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# Chapter 9 — Mutations—The Discoveries of De Vries

from *The Truth About Heredity: A Concise Explanation of Heredity for the Layman* (1927)
by
William S. Sadler, M.D., F.A.C.S.



## Sources for Chapter 9, in the order in which they first appear

**(1)** J. Arthur Thomson, M.A., *Heredity* (New York: G. Putnam's Sons, 1908)

**(2)** Edwin Grant Conklin, "The Mechanism of Evolution," in *The Scientific Monthly* (May, 1920).

**(3)** Herbert Eugene Walter, *Genetics: An Introduction to the Study of Heredity* (New York: The Macmillan Company, 1913)

**(4)** G. Archdall Reid, M.B., F.R.S.E., *The Laws of Heredity* (New York: The Macmillan Company, 1910)

**(5)** Horatio Hackett Newman, *Readings in Evolution, Genetics, and Eugenics* (Chicago: The University of Chicago Press, 1921)

**(6)** Thomas Hunt Morgan, *The Physical Basis of Heredity* (Philadelphia: J. B. Lippincott Company, 1919)

**(7)** Reginald Crundall Punnett, F.R.S., *Mendelism* (Fifth Edition) (London: Macmillan & Co., 1919)

## Key

**(a)** Green indicates where a source author first appears, or where he/she reappears.

**(b)** Yellow highlights most parallelisms.

**(c)** Tan highlights parallelisms not occurring on the same row, or parallelisms separated by yellowed parallelisms.

**(d)** An underlined word or words indicates where the source and Sadler pointedly differ from one another.

**(e)** **Bold type indicates passages which Sadler copied verbatim, or nearly verbatim, from an uncited source.**

**(f)** Pink indicates passages where Sadler specifically shares his own experiences, opinions, advice, etc.

**(g)** Light blue indicates passages which strongly resemble something in the Urantia Book, or which allude to the Urantia phenomenon.

**(h)** Red indicates an obvious mistake, in most cases brought about by Sadler's miscopying or misunderstanding his source.

# IX: MUTATIONS—THE DISCOVERIES OF DE VRIES

III: HEREDITY AND VARIATION (Thomson 66)

§7. *De Vries on Fluctuations and Mutations.* (Thomson 90)

[contd] Professor Hugo de Vries is one of the foremost of Darwin's intellectual heirs, with a rich endowment of his insight and patience.... His "Mutation Theory" is certainly one of the greatest advances since Darwin's day (T 90).

9:0.1 The discoveries of Professor De Vries probably constitute, up to their time, the greatest biologic advance since Darwin's day.

[Since the publication in 1901 of deVries' great monograph on the "Mutation Theory" the superlative importance of mutations in evolution has been widely accepted (Conklin 590-91).]

His *Mutation Theory* was first published in 1901.

In 1886, De Vries began hunting about around Amsterdam for a plant which would show hints of being in what we may call a changeful mood.

9:0.2 In 1886 De Vries began to search around the city of Amsterdam for a plant which might exhibit moods of changefulness.

He tried over a hundred species, bringing them under cultivation,

After observing over a hundred different species,

but almost all were disappointingly conservative. It seemed as if most of the species around Amsterdam were in a non-mutable state (T 91).

and meeting only failure

In the course of his wanderings around Amsterdam, De Vries came across a deserted potato-field at Hilversum—a field of treasure for him. For there he found his long-looked-for mutable plant,

he finally discovered, in a deserted potato field, the phenomenon he had so eagerly searched for.

an evening primrose (Œnothera lamarck-iana).

It was the evening primrose,

| SOURCE | 9: THE TRUTH ABOUT HEREDITY |
|---|---|
| Like its nearest relatives, (Œnothera biennis and Œnothera muricata, which it excels in size and beauty of flowers, it probably came from America, where it is a native. | supposedly an American variety, |
| It had probably “escaped” at Hilversum about 1875, | which had escaped from cultivation and started its free growth about the year 1875, |
| and in the following ten years it had spread in hundreds over the field. It had been extremely prolific in its freedom, but that was not its chief interest. | and which had been so prolific that it had spread far and wide in the ten years of its freedom. |
| [It is possible, as Weismann suggested in one of his first evolutionary essays (1872), that in the life of species periods of constancy alternate with periods of changefulness (T 91).] | 9:0.3 It would seem that this plant had reached a time in its natural history for frolic and play. |
| Its chief interest was its changefulness. It had, so to speak, frolicked in its freedom. Almost all its organs were varying—as if swayed by a restless tide of life. | Almost every feature of this variety of primrose seemed to be in a state of fluctuation or variation. |
| It showed minute fluctuations from generation to generation; | Not only did there appear minute fluctuations from one generation to another, |
| it showed extraordinary freaks like fasciation and pitcher-forming; | but extraordinary freaks and sports were appearing in almost endless profusion. |
| it showed hesitancy as to how long it meant to live, for while the majority were biennial, many were annual, and a few were triennial; | Some were annual, others biennial, and even triennial. |
| best of all, it showed what can hardly be otherwise described than as new species in the making (T 91–92). | It seemed to De Vries that he was actually observing new species in the making. |

