was interested in the problem and undertook the determination upon pedigreed material supplied from this Station. Dr. Gies has not yet reported fully, but there is reason for suspecting that a chemical difference exists in the feather of the two kinds of whites.

The number of problems of a chemical nature that have been opened by the breeding work has rendered advisable the appointment of a physiological chemist, and Dr. R. A. Gortner, a recent graduate of the department of physiological chemistry at Columbia University, entered upon this work September 1, 1909.

* W. L. Tower: An investigation of Evolution in Chrysomelid Beetles of the Genus Leptinotarsa. Publication No. 48 of the Carnegie Institution of Washington.

THE ONTOGENESIS OF CHARACTERISTICS.

While each transmissible character of the organism is latent in the germ, during ontogeny it gradually becomes potent and eventually acquires its adult condition. Since the germinal determiner bears no resemblance to the completed characteristic, there must be a series of fundamental changes in ontogeny. We know that the course of ontogenesis varies according as the germinal "determiner" comes from both parents or one only. In the latter case the characteristic (technically denominated heterozygous) is weakened and often remains at a low stage of development, even in the adult. Such heterozygous characters show how ontogenesis is controlled by heredity. In our publications we have repeatedly proved that heterozygous organs tend to remain at a low or incomplete stage of development, in consequence of which they sometimes, on the one hand, exhibit peculiar forms and, on the other, obscure the Mendelian proportions in transmission. Many of these heterozygous forms can be fully interpreted only by embryological studies.

Again, many organs show themselves, in transmission, to be complex—composed of several unit-characters or factors. It is probable that an interpretation of this peculiar behavior will be given by embryological studies. Arrangements have been made with Prof. F. R. Lillie, of the University of Chicago, by which he is furnishing a trained student to work upon the development of some of the hybrid organs of our pedigreed stock. In accordance with this arrangement Mr. J. C. Stevenson is at present resident at this Station and studying the developmental history of the heterozygous combs of poultry.

THE TRANSMISSION OF CHARACTERISTICS.

This is the phase of the study upon which most work has been done. The results have been published in a series of papers, a list of the more important of which is given below. Our results, so far as published, constitute a satisfactory part of the history of the remarkable development of our knowledge of this subject for which the present decade will ever be famous. A brief statement of the titles of the papers published by the different workers in this field will give an idea of the ground covered.

By the Director: Black sheep in the flock. Imperfection of Mendelian dominance in poultry hybrids. Inheritance in poultry. Heredity and Mendel's law. Dominance of characteristics in poultry. Determinance of dominance. Inheritance in canaries. Eye-color in man. Hair-form in man. Hair-color in man. Inheritance of characteristics in poultry.

By Dr. Shull: Latent characters in a white bean. Significance of latent characters. Variations in the *Oenotheras*. The pedigree culture. Mendelian inheritance. Branching and disk color of sunflowers. Flower color in *Lychnis* and the mullein. A new Mendelian ratio and several types of latency. The composition of a field of maize. A pure-line method in corn breeding. The "presence and absence" hypothesis. *Bursa bursa-pastoris* and *Bursa heegeri*, biotypes and hybrids. A simple chemical device to illustrate Mendelian inheritance.

By Dr. Lutz: The tegminal position in *Gryllus*. Inheritance of variations in the color pattern of *Crioceris*. Variation and correlation of characters of *Gryllus*. Inheritance of the manner of clasping the hands. Combination of alternative and blending inheritance.

By Mr. R. H. Johnson: Evolution in the lady-bird beetles.

In addition, our associate, Dr. W. E. Castle, at Harvard University, has published alone or with students papers on results of investigations on—

Heredity of coat characters in guinea-pigs and rabbits. Heredity of hair-length in guinea-pigs, and its bearing on the theory of pure gametes. Color varieties of the rabbit and other rodents, their origin and inheritance. Reversion induced by cross-breeding and fixation. Selection and cross-breeding in relation to the inheritance of coat-pigments and coat-patterns in rats and guinea-pigs. Studies in inheritance in ear-size, weight, skeletal dimensions, and color of rabbits.

