The case of the chrysanthemum and of the apple have been cited as exceptions to this rule of compensation. But there are evidently correlations "indiscernible," and others not necessarily of a nature to militate against the value of the plant for special purposes. Thus when we want apples we are ready to sacrifice the shading quality of tree, etc.

CONCLUSIONS.

Compensation tends to conserve the type.

There is a point in selective variation beyond which it is not desirable to push: when reversion threatens.

The potentialities of the stock regulate the possibilities of the product; and neither hybridizing nor selection adds appreciably to the fund of potentiality. Selection modifies the interchange of potentialities, and hybridization introduces new combinations which likewise interchange.

THE BACTERIAL SEMBLANCE OF THE CHROMOSOMES.

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We assume that the chromosomes are specific, self-propagating entities, independent of their colony and cell, except as regards nutrition and environment, and the perpetuity of their host—of which they are the builders!

Just as metazoan ontogeny is a true but broken history of phylogeny down to an amœba, sexual fertilization seems to carry the orders further down to the cystless colonies of primitive life—the uncelled group of male and female chromosomes loosely floating in the sea of nutrient. Some cytologists believe that "each chromosome of the colony conjugates with an individual of the other colony"; then fusion occurs, and by enzymatic, catalytic, chemical cleavage they seem to build their first habitat—the primitive cell of man or of monad.

We are assuming that each univalent in heterozygote, as well as each pair in homozygous, is of specific race; that these special breeds of chromosomes have a partly independent enzymatic action; that the various univalent or various like pairs in the one-cell colony are of different life cycles, and series of youth, adolescence and old age in their genetic term of potential, like the baker's yeast germ, or bacteria in diseases that lose their virulence through attenuation of the specific organism. Thus constant inbreeding of the chromosomes from the

blastomere to the developed embryo might, with the modification of cell position and other environment, account for differentiation of their cell host. This specific "running out" could account for the various differences in senility of cells at average maturity, i. e., that the specific bone-making chromosomes reach senility years ahead of pigment formers, etc.

It seems to supply the wherefore of sexual conjugation of the productive cells by starting all of the chromosome colony again on the equal footing of rejuvenated youth after lying dormant in the germ cells of the two animals.

Given the semblance of bacteria, and the varied-breed supposition like the *prodigiosus*, lactic and *beggiatoa* germs as illustration, occupying one cell, it could admit the climatic variation of Tower and the chemical variants of McDougall, for each species is differently potentialized by nutriment and differently attenuated by adverse environment. The elusive smallpox bacterium does not lose its reproductive power in the cow, but does lose its toxicity, which it may regain in the human host by a series of "arm to arm" vaccinations. Many bacteria, like the hog-cholera bacilli, are enzymatically attenuated by heat. And Dr. G. T. Moore, by gradually reducing the nitrogenous nutrient, bred the alfalfa bacteria to flourish in nitrogen-free water-glass solution.

Chittenden is requiring that the nuclei for organic growth be specific proteins to produce metabolism. You have them in the various bacteria for precipitating sulphur, iron, lime, and various carbohydrates, even for manufacturing pigment—the *Micrococcus prodigiosus* forming an intensely blood-red coloration in starchy foods, and another making black. In fact, bacteria are found outside of animal and plant bodies that may, it seems, actuate any and all the metabolisms required to build a biologic structure.

That something builds cells, we must admit; and that cells build higher organisms is known. Houses are built from bricks, and bricks must be manufactured. These cell bricks were perhaps first discovered by Hooke, in 1665; but applied as units by Schwan in the last century.

It is now so universally known that animal and plant are built from cells, and the bibliography is so extensive, that we will not discuss them; but we should try to discover the cell builders. The Hertwigs, Wilson and most cytologists, and Chittenden as chemist, are decided that the nucleus is the builder of cells. This nucleus

appears to be only a colony of something else—the chromosomes; so we may discuss these entities of the cell colony as the builders. But first let us view some completed structures. We find here one with white and black bricks; another with white and red bricks; still others all black, all white, or all red. Now perhaps all of the colony of chromosomes could work as a unit and build a kind of structure; but do they?

In the year 1865 a learned and inquiring Austrian monk (perhaps more deeply concerned in the labors of Darwin than for the futurity of his soul), working with peas of two or more contrasted, visible characters, had found by hybridizing and mating the hybrids, *inter se*, that their contrasted characters were units that did not correlate with other units of the same breed, but segregated, “heads or tails,” analytically. Now the chromosomes were not discovered until the eighties, and were first named as entities by Waldeyer in 1888, but have been seen by hundreds of observers since.