IV: MUTATION (Walter 56)

7. LAMARCK'S EVENING PRIMROSE (Walter 64)

He found that, out of 54,343 plants of the species *O. lamarckiana* grown during eight years,

9:0.4 He found that, out of 54,343 plants grown during eight years,

there appeared 837 mutants comprising seven different elementary species,

there appeared 837 mutants, comprising seven different elementary species,

all of which, with the exception of *O. scintillans,* bred true (W 65).

all of which, with the exception of one species, subsequently bred true.

9:0.5 And so, after observing the freakish behavior of this variety of primrose for a period, De Vries was led to espouse the doctrine of the sudden appearance of new species by mutation, and summed up his views in the following statement:

III: HEREDITY AND VARIATION (Thomson 66)

§7. *De Vries on Fluctuations and Mutations.* (Thomson 90)

" ... *The current belief assumes that species are slowly changed into new types. In contradiction to this conception the theory of mutation assumes that new species and varieties are produced from existing forms by sudden leaps.*

9:0.6 The current belief assumes that species are slowly changed into new types. In contradiction to this conception, the theory of mutation assumes that new species and varieties are produced from existing forms by sudden leaps.

*The parent-type itself remains unchanged throughout this process, and may repeatedly give birth to new forms.*

The parent type itself remains unchanged throughout this process, and may frequently give birth to new forms.

*These may arise simultaneously and in groups, or separately at more or less widely distant periods. . .*" (T 90).

These may arise simultaneously and in groups, or separately at more or less widely distant periods.

## VARIETIES OF SPECIES

IV: MUTATION (Walter 56)

4. KINDS OF MUTATION (Walter 59)

*Progressive* mutations are signalized by the addition of a new character to the sum of complex characters making up the individual (W 59).

9:1.1 Progressive mutants are those individuals which exhibit an addition of an apparent new character to the sum of previous inheritable characters which are characteristic of their species.

III: HEREDITY AND VARIATION (Thomson 66)

§7. *De Vries on Fluctuations and Mutations.* (Thomson 90)

**Retrograde Varieties.**—De Vries applies this term to those numerous forms which have thrown off some peculiarity characteristic of their ancestors.

A retrograde mutant would be one which has thrown off some special trait which was characteristic of its ancestors,

Retrograde varieties usually differ from their parent species by a single sharp character only,—they have lost pigment, or hairs, or spines, and so on;

and thus it differs from its parents by the absence of a single, sharply defined trait.

while elementary species are distinguished from their nearest allies in almost all organs (T 95).

9:1.2 It is clear that De Vries recognized the fact that some species are less stable than others in their genetic processes,

**Ever-sporting Varieties.**—De Vries uses this term to describe cases like the striped larkspur, which for centuries has gone on producing unstriped as well as striped flowers.

and he designated as "ever-sporting varieties"

those species which

"Its changes are limited to a rather narrow circle ... But within this circle it is always changing, from small stripes to broad streaks, and from them to pure colours..." (T 95-96).

show unusual variations or great range of variety within certain limits.

It is a fact that freaks and sports appear with greater frequency in certain species,

Plants with variegated leaves, with double flowers, with fasciated branches, with peloric flowers, and so on, often illustrate the "ever-sporting" tendency.

and illustrative of this sporting tendency is that group of plants which produce variegated leaves or double flowers;

such varieties are the common four-leaved clover,

the striped larkspur,

The common snapdragon (*Antirrhinum mains*) is a very good case,—the striped variety, for instance, cannot be fixed (T 95-96).

and the common snapdragon.

**Summary.—**De Vries has done great service in ... showing by historical research combined with experiment that many stable stocks of cultivated plants have arisen by mutation;

9:1.3 De Vries' experiments demonstrated the probability that many stable stocks of cultivated plants have arisen by mutation;

and by corroborating throughout the fundamental idea that

and he further gave abundant proof of the fundamental doctrine that,

"the characters of organisms are composed of units sharply distinguished from one another" (T 97-98).

"the characters of organisms are composed of units sharply distinguished from one another."

VI: RETROGRESSION (Reid 107)

9:1.4 It must be evident that

[Retrogression] furnishes a half of the sum of adaptation, leaving only the other half to the direct action of Natural Selection. *Yet all these great effects result solely because in every structure of every species the tendency to vary retrogressively is so much stronger than the tendency to vary progressively that retrogression is checked only by selection* (R 121-22).

the tendency to retrogression toward a more primitive type is more active than the tendency to progression toward new types;

[!]

but the selectionists get around this tendency by the doctrine of "adaptation" on the one hand, and the theory of natural selection on the other.

