GENETIC LAWS APPLIED.

Q. I. SIMPSON and J. P. SIMPSON, M. D., *Palmer, Ill.*

As Gallileo, Kepler, and Newton discovered laws that are since used for the accurate determination of celestial phenomena, likewise Mendel and other investigators have disclosed laws for genetic transmission.

These laws were uncovered by hybrid experiment; and the writers' insatiate desire for immediate utilization in the application to divergent individuals, inside pure breeds, is the apology for this title.

Volumes I, II, III, and IV of American Breeders' Association reports have articles relating to these laws, and repetition will only be made here for the sake of lucidity.

These laws were first observed in color principally; but Castle, with hair length, ear length and hair follicle in guinea pig and rabbit; Spillman, with form type in wheat hybrids and horn and hornless in cattle; Emerson with short and long bean stalks, and ourselves with strongly contrasted types of nose and ear, and of fine and coarse hair, and pigment pattern in swine, have demonstrated the laws' application to every detail in the building of plant and animal. So that we may now say that astronomical law is no more universal than are these laws of genetics.

To predict with accuracy, the planetary bodies must be carefully weighed, and to breed scientifically the units must be determined, and their value as to dominant, recessive or blended inheritance be ascertained.

Unfortunately, the Mendel laws have been designated as proving the purity of the "germ cell," which is misleading; and has discouraged experimenters, by their productions not agreeing with this misconception.

With a clear understanding of Mendel's laws, and their action, we may be prepared for observation of character units.

It is known that in double sexed animals and plants one-half of the primitive cell is from the father, the other half from the mother. All transmissible characters must be contained in one or both halves of the embryonic cell; and the authority of cytologists is against a character occurring from other sources, except where the combination of opposing characters exhibits a modified or invented form, or by chemical synthesis, creates new character.

It is now established by hybrid experimenters that character units may go through hybrid conjugation and reparate in next generation

clean from stain, and as with chemicals, we may judge the resublimed characters as being indivisible units of heredity.

In chemical analysis the chemist must not only recognize the inorganic base; but must be familiar with its compounds. So in analysis, for fundamental units we must detect the contaminating element that appears to stain the character.

Before entering further into detail, we had best make plain the supposed system of sexual transmission, as accepted by cytologists. This disproves the "purity of germ cell" heredity; but admits the purity of chromosome transmission, even after conjugation with an unlike character. It is known by investigators of plant and animal cells, that there exists a fixed number of rod-like forms in the body cells and in the first cell of the embryo. In many mammals, the number of these rod-like forms (named chromosomes) in a cell is sixteen. The ovum cell, when budded off from an ovarian cell, has eight *pair* of chromosomes. The spermatocyte of the male, when budded off from testis, has also eight pair of these rods. Before the female's ovum can unite with the male's sperm there is a division at the apex of each pair of rods, and one half of each pair is thrown away, as witnessed in the extrusion of the polar body. The spermatocyte, with its eight pair of rods, before it can fertilize the ovum, also splits into halves—making two spermatozoa—each of which as in the prepared ovum has now but eight chromosomes, proving them and the ovum to be each exactly a half normal body cell. In the V-shaped double chromosomes of whole cell ovum and whole cell sperm, the V is split in half at the apex—one-half of each being *thrown* away in the ovum, and one half *laid* away in the sperm for the making of another spermatozoön.

In the formation of the primitive cell for the little offspring, the half cell of male unites with a half cell of female joining each half chromosome of male to each half chromosome of female, making this new primitive cell contain exactly eight pair of chromosomes—the half of each pair furnished to it by each parent.

We will try to show the application of this phenomena to character pairs and half-pair characters.

Every *fixed* character, such as white or black, horn or polled must be governed by a *pair* of determiners (chromosomes if you like), then the sexual mating of two individuals of identical characters can only reproduce identical characters, and can not throw sports or variation. Many characters will *exhibit* when only one of its pair of determiners is in the cell; and all Mendelian *dominant* characters exhibit when only a *half* pair determiner is in the cell.