Mendel's paper was read at a meeting of the Brunn Society, March 8, 1865, and published in its proceedings; but lay unnoticed until the spring of 1900, when the three papers of De Vries, Correns, and Von Tschermak were published, stating again its substance. And, says Bateson, each of these three writers was able to confirm Mendel's conclusions from his own case.

At this time Spillman was developing these laws in wheat hybrids, and immediately following they were almost universally confirmed by Castle, Bateson, and others with animals.

We at Bear Creek Farm, isolated from seats of learning, did not hear of these laws until 1903, through an article by Castle. We had been making a variety of hybrid experiments with swine, using pedigreed animals of strongly contrasted visual features—partly for determining the economic value of their many mixtures, but chiefly to determine the then mooted question of sex potential in heredity. And Mendel's laws came to us like bright sunlight through a darkened sky, since we had a half hundred pig hybrids proving their truth and accuracy.

Now pardon us for a moment. When our bread was derived from the rearing of animals, and the more of it as these animals excelled; when all the statistics of the Mestons, the Galtons, and the Pearsons were proven *rotten* and twisted, because they did not consider the modifiers; when the only biological law then advanced—namely,

that "like begets like"—was proven a lie; when we knew that we had been floating on a sea of chance, can you imagine our ecstasy when we found a compass?

Bear with us yet a little farther. When with these laws we play with pedigreed life as one plays with building blocks; when, in our transference of the horns to or from a type or breed, we simulate the machinist, who transfers pieces of gear from implement to implement; when we may borrow a fancy stencil pattern that has used black pigment on a white field, and color thereon with red; when we can remove normal split hoofs from a normal breed type and place thereon solid mule hoofs; when we can borrow a fancy rolled tip ear from a low-standard hog and place it on another of more majestic mien; when in a series of analytical hybridizations we can detect contamination and name it, as does the chemist—thus taking our bearings at will through a knowledge of these laws, as does the mariner with the sextant, can you wonder at our enthusiasm and at our reverence for the memory of a departed monk?

Mendelians call for segregation, and Bateson last February (1909) gave a list of twenty-seven orders in plants and seventeen in animals that show by their contrasted characters in hybridization a segregation and non-correlation obeying Mendel's laws; and our own logically un-use their non-conformity as a means for impurity analysis.

Mendelism requires entities; if Mendelism is true, then there are entities. Two half nuclei could combine (which they do) and make a whole hog. A white with short nose combines with a red with long nose, the result being a white with medium nose; and the resulting F_2 litters show us that the two nuclei are not enough, for there are three noses on two colors and no correlation.

Then something of further division is required for the entity. There are centrosomes, but these are thought to be only centers of force; and they do not reproduce or divide by fission, nor does it appear that even the seed for these are brought in by the sperm.

Some cytologists and a noted embryologist have thought that the cytoplasm (which we consider the media, or cell nutrient) by its observed layers of differentiated substances might account for segregation; but we can not harmonize this with the clean-cut, specific segregation of unit characters observed in F_2 hybrids. Moreover, we find no exact and specific division of liquid chemicals save by septum osmosis, distillation, or precipitation. And who the precipitator? The

divorce of two or more characters from one subject and the separation of two or more characters from the other subject, as appearing in F_2 hybrids, show a "shuffling of entities like cards in a pack," that must have occurred before the male and female entities were conjugated.

Cytologists have not seen chromosomes shuffle, because they were always dead when observed; but McClung, by crossing two grasshoppers having different sized chromosomes, found both kinds in the hybrid; while Baumgartner, another Kansan, finds a great variation in size and number among nine species of crickets—constant in each for its species. Aside from this, aside from Mendelian requirement, Wilson's sex chromosome should silence all men for all time against the importance of chromosomes in genetics.

This "heads, I win; tails, you lose" shuffle at fertilization also proves segregation. And the exhibit of extracted recessives in F_2 hybrids we have found as pure as *C. P.* chemicals. This established condition of visible segregation upsets "mnemons," for we have by analytical breeding tests proven that the F_2 extracted, recessive reds from pure wild brown plus Tamworth red grandparents have forgotten that they owned two wild brown parents (in appearance) and two wild brown grandparents—forgotten it, both as to exhibit and germ test, throwing nothing but clean reds.