The tendency to retrogression is only one of the ways in which variability is regulated (R 122)

The selectionist looks upon reversion as one of the modes of regulating variation.

XXIV: THE MUTATION THEORY (Newman 346)

NEW SPECIES (MUTANTS) OF OENOTHERA [HUGO DE VRIES] (Newman 348)

9:1.5 De Vries tells of finding

[Besides the mutants just described there occurred two weak forms that could survive only if reared under protection and would have failed to survive in nature.

"two weak forms that could survive only if reared under protection and would have failed to survive in nature."

Here we have a place for the action of natural selection, but operating with mutations instead of with fluctuating variations....—ED.] (N 355)

Here we have a place for the action of natural selection, but operating with mutations instead of fluctuating variations.

## THE MUTATION THEORY

XX: MUTATION (Morgan 247)

9:2.1 One of the great objections which some biologists urge against the mutation theory is, not only that

[contd] Concerning the origin of the germinal differences that give rise to mutant characters very little is known at present except, (1) that they appear infrequently, (2) that the change is definite from the beginning, (3) that some of the changes at least are recurrent, and (4) that the difference between the old character and the new one is small in some cases and greater in others.

it appears so infrequently,

I do not think that any of the work purporting to produce specific mutational changes has succeeded in establishing its claims, at least in the sense that we can pretend at present to control the appearance of specific mutant changes ... (M 247).

but that experimentally very little has been done to develop the idea or bring about the production of mutants.

The impression prevails that mutation is less rare in some species than in others, and while I am inclined to think that this may be true, not much value can be ascribed to such impressions ... (M 247).

There is reason to believe that mutation is much more frequent in some species than in others,

but careful observations in the future will probably disclose the fact that

The discovery of new mutant types in almost every plant and animal that has been carefully examined indicates at least the very general occurrence of definite mutations ... (M 247).

these mutations occur in all species of both plants and animals.

One of the most interesting phenomena connected with mutation is the recurrence of the same change.... It is true that not all such appearances are to be accepted offhand as the first appearance of the mutative change, since when these are recessive it is probable in most cases that the actual mutation occurred several generations before the mutated genes came together to produce the mutant character (M 248).

We must always be careful not to confuse genuine mutations with phenomena of reversion to previous types.

9:2.2 Respecting the origin of these mutations in the germ plasm, little is actually known.

Obviously, not all such mutants can be due to the absence of a factor present in the germ-plasm of the wild type, since only one kind of absence is thinkable. If to save the situation for the theory of presence and absence it be assumed that only a part of the original gene is absent, and a different part in each case, then nothing is gained by the admission; and while this may be true it is equally possible that the genes change in other ways.

Attempts to explain mutations have been made on the "presence and absence" theory;

more recently on the theory that

It is not essential that we should specify the nature of the change, but simpler to look upon the mutant gene as due to some kind of change or changes that have taken place in the original germ-plasm at a specific locus ... (M 251).

the genes or factors of the germ plasm have been changed or modified, or combined in a new way, at some specific point in the chromosome—

that is a sort of anatomic-geographic hypothesis, and comparable in organic chemistry to the large number of isomeric (chemically identical, but physically different) compounds which may belong to a given group.

[Source?]

9:2.3 We know that white of egg, for instance, and rattlesnake venom are very similar in actual chemical composition, that they contain approximately the same number of atoms of the same elements, but they are structurally different—that is, they are put together differently; just as it might be possible to take, say ten thousand identical bricks, and build a hundred houses entirely different from the architectural standpoint.

9:2.4 And so an effort has been made to explain mutations on the theory that the genetic factors or hereditary genes (chromomeres) of the germ plasm may be subject to such combination, crossing, and recombination as involves their geographical whereabouts in the cell, as well as regards their actual association with one another in functionating groups.

9:2.5 *Mutations compared to radium.*

VI: THE CELLULAR BASIS OF EVOLUTION (Conklin 496)

3. *Changes in Genes* (Conklin 504)

(*e*) *Intrinsic Causes of Mutation.* (C 513)

Another hypothesis which is the result of a too extreme insistence on the intrinsic factor of mutation is found in the view that all mutations of genes are in the nature of losses or disintegrations more or less comparable to the disintegrations of the radium atom (C 514).

Again, the appearance of mutations may be found to be comparable to the physical and chemical behavior of radium,

which is an element behaving, as it were, according to a law of its own, as compared with the rest of the world. Spontaneous changes are going on in radium all the while.