It is impossible to state in a few words the chief results of these varied contributions. In the main they have demonstrated the wide application of the Mendelian principles of inheritance to the characteristics of animals and plants, both domesticated and feral. They have silenced the objection that the Mendelian phenomena related only to "artificial" varieties and proved that they hold equally for species in nature. They have thoroughly analyzed, for the first time, the phenomena of dominance in transmission, and have shown its wide fluctuation from perfection to an impotency such that apparently there is no transmission. They have introduced the idea of the dominance of the more-developed characteristics over the less-developed, and have extended the ideas that while the absence of a characteristic is recessive to presence, the characteristic itself may be an inhibiting factor. They have shown the composition of many color-characteristics out of several factors, revealing a hitherto unsuspected complexity of the germ-plasm. They have, on the other hand, dealt with certain cases, particularly in insects and oenotheras, where segregation of characters seems not to occur.

Finally, this Station has collected and begun to publish studies on data relating to inheritance of human qualities. Eye-color, hair-color, and hair-form have been by us first demonstrated to behave in Mendelian fashion and to be predictable in the offspring. In cooperation with the Committee of Eugenics of the American Breeders' Association the work of gathering data concerning the transmission of human characteristics goes on apace.

Studies have been undertaken on the mechanism of heredity, which is currently thought to reside in the stainable bodies (chromosomes) of the germ-cells. Miss Lutz has organized a series of critical studies which will, it is expected, answer definitely the question whether the determiners of characteristics are carried exclusively in the chromosomes.

THE MODIFICATION OF CHARACTERISTICS.

By changed environmental conditions characteristics may, of course, be changed and the modifications, though usually somatic only, are sometimes transmissible (Tower). By selective breeding, characteristics may be modi-

fied, increased, or diminished, and there is evidence that such modifications are sometimes inherited. Thus Castle has shown that the extent of the pigmented area in rats may be varied in an inheritable fashion by selection of slight variations and, beginning with a scarcely recognizable trace of syndactylism, I have succeeded in getting very exaggerated forms of this condition. On the other hand attempts, in other cases, to increase or diminish characteristics (*i. e.*, certain color-characters) by selection have not yet met with success. This whole subject of the modifiability (and particularly the inheritable modifiability) of characters deserves thorough investigation. Here lies the crux of the controversy between the Darwinian "selectionists" and the De Vriesian mutationists.

Of great importance in this regard is the question whether the soma can modify the germ-plasm in a detailed way. Guthrie, two years ago, adduced evidence for this view, but his results have not been confirmed either subsequently in his own publications nor by Dr. Castle working with rats. We are making experiments with poultry that should test this doubtful matter thoroughly.

Meanwhile we are extending our knowledge of the extent of modification that characteristics undergo in nature, Drs. Harris and Shull and R. H. Johnson and W. L. Tower having obtained extensive series of data from various species of plants and insects. These studies, as well as those on selection, lend support, in many cases, to the view that natural characteristics in a state of nature undergo a progressive change in a definite direction. Evolution is proceeding in consequence of internal changes in the germ-plasm that are doubtless controlled by external conditions.

Extensive studies on the effect of external, particularly nutritive, conditions on the development of the form and structure of plants were begun by Dr. E. F. Transeau at this Station, but they have not yet been reported on. The results of starvation or semistarvation were very marked.

THE RELATIONS OF CHARACTERISTICS.

In any organism characters do not exist alone but are related to other characters and to the external world. This fact is the basis of the phenomena of correlation of characters and of the elimination of unfit characters by the selective annihilation of individuals carrying them. We have seen how the whites and the solid black of poultry make them conspicuous and especially liable to be killed by crows. Dr. Harris has published accounts of a series of observations directed toward determining whether the eliminated differ in a given particular from the surviving. The results are usually negative, for the characters considered.

This is, then, the situation in which this Station finds itself at the end of the first half-decade. The attack on the problem of the organic characteristic

is well begun. This attack is being made from six sides—the origination of the character, its chemical basis in the germ-plasm, its ontogenetic development, its modifiability, its transmissibility, and its relations to the other characters and to the external world.

CHANGES IN STAFF.