It seems we are so inflated with Ptolemaic systems, mnemons, pangens, acquired characters, telegonies, and preordinations that we cannot alight upon earth and view the simple, natural and known effects of earthly laws. Joe Wing, the word painter says: "The attic must be cleared of stale rubbish before it can hold truth." And it seems to us that Boveri was ripe for the birth of a true conception when, in 1888, he said: "The splitting of the chromosomes appears to be an independent, vital manifestation—an act of reproduction on the part of the chromosomes." But it seems that this was too simple for its time; for there were Darwin's gemmules, De Vries's million pangens, and Weismann's many ids, each with their thousands of biphores.

Dr. Riddle took a shot at the Ptolemaic gas bag and liberated a few million pangens by reducing feather barring to the simplicity of a child's squirt-gun. And Mendel turns "memory" "heads or tails." A few more shots, and Biology will descend to earth, where she must subject herself to the unromantic laws of the physicist, the chemist, and the gambler.

Let us segregate our biology from aeronautics. Dr. Lillie has truthfully said, in substance, that no genetic scheme can be recognized that does not meet the need in growth and development. And Tower will tell you, "it must obey evolution." So, all along, the different biological branches must be satisfied. We, as breed experimenters, the untutored onlookers, seeing only the outside of the completed structure, might also be appeased. If you will pardon the rude observers, we will take a peep in at the door of your work shops—the laboratories.

In metabolic growth, biological chemists ask for catalytic enzymes, but can furnish us with no reproducible inanimate element or compound. In cell manufacture, cytologists require a builder. In development, embryologists require cell differenters. Sexuality begs the cause for conjugal rejuvenation.

Experimental evolutionists ask reason for visual and genetic variation in climatic evolution; and the McDougall and the Stockard chemical variants and the Webber frost mutants are at issue.

Cancer, teratoma, and other abnormal supposedly non-microbial growths might be accounted for, while "mule hybrids" might also be explained. Mendelian hybrid experimenters are demanding several entities; and of the class that reproduce.

You men of technique and of research tell us that the animal is a colony of Protozoa, and with childhood innocence we ask, who their maker?

But let us not further try your patience. We assume that a chromosome is a form of bacterium; a real, self-breeding, self-propagating individual, whose evolutionary, genetic line has been handed down since he was a lonesome, homeless individual in the sea, long before the accidental bunching with kindred species could by their combined secretion and metabolism of their media form a cyst wall, or cell, to contain the colony.

Fertilization takes us to this cystless stage, just as embryology carries down to the monad. We are so familiar only with the pathogenic kinds that this bacterial idea strikes our minds with horror. Our studies in bacteriology have been limited, and for that reason not apt to acquire a bacterial hobby. However, we learn that in a great variety of media there is a great variety of bacteria, with a great variety of enzymatic actions. One makes red pigment in starch solution, another makes black, and yet another, white; some throw

down sulphur, which with other products would grow hair, hoof, and horn; some cause albumin to form in sheets, which with a lime phosphate would form bone. There is a world of unstudied, non-pathogenic bacteria, and we leave the subject here, only reminding you that some propagate by fission, as do chromosomes.

Now, if we can decide that the chromosomes are individual, self-producing entities, with the various attributes of bacteria, and can safely assume that in each cell colony there exist numerous distinct species with distinct catalytic action, and that they possess the further semblance of youth, potential and senility for their specific series of life cycles, may we not, with trophism, polarity, tropism, totipotence, and chemistry, picture the possibility of embryonic development from these means?

As Galtonians we viewed architecture from air ships; as breeders we look on from a neighboring hill.

Now pardon the impertinence while we consult the histologist and the chemist—the investigators of the “building bricks”—even of the buildings—for these bricks are automatons. Man thinks backwards, now not too far back. Let us start with glands. These secrete things. We had seen the paint and pattern “from the hill,” so we will ask you of pigment. Dahlgren and Kepner have investigated the ink factory of a squid, where the cells were over-specialized as pigment formers, making an abundance and storing it into a sack, so when there was danger from an enemy he could color the water. This was a pigment gland, a colony of extra-specialized pigment cells, for protective purpose—evolution. These histologists show how the pigment is made with a layer of cells containing chromosomes and they say the pigment was formed inside the cells; so says Ehrman also; and the chemist tells us there is not metabolism without a catalyser; then, who made the ink?