Ordinarily, in chemistry, you can only get out of a chemical reaction the factors you put in, and this is true of the usual run of heredity; but in radium we do get out, including its emanations and the end products, something that apparently was not definitely present in the ancestral body at the start; and so the germ plasm which gives rise to mutations would seem to be a sort of biological radium—something unstable and able, apparently, to give rise to new genes, or to combinations of factors and chromomeres new to the species.

[?]

9:2.6 Some geneticists still doubt that mutations really occur, maintaining that these freaks and sports are due to segregation and recombination of old Mendelian units, rather than to the appearance of entirely new factors.

XXIV: THE MUTATION THEORY (Newman 346)

CRITICISMS (Newman 360)

[ ... B.M. Davis has succeeded in producing by crossing two American wild species a hybrid form distinctly resembling *Oenothera lamarckiana* in numerous respects ... —ED.] (N 360)

In fact, Davis has experimentally gone a considerable way toward reproducing a plant, after the order of De Vries' mutant;

but there still remains undisputed evidence of the existence of mutations, as shown in the animal world by the undoubted appearance of new species among the common fruit fly.

XX: MUTATION (Morgan 247)

It is true that of the twelve dominant mutants that have appeared in *Drosophila*

Of the twelve or more mutations which have appeared in this species,

it should be recorded that

each appeared at first in a single individual—never two—

in each case they have appeared in a single individual,

which might appear to favor the single locus view, but this evidence is too meagre to be significant (M 249).

then have subsequently bred true.

## BEHAVIOR OF MUTATIONS

VI: THE CELLULAR BASIS OF EVOLUTION (Conklin 496)

3. *Changes in Genes* (Conklin 504)

(*c*) *Mutation of Genes.* (C 508)

Mutants are in the main recessives when mated with their normal allelomorphs,

9:3.1 As a rule mutations prove to be "recessives" when mated with the normal individuals of their kind

but they are not always recessive as is claimed by Lotsy.

but this is not always so, as claimed by some;

and as shown by the fact that

Among more than 150 mutants which have appeared in Morgan's cultures of *Drosophila* 12 are dominant or semi-dominant.

out of 150 mutants in the fruit fly produced by Morgan, twelve are "dominant," or at least semi-dominant.

Besides this,

Many other dominant mutants are known such as abnormally short limbs, fingers and toes, supernumerary digits, hereditary cataract and other eye defects in man,

many other dominant forms of mutation are seen, such as abnormally short fingers, toes and limbs, extra fingers, hereditary cataract of the eye,

| | |
|---|---|
| hornlessness in cattle, rumplessness in poultry, red sunflowers, red buds in *Œnothera lamarckiana, mut, rubricalyx, et al.* (C 509). | as well as hornlessness in cattle, the red sunflower, etc. |
| | 9:3.2 It has seemed to us that |
| Morgan and his school have proved by genetical evidence that a particular gene may change in any one of several different ways, | Morgan has proved, by good and sufficient evidence, that a gene, or inheritance factor, may change in any one of several different directions. |
| probably owing to various changes in its composition. | |
| | For instance, he presents evidence that would lead us to believe that |
| Thus the gene for the normal red eye color may change so as to give rise to “blood,” “cherry,” “eosin,” “buff,” “tinged” or “white” eyes. | the factor for normal red eye color may undergo such changes as to give rise to cherry, blood, eosin, buff, or white eye. |
| Genes, or allelomorphs, that mutate in various directions give rise to what are known as “multiple allelomorphs”; | The genes (factors) that mutate in different directions probably do so by combinations known as “multiple factors,” |
| hypothetically | and, theoretically, |
| | it is thought, at least by some authorities, that |
| these may be explained as due to different changes, probably of a chemical nature, in a particular gene. | the underlying changes in the genes in such cases are probably of a chemical nature, |
| DeVries especially has long maintained that some genes are more “labile” than others, although more recent work on *Œnothera* indicates that | and more recent experiments tend to prove that |
| this so-called lability may be caused by crossing-over, at least in some instances (C 509-10). | this instability in the inheritance factors is greatly accentuated, at least in some instances, by the repeated crossing-over of the chromosomes, |

with consequent interchanging of chromomeres—as already described.

DeVries has observed the independent recurrence of the same mutation in different cultures of Œnothera, and other investigators have noted a similar phenomenon in other organisms; these are probably caused by identical changes in particular genes. The independent recurrence of a mutation

9:3.3 The observed tendency for mutation changes to recur independently when such changes are supposed to take place in an identical gene,

must indicate a tendency for a gene to change in a particular way

would suggest that some of these inheritance factors found in the chromosomes are predisposed, or more susceptible, to this sort of change;

just as chemical changes tend to go in certain directions.

just as we find that certain chemical combinations or reactions tend to take place in certain directions of predilection,

only in the latter case, we understand the chemical laws underlying this behavior, while in the case of the inheritance factors, we are quite ignorant of the exact reasons for the behavior observed.