Each *recessive* color, form or other unit must have *both* halves of its determiner to cause it to exhibit.

To make plain, we will now cite some instances from our own experiments. We take a boar and sow, both clean white, and but for a medium length nose, would pass for pure Yorkshires. We mate this clean white pair, and get with every four pigs, three whites and one clean red. This pair of hogs were sired by a long nosed pure red Tamworth, of pure and fixed character pairs in all the chromosomes. The dam of this pair was a pure, typical pug nosed white Yorkshire. The white of the Yorkshire was completely dominant over the red, and the nose length character of the Yorkshire was neither dominant nor recessive, but blended—causing the nose length to be an exact blend between long nosed Tamworth and short nosed Yorkshire. Now when these white with blended nose hybrids are mated *sorofeat*, the progeny will be of various combinations that indicate to us the unit separation in heredity of nose length and color, that tell us that these two characters are carried through the cells in separate vehicles. Among this sorofrat litter of complex hybrid pigs may be one clean white with long Tamworth nose, one white with blended nose length, one white with pug nose, one clean red with pug nose, one red with blended nose or one red with long nose. White in this case was dominant, red recessive, and nose character blended.

The knowledge of color heredity in pure short-horn cattle is now perhaps established, and it is known that a roan is a chromosome hybrid of red and white, and of blended inheritance. And two roans conjugated should produce one white, one red, and two roan, among four offspring. This has also been proved by Cruickshank's herd record. (*Breeder's Gazette*, November 25, '08.)

Many bay horses are color hybrids in their productive cells, and all will recall that sorrel colts many times result from the union of two bays. When this occurs it is proof that each bay is a color hybrid, because it is known that a sorrel must be sorrel in both chromosomes before it can exhibit, for it is a *recessive* character. One-half of this determiner must have been contributed by each parent, but in each parent it had been resting in their cells as a latent element.

Within the memory of middle-aged men, there were brought from England to the central west some stallions of a breed called Cleveland Bays, whose keepers guaranteed (by gift of service in default) that they would sire only bays, regardless of the mare's color. Their knowledge though accurate was empirical; but we now have scientific explanation. It is now believed that any pair of *sorrel* horses can only produce

sorrel offspring, because every sorrel is absolutely color pure in color determiner—even though both its parents were bays.

The gray color in horses seems to dominate the other half pair chromosome lying with it in same cell, and ourselves would doubt the authenticity of a pedigree for a gray horse that had neither parent gray: This being true any gray horse of *fixed* heredity should produce only gray offspring.

We have fairly authentic record of a white jack (perhaps an albino sport) that sired only white mules and white jack stock.

In swine we have made a hundred breeding experiments, testing and proving the purity in transmittal of unit color character, pattern, and exaggerated form type, so that now we can state absolutely, that *all characters of fixed breeds are governed by two half determiners* that can be separated by hybridization and in next generation be recombined as before.

Unit inheritance can best be discovered by hybridizing distinct types; but when found can then be applied inside a single breed. If the various units are known we may breed for type, for show, for matched pairs, milking quality, speed, butcher form, size or fecundity. In fact every desired type, form and function may be obtained and perpetuated when the unit characters and their appearance with antagonistic units are known to be either dominant, recessive, or blended.

"Hereditary qualities must be carried by the chromosomes," says Wilson, in *The Cell*, page 185.

Where the grandparents are not akin two progeny from same loin and womb, in fact from same litter, may not be akin in every part of their inheritance; and our observation of results from complex hybrids proves this.

A half determiner for a recessive unit may lie unexhibited through several generations and again exhibit somatically when it happens to pair with any opposing character of less dominant potential, as in our results of clean white pigs from black Poland males out of dark red-roan Tam-York sows of complex hybrid make-up. Blended inheritance is of two classes, viz: in exhibit only and in both exhibit and germ; the latter an inseparable amalgam—the classes of which may be easily distinguished in their next generation. Both classes are of value to breed improvement and we may in one instance require the first and in another case desire the amalgamated form.

Dominant inheritance has only *equal breed value* with pure *recessive* inheritance but surmounts the latter when only an individual is desired.