While stability in the resident staff is to be nominally sought for in dealing with problems involving the long-continued breeding of strains of animals and plants, yet a not unimportant part of the work of the Station must be for some years, until the work is more generally introduced into universities, to train young men for positions elsewhere. Dr. Lutz, resident investigator since the beginning of the Station, received and accepted, early in the calendar year, a call to the American Museum of Natural History in New York City, where he will take part in making collections and installing exhibits illustrating evolutionary principles. Owing to the proximity of Dr. Lutz in his new position to the Station, his experiments were continued here for several months under his supervision and, by agreement with the direction of the museum, his work on heredity of fruit-flies will be continued there.

The place vacated by Dr. Lutz has been filled by Dr. R. A. Gortner, referred to in the general part of this report, who will help answer some of the chemical questions that arise in all experiments on the heredity of color-characteristics. The vacancy made by the resignation of Mr. R. H. Johnson has been filled by the appointment of Dr. Arthur M. Banta, professor of biology at Marietta College, formerly a student of Prof. Carl H. Eigenmann, under whose stimulus he began and completed an extensive study of the "Fauna of Mayfield's Cave" (Publication No. 67 of the Carnegie Institution of Washington). Dr. Banta will, as stated above, devote himself to a study of the modifying influence of cave conditions upon organisms. Valuable results are to be anticipated from such an experimental study, since, in nature, cave life is associated with striking modifications, such as loss of pigment, loss of sight, and elongation of antennæ. Such studies were anticipated at the time the main building was erected but have hitherto not been carried on, awaiting the appearance of a properly equipped investigator.

DETAILED REPORTS ON SCIENTIFIC WORK.

WORK ON ANIMALS.

Poultry.—In this work 55 pens were maintained and 3,005 chicks hatched. One of the vivaria was used for indoor brooding with success. Four fireless brooders were purchased and found to be superior for our purpose over the heated brooders, while their care and expense of maintenance was much less. Two matings were made between white and pearl guinea-fowl. All offspring were of "pearl" color except that they were mottled with large white patches

on belly and primaries. This year the mottled birds were bred together and produced almost exactly one-fourth white birds. The black pigmentation is dominant over its absence, but in the heterozygote does not develop on the belly and the feathers of the extremity of the hand.

Finches.—The breeding of these birds was in some respects more successful than last year, 148 having been reared, an increase of 48 per cent. This success was chiefly due to a slight alteration of the heating system and better night firing.

Sheep and Goats.—Thirteen sheep and six goats were reared in the various matings. Cooperative work in sheep-breeding has been begun with the New Hampshire Agricultural Experiment Station.

Cats.—In October, 1908, a new cat-house of concrete blocks was erected, giving four compartments for breeding cats and four for mothers with young. The health of the cats was greatly improved, but they have shown a large degree of sterility in confinement. Nine young were born in the spring.

Insects.—Dr. Lutz reports as follows:

From September 1, 1908, to March 1, 1909, the work with *Drosophila* was continued along the same lines as in previous years. Considerable breeding was also done with *Gryllus,* in the greenhouse, in order to continue the long-winged strain brought from Mexico and to cross it with our native crickets. Having accepted a position with the American Museum of Natural History, the work with *Drosophila* has been continued there with some slight modification, and a report is now being prepared upon the greater part of it. Through the kindness of the Station the crickets were kept for me at Cold Spring Harbor until the middle of July, 1909. The strains are now being kept at the museum for use in future work, and it is hoped that a report upon the work done with them at the Station will be ready shortly.

WORK ON PLANTS.

Dr. Shull, upon his return from his European trip, continued his study of Mr. Burbank's horticultural methods and results, and in the limited time at his disposal at the Station continued the strains of plants upon which he has been at work for the last few years. He reports as follows:

In the pedigree studies of plants attention has been mainly given, as in the past several years, to the range of applicability of such recently developed conceptions of variation and heredity as are involved in the words "mutation," "biotype," "segregation," "unit-characters," "fluctuation," "regression," etc. The cultures have been in unusually good condition, except those of *Helianthus* and *Verbascum,* and a small portion of the *Lychnis* cultures which were taken to a plot of ground at some distance from the Station, which had not been sufficiently fertilized. The effect of this was that the branching which is being investigated in *Helianthus* was very much reduced, very few of the *Verbascums* reached maturity the first season, and the *Lychnis* remained small and bore relatively few flowers, so that the time within which observations could be made upon them was much limited.