A similar cause probably underlies

9:3.4 In all probability a similar explanation must lie at the base of

the tendency of organisms to evolve in definite directions—a phenomenon which has been called "orthogenesis" (Haacke, Eimer, Whitman)

orthogenesis—a phenomenon characterized by the supposed tendency of organisms continuously to evolve in a certain definite direction.

and which has been especially emphasized by paleontologists (C 510).

XX: MUTATION (Morgan 247)

9:3.5 *Suicidal inheritance factors.* It might be well, in this connection, to mention the fact that, under certain circumstances, the protoplasm of the germ cell gives rise to

The question of lethal genes has attracted in recent years increasing attention, both on account of their frequency and because of a curious complication they may produce in hiding the effects of other genes also present (M 254).

"lethal genes," or suicidal factors.

For instance,

The "yellow mouse case" is an example of a *zygotic lethal* effect. The gene that produces the dominant yellow color is lethal in double dose,

the gene that produces the dominant yellow color of the yellow mouse is suicidal when present in a double dose,

so that all homozygous yellow mice die,

so that all such yellow mice who have this factor from both sides of the house (who are homozygous) never live—they always die,

as Cuénot first discovered, and as has been more positively demonstrated by the work of Castle and Little.

as was conclusively shown by the painstaking work of Castle.

Little has also shown that black-eyed white mice carry a lethal, that acts in the same way.

9:3.6 Little also demonstrated that black-eyed white mice carry a fatal lethal gene that acts in this same peculiar way.

9:3.7 Morgan has shown that

In *Drosophila* there is a sex-linked recessive lethal factor that causes the development of tumors in the larvæ,

the fruit fly carries a sex-linked, recessive, suicidal factor that causes the development of tumors in the larval stage

destroying every male larva that contains the sex-chromosome carrying this gene (M 256).

which unfailingly destroy every male that contains the sex-chromosome which carries this ill-fated gene.

IV: MUTATION (Walter 56)

2. MUTATION AND FLUCTUATION (Walter 57)

| SOURCE | 9: THE TRUTH ABOUT HEREDITY |
|---|---|
| *The test comes in breeding,* | 9:3.8 The test, then, of a mutation, is its behavior when it comes to breeding. |
| for the progeny of a fluctuation will vary around the old average of the parental generation, | The offspring of a mere "fluctuation" will vary around the old average of its ancestors; |
| while the progeny of a mutation will vary around a new average, set by the mutation itself (W 57). | while the progeny of a "mutation" will vary around a new average—an average set by the mutation itself. |

3. FREAKS (Walter 58)

| SOURCE | 9: THE TRUTH ABOUT HEREDITY |
|---|---|
| [contd] A further distinction should be made between mutations and so-called freaks or monstrosities, | 9:3.9 A further distinction should be made between the real mutations and so-called freaks, or monstrosities, |
| namely, that the former breed true, while the latter do not. | in that the former breed true while the latter do not. |
| A human physical deformity, such as a club-foot, for example, or a humped back, is not a mutation, | For instance, in the human species, the clubbed foot or humped back is not a mutation, |
| because it does not reappear as a heritable character. | because it does not reappear as a heritable character. |
| Variations of this kind are not pre-determined in the germplasm, | Variations of this sort are not due to any change in the germ plasm, |
| but are <u>usually</u> instances of something that went wrong during the development of the individual somatoplasm (W 58). | but are <u>invariably</u> the result of errors in early embryonic development. |

## THE MUTATION CYCLE

9. POSSIBLE EXPLANATIONS OF MUTATION (Walter 69)

It has been suggested by Standfuss that species may go through the same kind of a life-cycle that individuals do,

9:4.1 It has been suggested by Standfuss that species may go through something like the same sort of a life-cycle that individuals do,

only taking infinitely more time to do it.

only of course, taking infinitely more time in doing so.

As shown in Figure 32, they are born of other species and enter the prodigious growth period of infancy and youth,

This idea suggests that a species, when young—soon after it is born—enters upon a period of prodigious growth.

both of which are characterized by much fluctuation.

This period of infancy and youth is supposed to be characterized by much fluctuation.

With maturity they gradually become comparatively stable until the reproductive period is reached, when they throw off their progeny, as on a tangent.

With maturity the organisms gradually become more stable and settled until the reproductive period is reached, when they throw off their progeny.

They ultimately enter the more highly organized and settled adult stage,

They finally pass into the excessively differentiated period of old age, from which there is no recall,

followed by old age, from which there is no recall,

although they approach in many features the infantile condition, and end in death or extinction (W 70).

even though in some ways they may stimulate the infantile condition, they soon terminate in death or by extinction.

[Compare 9:12.3.]