Hybrid experimenters may forget that first cross hybrids contain *exactly equal amount* in productive germs from *each parent* regardless of dominant or recessive exhibit, the proof of which is always clearly established by pairing the hybrid with a third contrasted breed, when the offsprings will be exactly of two distinct hybrid types.

The genetic mechanism of a pure breed cannot be unlike a hybrid; and this law may be applied in the selection of a pure-bred for pure propagation; the moral is that both parents of an individual should be inspected before its breeding qualities are accepted.

Recessive units cannot exhibit unless *both* halves of its determiner are in the cells—unless its half determiner can meet with a less potential opposing character—except in a few cases where hybridizing appears to raise its heredity potential by rejuvenation of chromosome activity.

Our experiments with eleven swine breeds indicate that *first hybrids* are always *uniform* in type, of better growth, and of greater vigor; but three-quarter hybrids are uneven and of various types, but among them we may find characters of value.

Hybridizing is perhaps *the only way* to rapidly form new or more desirable breeds and our own immature experiments are indicating that new and useful types produced by hybridization may be rapidly and knowingly fixed: so that their units may have the same stability as in the oldest breeds and this conception of genetics indicate that a compound hybrid may have units as indelible as the buffalo or wild boar—the only requisite is, *both halves of its determiner must be present*. Men with empirical knowledge fixed breed types by long and incestuous inbreeding, but Castle or Spillman will tell you how, with four or less generations, and give you rules for proving its fixity.

Hybridizing compares with the chemist's analytical laboratory and is the only way by which units of heredity may be learned.

The observation of generative and body cells by cytologists agree with these laws, which would scarcely be accepted without this technical confirmation by the microscope.

Dr. C. C. Guthrie from this university (Columbia, Mo.) is transplanting ovaries from hens of one breed into hens of another and successfully making breed tests by their progeny; that will silence the dogma of acquired inheritance.

Mossom Boyd of our hybrid committee with man-made Angus and Hereford has dehorned and face-washed the Creator's buffalo, and the writers have obliterated all but the bristles from the wild boar of sixty centuries with two generations of new breed hybrids, thereby deadening the dogma of old-breed potential.

Charles Darwin found the kinship of the organic world, and even the horsebreeder awaits with impatience the result of breed experiment in potato bug and Kansas grasshopper, while Castle's twenty inbred generations of vinegar flies simulates the fate of the Bates short horn.

The guesses of Aristotle are being replaced by the laws of causation.

We are nearing the dawn of genetic science and let us utilize its light while approaching.

PRELIMINARY REPORT OF THE CHAIRMAN OF THE COMMITTEE ON BREEDING NUT AND FOREST TREES.

BY GEO. B. SUDWORTH, *Washington, D. C.*

The report, this year, of the Chairman of the Committee on Breeding of Nut and Forest Trees must be largely an apology for studies either not begun or only partly completed. A complete survey and summary was presented at the Association's last meeting in Washington, of what has been accomplished in the past regarding the betterment of commercially useful forest and nut trees. It was hoped that upon the basis of certain conclusions brought out in this last year's study of published results, several lines of investigation could be gotten under way, and at least a tentative report of progress presented at this session's meeting. Practically, however, no time has been afforded in advance of this meeting, in which to formulate and to assign for study the suggestive topics already in hand.

Delay in getting the year's studies shaped up was largely due to the difficulty in settling upon a chairman for the committee on tree breeding, made necessary by the regretted retirement from that office of the previous year's chairman, Mr. Gifford Pinchot, whose onerous official duties at Washington made it impossible for him to longer serve as chairman.

THE PRESENT FIELD OF INVESTIGATION

Unlike the many herbaceous agricultural and garden plants, which yield comparatively immediate results under breeding experiments, forest trees will require a much longer term of years in which to determine the exact influence of pure breeding experiments. This view, at the outset, compels a division of the field of investigation into two parts:

First, lines of study which will yield the most immediate results; second, lines of study which, from the nature of things, can yield results only after a longer term of years.