The cultures of Indian corn were somewhat enlarged to allow a fuller test of the relative vigor of pure-bred types and their hybrids. The results have been consistent throughout, the self-fertilized families appearing to have reached a certain low state of vigor which is not further decreased by continued self-fertilization. Crossing between individuals belonging to a single pure type appears to give no advantage over self-fertilization, while all crosses between individuals belonging to distinct types are of superior vigor.

In Shirley poppies the color-characters have been followed through another generation and several of the unit-characters involved have been recognized. Several pedigrees have shown the segregation of the characters into homozygous types. Many crosses have been made in order to determine the composition of each type which has appeared, and especially to compare each with the wild type of *Papaver rhœas,* from which the Shirley poppies are reputed to have sprung.

The greatest amount of space and attention have been given to studies of heredity in *Lychnis alba,* largely with reference to problems of sex-determination and sex-heredity. The rare occurrence of hermaphrodite mutants in this usually dicœcious species has provided excellent material for the study of certain phases of the sex-problem. The great differences in the sex-ratios in different families and the usual excess of females over males present other problems of quite general interest and importance. Besides making observations on over 12,000 individuals of this species during the past season, more than 230 definite crosses have been made for the continuation of the work next year.

The comparative cultures of cross-fertilized and self-fertilized oenotheras have been continued and the tests of elementary species in *Lactuca canadensis, Erigeron ramosus,* and *Oenothera cruciata* have further demonstrated their permanence and distinctness.

A census of the cultures for the past season shows the following results:

	No. of pedigrees.	No. of individuals.		No. of pedigrees.	No. of individuals.
Chrysanthemum leucanthemum	1	10	Oenothera gigas	2	34
Erigeron ramosus	2	120	Oenothera lamarckiana	11	743
Helianthus annuus	29	2,039	Oenothera lata	1	47
Lactuca canadensis	5	447	Oenothera nanella	1	38
Lychnis alba	139	12,238	Oenothera rubrinervis	6	2,388
Lychnis chalcedonica	2	100	Oenothera scintillans	1	20
Lychnis haageana and varieties	6	301	Oenothera spp	2	32
Lychnis (Viscaria) splendens	1	55	Papaver rhœas	22	4,492
Nigella damascena	3	632	Verbascum blattaria	6	598
Oenothera cruciata	4	2,092	Verbena stricta	2	50
			Zea mays	41	4,000 (?)
			Total	287	30,476

Dr. J. Arthur Harris has had general oversight of the preceding cultures during Dr. Shull's absence. In addition to this work he has been making preliminary observations on species of Cucurbitaceæ, Passifloraceæ, Malvaceæ, and Solanaceæ, to determine their fitness for experimental work before serious and detailed studies are undertaken. He has also continued work along four other lines as follows:

Variation in Wild Plants.—During the year about the same progress was made in this work as reported in Year Book No. 7. Dr. Harris reports that the results of considerable of the work are nearly ready for publication.

Quantitative Investigations of Fertility and Fecundity in Plants.—The fitness of an organism to survive in the struggle for existence is of evolutionary significance only if it is also capable of leaving a sufficient number of descendants to give them an excess of weight in determining the characteristics of succeeding generations. This must be admitted, whether one holds that evolution is due to the accumulation of fluctuating variations or to mutations. Thus studies of fertility and fecundity are of cardinal importance in evolutionary investigations.

For some years past Dr. Harris has been accumulating extensive series of quantitative data on fertility in various wild and cultivated species. Some of the problems under consideration are:

The relationship between the degree of vegetative development and fertility and fecundity.
The correlation between the number of reproductive bodies formed and the number which develop to a stage in which they may function in propagation.
The correlation between somatic characters and fertility.
The relationship between symmetry in the fruit and fecundity.
Fertility and fecundity of homologous material under different environmental conditions.

Some of the results of these studies will be ready for publication shortly.