9:4.2 There is further evidence, when we come to study the fossils of extinct species, which would point to the fact that in times past species have passed through this fantastic stage, characterized by the tendency toward excessive mutation, as evidenced by the large number of dissimilar specimens to be found among the discovered remains of numerous extinct species.

9:4.3 Now, the period for the abundant production of mutations would compare with

| SOURCE | 9: THE TRUTH ABOUT HEREDITY |
| --- | --- |
| The reproductive period of a species when mutants are being thrown off, as of an individual, | the reproductive phase in the life-cycle of a species; |
| | and of course, |
| may extend over a considerable period of the whole cycle, | might extend over a considerable period of the whole cycle, |
| or it may be confined to a relatively small segment. | or might be confined to one that was relatively small. |
| It is possible that in the evening primrose de Vries may have caught a plant passing through the crucial period of species-reproduction (W 71). | And who knows but that De Vries caught his evening primrose at a time when that plant may have been passing through this interesting adolescent period of species reproduction, |
| | and was, therefore, able to secure a large number of stable mutants? |

## PROBABLE NATURE OF MUTATIONS

9:5.1 There is some reason to believe that mutations may possibly originate in the chemical composition of the germ plasm, but more particularly the chemical composition of the chromatin or chromomere—the ultimate factors (genes) of inheritance.

9:5.2 Only recently has scientific investigation been turned toward the origin of mutations. Formerly it was supposed that all these variations, of whatever sort, originated as the result of changes in the external environment. In other words, formerly, mutations were more or less confused with fluctuations.

[?]

[*Compare:* Although abnormality in chromosome number is found in some mutants it is by no means certain that this abnormal number is the cause of mutation and there are some good evidences that it is not (Conklin 502).]

9:5.3 It is doubtful if mutations are in any way connected with an alteration in the number of chromosomes,

though there is no way of positively knowing that they are not directly due to certain changes in the chromomeres—as already suggested.

One thing is sure in mutations, whatever the changes are, there results a new arrangement in the hereditary factors, due either to chemical, combinational, or geographic alterations in the relationship of these inheritance factors. Whether the actual results are achieved through a loss, a gain or through new combination—is not definitely known.

VI: THE CELLULAR BASIS OF EVOLUTION (Conklin 496)

3. *Changes in Genes* (Conklin 504)

(*e*) *Intrinsic Causes of Mutation.* (C 513)

9:5.4 In most of the mutations studied by De Vries, Bateson, and Morgan, it would appear that

[S]ince regressive mutations, in which some dominant character becomes recessive, are much more numerous than progressive ones,

they were of the regressive variety;

that is, some trait or character was dropped out, or some factor was divided and part of it was lost, and thus changes were brought about in this way rather than by the addition of new factors,

it was suggested by Shull, Bateson and Davenport that evolution might be due to the loss or disintegration of factors or genes.... Bateson (1914) ... proposed ... in his well-known inquiry

and this has led to the pertinent inquiry as to

"whether the course of evolution can at all reasonably be represented as an unpacking of an original complex, which contained within itself the whole range of diversity which living things present";

"whether the course of evolution can at all reasonably be represented as an unpacking of an original complex which contained within itself the whole range of diversity which living things present."

and in the same category is the speculation by Davenport that "the foundations of the organic world were laid when a tremendously complex molecule, capable of splitting up into a vast number of simpler molecules, was evolved" (C 514).

[*Compare:* The original life plasm of an evolutionary world must contain the full potential for all future developmental variations and for all subsequent evolutionary changes and modifications (36:2.10).]

## EXTERNAL AND INTERNAL INFLUENCES

9:6.1 Other investigators have studied the possible source of mutation under two heads, as follows:

VI: THE CELLULAR BASIS OF EVOLUTION (Conklin 496)

3. *Changes in Genes* (Conklin 504)

9:6.2 1. *External causes (alleged) of mutation.*

(*d*) *Extrinsic Causes of Mutation.* (C 511)

Under this head may be noted

[contd] Various changes in the chemical and physical environment produce abnormalities in the number, distribution and constitution of chromosomes,

possible changes in the chemical and physical environment which might result in altering the number, distribution, or constitution of the chromosomes,

as was pointed out on a previous page,

and it is not antecedently improbable that such environmental changes may produce similar modifications in genes themselves (C 511).

ultimately producing analogous changes even in the genes (chromomeres) themselves.

It is doubtful if there exists experimental evidence in proof of this assumption,

One of the first instances of the supposed experimental production of a mutation was described by MacDougal in 1905. He reported that

though MacDougal did report that

he had injected various solutions, particularly zinc sulphate in different concentrations, into the ovaries of a species of *Œnothera* (*Raimannia*) and had obtained as many as 13 different mutants (C 511).

he had experimentally produced a series of thirteen mutants by injecting zinc sulphate into the ovary of a certain species,

These results have not been confirmed by other workers and the evidence seems to favor the view that

but it seems to be the opinion of other observers that

MacDougal was dealing with a naturally mutating stock and that the mutants were not caused by the experimental conditions (C 511).

this investigator was dealing with an already mutating stock.