There are pigment cells that are also for protective purposes but not so greatly specialized—coloring only skin or hair or both; and Dr. Riddle found how barred bird-feathers were striped across by simple diurnal variation of blood pressure, which also applies to the barred hairs of the peccary, the raccoon, and the rabbit. Then with bacterial catalysers and some simple law we may paint Barred Rocks, guinea fowls, peccaries, and place the fancy pattern on the peacock's tail.

Our one deduction from the "hillside" is that the specific catalyzing entities shuffle "spades or diamonds" when there are two species or more in the germ cells, as in hybrids.

We have been making some observations in spots—belt patterns and stripes of pigment on swine, and black tongue and tail switch, and white tongue and tail switch, which always correlate in cattle. In the belt pattern the amount of pigment area on front and hinder ends also always correlate, and from this we are conceiving that the size of area is in direct ratio to the time genesis of the first pigment primordium. (Dr. Lillie has promised to direct some histological and embryonic work to confirm or refute this.) This pigment pattern, location and size of area, is proved "heads or tails" in hybrid heredity, hence determined by entities that shuffle. (See Castle's Dutch Pattern and Hooded.)

E. B. Wilson, the cautious cytologist, and T. H. Morgan, the world's greatest investigator in regeneration, think they are not agreed. The former shuffles the entities; the latter shuffles the things (that the entities must have built) by substituting a hypothesis of "transference of dominance" of the exhibited characters.

In going down the line of laboratories may we not try to harmonize their workers and make all of them preformationists, all epigenests, all vitalists, all materialists (you may have gleaned that ourselves have straddled). Let us again call the histologist for peace-maker. And the first fellow is the embryologist. We will talk to him of glands and he will remember that in the blastomere they are undeveloped, yet we must use the effect of glands to account for trophism (which we here mean as the effect of one thing on another). We will start with "hillside" histology and cite the effect of testes and ovarian glands on bovines. The farm boy can say if masculine, feminine, or neuter by viewing the horns; if hornless, then easily by the thickness of the neck, the bull being much thicker developed in the neck and horns than the steer or cow. Then these testes glands secrete something that aids nutrition? No, for the bull's hind quarters are lighter in weight than the steer's. Then this gland must secrete an enzyme or stimulant that aids differentiation by accelerating mitotic division in the front end and slowing down the same in the hinder end. Now recall that Dr. Moore bred down alfalfa bacteria in a few days and a few thousand generations, and that there were a great many thousand chromosome generations of fission and differentiation sepa-

rating at the blastula and widening to the front and hinder ends of the bull; then is it hard to account for the species change in the catalytic independence of these bacterial chromosomes that are accelerated in one family line and retarded in the other by the same secreted chemical flowing through the blood? That is the medium after septum-filtering for both sets of chromosome colonies.

Before leaving the glands we will mention the thyroid; that all of you are familiar with; and also speak of the largest gland of the body—the liver—whose function is the secretion of bile, which is a yellowish or greenish alkaline fluid that saponifies fat, hence aids digestion. We quote from Dahlgren and Kepner's *Histology* (1908): "The liver of *Cryptobranchus*. * * * These bile capillaries may have five or six surrounding cells or but two. Hepatic cells are cubic to polyhedral. Their faces approximate to form lumina or bile capillaries, these send *intra-cellular* branches *into* the cytoplasm of the cells * * * *Chromatin is very conspicuous in the nuclei.*" (Words potentialized by us.) A chemical cleavage of the blood lymph—catalytic enzymatic action of something—not an inanimate compound, for these cells are constantly degenerating and are constantly being reproduced, and chemists do not tell us of self-repeating chemicals, intra-cellular things inside the cells are the elaborators and the cell builders. But this last is not the special point to appease the embryologist. These hepatic cells by their internal secretions effect the nutrition and catalysis of all the other catalytic entities of all the other cells of the animal; and this is now the point—co-ordinating trophism—the relation of entity colony to entity colony. Let us visit with Morgan, the regenerator, who has also punctured the "Ptolemaic gas bag." He finds that if the first two cells of a blastomere are separated, they each make a complete individual (perhaps "identical twins" in man are caused by this); but if in the two-cell stage one is killed by a hot needle, then an imperfect, one-sided dwarf results. We think he states that in some orders even one cell of the eight-cell blastomere is capable of completing another animal; then here is the trophic effect of cell upon cell in differentiation. In the work of J. F. McClendon in the cell lineage of parasitic copepods, he first finds the differentiated primordium of the germ cells by its slow rate of division. He says: "In the thirty-two cell stage, one cell is the primary germ cell and it does not divide as soon as the other cells do, but grows larger than they do." This to us seems to be a slowing down of reproduction in the colony of catalytic entities.