Investigations of Variation, Correlation, and Inheritance of Quantitative Characters in Garden Beans.—Dr. Harris's chief attention, since coming to the Station, has been given to quantitative investigation of variation, correlation, and inheritance of the minute differences commonly described as fluctuations, in several varieties of garden beans. The experiments are being carried out on an extensive scale in various habitats at the Station for Experimental Evolution, in eastern Kansas, the Missouri Botanical Garden, and southeastern Ohio. Some of the chief problems under consideration are:

The factors influencing the size of the bean seed.
A detailed investigation of the problem of pure-line inheritance, under various conditions and with several varieties.
The influence of the weight of the seed upon the characteristics of the plant developing from it.
The influence of environmental conditions upon the characteristics of individuals and their offspring.
The inheritance of fertility and fecundity.

This year the cultures were cut down to the lowest point possible to permit working up the large amount of material grown last year and to set time free for the larger experiments planned for 1911. About 15,000 individually recorded seeds were planted.

Studies in Vegetable Teratology.—In their bearing upon problems of mutation and fluctuating variation, series of teratological forms are of considerable interest. Experimental and statistical studies on proliferation of the fruit in *Passiflora* and *Capsicum,* and on seedling abnormalities in *Phaseolus* are being carried out by Dr. Harris. Extensive cultures of *Passiflora* and smaller series of *Capsicum* are being grown and their fruits dissected and classified. During the year about 40,000 bean seedlings were grown in the greenhouse to a sufficiently advanced stage of development to permit necessary determinations concerning abnormalities, and selected types have been transferred to the garden for inheritance studies.

CELL STUDIES IN HEREDITY.

These studies were continued by Miss Lutz, who reports as follows:

The work upon the somatic chromosomes of the oenotheras, begun in 1907 and reported upon in the two preceding Year Books, has been continued throughout the present season. As the problem requires a thorough knowledge of the vegetative characters and life-history of each individual plant, attention has been given exclusively to this study since the germination of the first seed and will be continued until the end of the flowering season. The winter months, as heretofore, will be devoted to the study of the chromosomes.

Of especial interest are the progeny derived from the artificial self-pollination of four offspring of *Oenothera lata* ♀ × *O. gigas* ♂, 1908. Of these, No. 3378, resembling *lata,* produced 12 offspring; No. 3368, resembling *gigas,* 52, and No. 3375, a plant with *gigas* number of chromosomes, but having some vegetative characters that resembled the female parent, 109. Five or six fixations of root-tips have been made, from each of these 173 plants for chromosome study; all have been carefully measured and described at regular intervals and many photographed in rosette and flowering stages.

Particular attention has been given to the F_1 offspring of *O. lamarckiana* ♀ × *O. gigas* ♂, derived from a single pair of pedigreed parents by means of guarded artificial cross-pollination. Each plant was also artificially self-fertilized and the offspring grown on either side of the hybrids in the garden for comparison with the latter (40 *lamarckiana,* 31 *gigas*). Observations were recorded in detail throughout the season, preservations made for bud, flower, and leaf measurements, and fixations for chromosome studies. Many also were photographed in various stages of development. Since *lamarckiana* is characterized by the presence of many basal branches (ordinarily 12 to 18, sometimes as many as 22) and *gigas* by their complete absence or presence in limited numbers (commonly not exceeding 3 in my cultures), this character became important in the study of inheritance among the progeny of this cross. Therefore 31 offspring were grown from seed of one artificially self-pollinated branched *gigas* having two basal branches and 31 from an unbranched individual.

Lata does not ordinarily mature pollen; but by opening several dozen buds daily for a week during the height of the flowering season enough pollen may occasionally be secured to artificially self-fertilize a flower. In this

manner seed was obtained during the summer of 1908 from 3 *latas* arising as mutants from pure-bred *lamarckiana;* these have produced respectively 73, 35, and 18 offspring during the season of 1909. (The same method was employed to secure fertilization of No. 3378 F_1 extracted *lata* derived from *O. lata* ♀ × *O. gigas* ♂, 1908, mentioned in the second paragraph of this report.) One individual from each of the three families has been artificially self-pollinated, and it is hoped that seed will be obtained for a second generation. Of equal interest is the cross between *O. lamarckiana* ♀ and *O. lata* ♂ (76 offspring) never before produced, so far as has been ascertained. The reciprocal cross (repeatedly grown at this station) was also included (45 offspring), but, owing to limitations of space and time for study, all of these two lots were discarded at the time of transplantation, except such mutants as were recognized among them.