[contd] Tower (1906) carried on extensive and prolonged studies on the evolution of the potato beetle, *Leptinotarsa,* and concluded that he had induced mutations in this form by changes in humidity and temperature acting upon the germ cells at a sensitive stage in their genesis,

9:6.3 Tower claims that he was able to produce mutations in the potato bug by exposing the germ plasm to alterations of temperature and humidity.

presumably by causing mutations in the genes.

This investigator supposed that he was in this way influencing the genes, or inheritance factors;

But in this case also it is not certain that the mutations observed were actually caused by the experimental treatment and there are many reasons for concluding that they were not (C 511).

but again there is no way of absolutely knowing whether or not the observed mutations were actually caused by the experimental treatment.

[Compare C 512.]

It is a fact that the vast majority of supposed mutants of this sort do not breed true.

XXIV: THE MUTATION THEORY (Newman 346)

CAUSES OF MUTATIONS (Newman 360)

[ ... **Gager discovered that the action of radium rays on the pollen grains of various plants had a profound effect on the chromatin.**

9:6.4 **Gager discovered that "the action of radium rays on the pollen grains of various plants had a profound effect upon the chromatin.**

**Some of the latter was apparently lost during mitotic cell division.**

**Some of the latter was apparently lost during cell division."**

**The same writer exposed the ovules of plants to radium rays and produced marked changes in the germ cells so that**

**The same writer exposed the ovules of plants to radium rays and produced marked changes in the germ cells so that**

**they grew into various stunted and otherwise abnormal plants, some of which bred true for several generations...** —ED.] (N 361)

**they "grew into various stunted and otherwise abnormal plants, some of which bred true for several generations."**

VI: THE CELLULAR BASIS OF EVOLUTION (Conklin 496)

3. *Changes in Genes* (Conklin 504)

9:6.5 2. *Internal causes of mutations.*

(*e*) *Intrinsic Causes of Mutation.* (C 513)

The failure to find definite extrinsic causes of mutation

The failure definitely to prove the influence of external causes in the origin of mutations,

has led certain students of the subject to conclude that all changes in the genes are due to intrinsic causes.

has led most students to suspect these origins in causes which are internal—

that is, located in the germ plasm,

[See 9:2.5, above.]

and, as already suggested,

| SOURCE | 9: THE TRUTH ABOUT HEREDITY |
|---|---|
| The gene has been compared to the radium atom | the genes (chromomeres) or inheritance factors have been compared with radium, |
| which undergoes disintegration wholly uninfluenced by temperature or other physical or chemical conditions. | which undergoes changes quite uninfluenced by temperature, or any other physical or chemical condition. |
| But, as has been indicated, the gene is not an atom but at the very least an extremely complex molecule | The inheritance factor is, of course, probably, not an atom, but more likely an extremely complex molecule, |
| | when considered from the chemical standpoint, |
| and it is incredible that it should be wholly removed from environmental influences, | and it is only reasonable to suppose that it would be subject to numerous influences concerned in its innermost environment, |
| since this is true of no other molecule or group of molecules (C 513). | as would any other organic molecule. |
| | 9:6.6 But the difficulty is that |
| [contd] We have no more direct knowledge regarding the intrinsic causes of mutation than concerning the extrinsic ones | we have but little more real evidence going to substantiate our theories of the internal causes of mutation than we have of the supposed external causes. |
| and yet we may safely assume that certain general principles which apply to visible portions of the organism are true of invisible genes. | |
| | The only theory that seems entirely plausible, respecting internal influence, would be the conclusion which might be reached by reasoning from analogy. That is, since in the case of the organism as a whole we know that |
| As development or any physiological process is the response of an organism to various stimuli, | both development and physiologic processes in general are the result of reaction to numerous stimuli, |

so we may assume that mutations also represent the response of the hereditary organization to certain stimuli;

we might with some degree of logic assume that mutations might also represent the response of this delicate and innermost hereditary organism to the presence of ever-varying stimuli;

and just as the nature of any response is primarily determined by the nature of the organism while the stimuli serve merely to initiate, hasten or retard the response,

and, just as the organism as a whole may be stimulated or retarded in its reactions by the nature of the stimuli,

so the nature of a mutation is probably definitely limited by the organization of the germplasm while its extrinsic causes serve only to initiate or retard it.

so possibly may these inheritance factors also be accelerated, retarded, or otherwise modified, by their reaction to the various chemical and physical stimuli which may surround them.