Returning again to "hillside histology" we will quote a phenomenal case of seemingly enzymatic poisoning from chromosome "bacteria." This is given by our colleague on the hybridization committee. The Hon. Mossom Boyd of Bobcaygeon, Ontario, in American Breeders Association report, Volume 4, relating to service of an American bison bull on domestic cow. He impregnated 102 cows with the bison. Thirty-nine gave successful birth and 63 aborted. He had obtained the bison from a Mr. Winston in California, who had similar luck; and Mr. Boyd states: "It became apparent in the season of 1894 that the effect upon domestic cows of impregnation by the buffalo was almost without exception an abnormal secretion of the amniotic fluid; and to such an extent was this dropsical condition of the womb developed that it caused many abortions and deaths [the period averaged 178 days]. * * * There was no exception to this abnormal secretion. * * * Many of the cows which pulled through to the end [averaged 264 days] and produced healthy calves were thus afflicted almost to the same extent as those which succumbed, although the calves were not adversely affected."

We can assume safely that the only buffalo product remaining in the cows after fertilization was the microscopic half nuclei containing the half colony of spermatozoa-chromosomes; and this weight of strychnine could not produce death. Then could the effect be the accumulation of these buffalo chromosomes in their millions of mitotic generations in the hybrid embryo.

Lest some one might misunderstand our idea of chromosome and bacterium relation, we will explain that we do not assume that any loose bacterium, either pathogenic or non-pathogenic, that is now known is building plant and animal cells; but that the bacterial chromosome has the same relation to the floating kinds as have the individual cells of animal to protozoan or paramecium. And as evolution shows the connection of man and protozoa, so does the seemingly catalytic action of chromosomes agree with known bacteria.

In further explanation we hypothesize that the undifferentiated blood lymph flowing in like chemical homogeneity from the same heart in the same animal, and the cell sap arising from the same soil in the same plant, could not build up the many very differently constructed chemical cells out of the same media, or nutrition, without each form of cells containing therein a specific catalyzer. The present knowledge of the rapid mutability of bacterial species leads us to the

idea that the millions of bacterial chromosomes may go through species change in their genesis from the primordial embryo cell of the blastomere to the differentiated cells that are building bone, hoof, hair, and pigment. We further assert that the hormones and floating enzymes carried by the blood or sap are themselves products from these bacterial catalyzing chromosomes.

And the self-producing, fission-dividing of the chromosomes are counterpart to the reproduction of bacteria. They seem to obey the same laws of senility and rejuvenation and seem to further establish the generalization that all beings must be restored by conjugal mutuality as dying suns must meet catastrophe for the restoration of nebulous youth.

Spencer said, "The very conception of spontaneity is wholly incongruous with the conception of evolution." And it seems that evolution now awaits the combined reasoning of Chamberlin logicians and Chittenden chemists, not for the origin theory of the first paramécium but for the origin theory of the first bacterium. And until chemists tell us of self-perpetuating elements, we must bear the reproachable stigma of vitalists, for the chromosomes appear to us as bacteria, as vital beings.

NOTE.—When this paper was written, we had not recalled that many bacteria are capsulated. During the Omaha meeting Dr. Chas. E. M. Fischer wrote us that the pneumococcus and several other germs are sometimes encased.

In the discussion following the delivery, Dr. A. P. Condon stated that the bacillus causing gas gangrene many times is found with a capsule, and next day in his laboratory showed one of the writers these bacteria with a skin case on a fresh smear slide from a recent amputation. Some of the capsules were almost half as large as a normal somatic cell.

Bearing on the evolution side of this theory is an editorial in the Journal of the American Medical Association, December 18, 1909, commenting on Jensen's recent classification.

1. Bacteria which are like the green plants in requiring neither organic carbon nor organic nitrogen, * * * which possess the remarkable property of building up carbohydrates and protein out of carbon dioxide and inorganic salts.

2. Bacteria which need organic compounds, but can dispense with organic nitrogen. These can synthesize protein out of carbohydrates.

3. Bacteria which are like animals in requiring both organic carbon and organic nitrogen compounds.

The mode of nutrition of the first-mentioned group points to them as being in all probability the first living organisms to appear on the earth's surface. Both plants and animals originated from such a parent stock. Jensen's opinion being that the animals—Flagellates—were first to appear on the one side and the blue-green algae on the other.

[Presented by the Committee on Theoretical Research and Heredity.]