All of the above-mentioned species, mutants, and hybrids have been the subject of individual daily study since germination and, as mentioned for the offspring of *O. lamarckiana* ♀ × *O. gigas* ♂, each has been carefully described at regular intervals throughout its life-history; leaves, buds, and flowers have been preserved for measurements, and (with the exception of a few recorded in the summary appended) five or six fixations of root-tips for chromosome study have been made from each of the above in early rosette stages.

The cross between *O. lata* ♀ and *O. gigas* ♂, studied in detail in 1908, was repeated to determine whether the offspring of a second cross would behave in general as did those of the previous season. 33 of the 71 plants under observation during early rosette stages were transplanted to the garden in May. No chromosome fixations were made.

The majority of the offspring of *O. lata* ♀ × *O. gigas* ♂ having shown themselves to be intermediate between the two parents, both in respect to external vegetative characters and number of chromosomes, I became interested in ascertaining whether two parents differing widely in number of chromosomes as do *lata* (15) and *gigas* (28–29 or 30) would not regularly produce intermediate offspring; also whether two parents having the same number of chromosomes, or differing in point of 1 (as *lata* 15, *lamarckiana* 14) might not produce, as a rule, only pure parental types among the offspring (exclusive of mutants), as had been demonstrated to be the case with *lata* ♀ × *lamarckiana* ♂. With this in view the following cultures were grown:

O. nanella ♀ × O. gigas ♂..... 90 offspring.
O. lamarckiana ♀ × O. gigas ♂.... 52 offspring.
O. nanella ♀ × O. lamarckiana ♂.. 134 offspring.

In addition to the above cultures 1 plant kept in sphagnum moss for two years was brought to maturity as a perfectly normal healthy *lamarckiana.*

Late in the summer young rosettes were found growing up from the roots of flowering F_1 offspring of *O. lata* ♀ × *O. gigas* ♂; one was removed from hybrid No. 3380, 2 from No. 3750, 4 from No. 3385, and 6 from No. 3372. These have been brought through the summer in excellent condition. An opportunity was here presented to observe the effect of external conditions upon the various cuttings taken from a single plant, with respect to bud-coloration, branching habits, size of adult plant, date of maturity, etc.

The following outline is added in conclusion to give a more concise idea of the investigations carried on during the season of 1909.

Culture.	Seeds sown.	No. of plants reared through early rosette stages.	No. of plants transferred to garden.	Date of transplantation.	No. of plants from which root-tip fixations were made for chromosome study.
O. lata (No. 3500), self-pollinated	Dec. 11, 1908	73	73	May 12, 1909	73
O. lata (No. 3527), self-pollinated	Do.	35	35	Do.	35
O. lata (No. 3571), self-pollinated	Do.	18	18	Do.	18
O. lamarckiana ♀ (No. 3814) × O. lata ♂ (No. 3500)	Do. / Feb. 1, 1909	76	8	May 13, 1909	8
O. lata ♀ (No 3500) × O. lamarckiana ♂ (No. 3814)	Dec. 12, 1909	45	3	May 12, 1909	31
O. lamarckiana ♀ (No. 3814), self-pollinated	Dec. 12, 1908 / Feb. 4, 1909	40	40	May 12, 13, 1909	5
O. gigas (No. 3672, basal branches), self-pollinated	Dec. 12, 1908	31	31	May 12, 1909	31
O. gigas (No. 3671), lacking basal branches, self-pollinated	Do.	31	31	Do.	31
O. lamarckiana ♀ (No. 3814) × O. gigas ♂ (No. 3672)	Dec. 14, 1908	52	52	Do.	52
O. lata ♀ (No. 3500) × O. gigas ♂ (No. 3672)	Do.	71	33	Do.	1
Lata-like (No. 3378) F_1 offspring O. lata ♀ × O. gigas ♂, 1908, self-pollinated	Dec. 12, 1908	12	12	Do.	12
Gigas-like (No. 3368) F_1 offspring O. lata ♀ × O. gigas ♂, 1908, self-pollinated	Dec. 14, 1908	52	52	Do.	52
—— (No. 3375) F_1 offspring O. lata ♀ × O. gigas ♂, 1908, self-pollinated	Do.	109	109	Do.	109
Intermediate (No. 3379) F_1 offspring O. lata ♀ × O. gigas ♂, 1908, self-pollinated	Dec. 15, 1908	8	8	Do.	8
Intermediate (No. 3750) F_1 offspring O. lata ♀ × O. gigas ♂, 1908, self-pollinated	Do.	3	3	Do.	3
O. nanella ♀ (No. 3704) × O. lamarckiana ♂ (No. 3796)	Mar. 1, 1909	134	134	May 13, 1909	0
O. nanella ♀ (No. 3704) × O. gigas ♂ (No. 3671)	Mar. 2, 1909	90	90	Do.	0
Lamarckiana (No. 1166) having remained in sphagnum moss as young rosette for 2 years	Feb. —, 1909	1	1	May 13, 1909	0
Cuttings from F_1 offspring O. lata ♀ × O. gigas ♂, 1908	.....	13	13	May 12, 1909	13
Biennials from 1908	.....	20	.....	.....	20
Total	.....	914	746	.....	502

HUMAN HEREDITY.

Although not strictly within the scope of experimental work, the necessity of applying the new knowledge of heredity to human affairs has been too evident to permit us to overlook it. For the last two years Mrs. Davenport and I have been collecting data on the inheritance of eye and hair characters. Last winter blanks for the record of family characters were prepared and distributed to the number of over 5,000 and over 250 of these have been returned. In many cases the greatest pains have evidently been taken to give full and accurate data. The reduction of these data will be begun at once. Only one character can be studied at a time and it will be at the best several years before all of the material can be utilized. Expectation is that it will eventually be possible, in the case of marriage of two individuals with the same characteristic or differing in respect to any characteristic, to state how the characteristic will be distributed among the children.

EQUIPMENT AND CONSTRUCTION.

During the spring the Department purchased Goose Island, one of the Norwalk Islands, belonging to the town of Westport and lying in Long Island Sound at a distance of 1.75 miles from the mainland, 0.5 mile from the nearest island of the group, Grassy Island. This island has the form of a crescent, the two arms of which at low tide partly inclose an admirable harbor whose shore is probably not less than 800 meters long. At high tide a grassy knoll is exposed, 200 meters long by about 30 meters wide at its widest part. This knoll is covered with a rich stony loam at least 1.3 meters deep, protected on all sides by a natural wall of stones, many of them nearly a meter in diameter. The northern part of the harbor has deep water, a bottom without rocks, and is well sheltered. The purchase will afford means of trying certain isolation experiments and of breeding some animals and plants under natural conditions without close confinement. In view of the distance of the island from the mainland and from the nearest island, and its position on the outer edge of the archipelago, it is well situated for the purpose. The principal difficulty to be anticipated is from trespassers. In the attempt to educate the public two large signs have been erected prohibiting trespassing. During the summer a list of the plants growing on the island was made by Dr. H. S. Conard and Messrs. H. H. York and Collins, and the animals were collected by students at the Biological Laboratory of the Brooklyn Institute. Among the animals the brown or Norway rat is very common and easily trapped. A small brown snake (*Storeria dekayi*), allied to the garter snakes, was found on the island. This snake can live for several hours on sea-water and probably swam from the mainland. No toads were found on the island, which contains no fresh water.

During the year the following pieces of work were finished by the constructor, Mr. Frank Allen: The cat-house, retaining-wall around shop, manufacture of additional cold-frames, stone steps on terrace from laboratory to residence, shed for wood-saw, concrete bridge on service road over ravine.

The Station launch *Eva* being too slow, small, and old for our purposes, it was sold and a 34-foot boat, the *Beagle,* with a 2-cylinder engine was purchased at a slightly higher price than that obtained from the sale of the old boat.

MAINTENANCE.

The source of our irrigation supply from Mr. Townsend Jones's spring was enlarged and improved, and the bed of the ravine was cobblestoned to prevent wear and conserve water. During the spring shrubbery was placed along the road to cut off automobile dust, electric connection with the buildings was made by an overhead wire (replacing underground cables), a burglar-alarm system was installed on the poultry plant, and an improved rack made in the shed for holding lumber.