9:6.7 Darwin, it would seem, was sagacious enough to recognize this possibility even in his day,

With true insight Charles Darwin wrote many years ago:

when he said,

Although every variation is either directly or indirectly caused by some change in the surrounding conditions, we must never forget that the nature of the organization which is acted on essentially governs the result (C 513).

"Although every variation is either directly or indirectly caused by some change in the surrounding conditions, we must never forget that the nature of the organization which is acted on essentially governs the result."

XXIV: THE MUTATION THEORY (Newman 346)

CAUSES OF MUTATIONS (Newman 360)

**"There is a limited amount of evidence which indicates that groups of species have arisen by progressive alterations in chromosome number.**

9:6.8 **There is a limited amount of evidence which indicates that groups of species have arisen by progressive alterations in chromosome number.**

**Thus in *Drosophila,* Metz has found ten species in which the chromosome numbers range from 6 to 12**

**Thus, in Drosophila, Metz has found ten species in which the chromosome numbers range from 6 to 12,**

and the larger numbers appear to have arisen by the subdivision of the large dumbbell-shaped chromosomes found in this species having smaller numbers...” (N 363).

and the “larger numbers appear to have arisen by subdivision of the large, dumbbell-shaped chromosomes found in the species having smaller numbers.”

## MUTATION STILL A MYSTERY

VI: THE CELLULAR BASIS OF EVOLUTION (Conklin 496)

3. *Changes in Genes* (Conklin 504)

(*e*) *Intrinsic Causes of Mutation.* (C 513)

Mutations can not therefore take place in all conceivable directions,

9:7.1 Mutations, it should be observed, do not take place in purely random directions.

They follow some general law.

“Whales never produce feathers, nor birds whale bone,” said Huxley;

As Huxley said, “Whales never produce feathers, nor birds whalebone”;

and while we see endless change in flower coloring,

and probably no one ever really saw a green horse or a purple cow (C 513).

we don’t find purple horses or green cows.

IV: MUTATION (Walter 56)

9. POSSIBLE EXPLANATIONS OF MUTATION (Walter 69)

A further suggestion in connection with the possible sources of mutation is that mutations may be the results of hybridization,

9:7.2 Mutation, of course, has been explained on the ground of pure and simple hybridization,

and in such cases is supposed to be

appearing as Mendelian recessives after crossing.

the reappearance of Mendelian recessive traits, as the result of crossing.

As a matter of fact, Sprengel's *Chelidonium lacinatium*, already cited, when crossed with *Chelidonium majus*, behaves according to such an expectation (W 71).

And while these mutations appear to behave after the order of Mendelian inheritance,

nevertheless they represent a form of variation which must be studied and explained as things separate and apart from all other forms of fluctuation.

VI: THE CELLULAR BASIS OF EVOLUTION (Conklin 496)

3. *Changes in Genes* (Conklin 504)

(*e*) *Intrinsic Causes of Mutation.* (C 513)

9:7.3 Whatever the opinions of the various schools of thought respecting the origin of mutations,

In conclusion we find that it is impossible to avoid the conviction that the initial stages in evolution are caused by

we can hardly avoid the conviction that their explanation is to be found in

alterations of chromosomes,

new combinations of chromosomes, chromomeres, genes or subgenes,

with consequent new combinations in the genes or subgenes (chromomeres),

if such a supposition is admissible.

9:7.4 It is relatively unimportant whether

and that these new combinations take place in response to stimuli from the external or internal environment (C 515).

these new combinations or alterations take place in response to stimuli which may be external or internal.

The difficulties of experimentation along these lines are obvious.

| SOURCE | 9: THE TRUTH ABOUT HEREDITY |
| --- | --- |
| Germs cells are so complex and are so delicately adjusted and balanced that | The delicacy of the germ plasm |
| they can not usually be greatly changed without rendering them incapable of continued life (C 515). | does not lend itself readily to extensive experimental manipulation, |
| [*Compare:* Experimentalists have aimed to produce changes in germ cells or embryos which could be seen with the microscope, but it will be necessary to produce more subtle changes in the germplasm if we are to determine their effects on succeeding generations (C 515).] | and the whole field is one that is so minute that it is almost ultramicroscopic. |
| The mystery of mysteries in evolution is how germplasm ever became so complex as it is, | The ultracomplexity and delicacy of the germ plasm is the mystery of mysteries in heredity, |
| so well adapted to give rise to viable organisms, so filled with the marvellous potencies of development (C 515). | |
| The future may show us methods of modifying the germplasm, more delicate and effective than any that have been discovered as yet, and when that time goes, if it ever comes, a real experimental evolution will be possible (C 515). | and the hope of the future is that we may discover more refined and delicate methods of experimentation; |
| | for, as one writer has said, |
| The greatest problem which confronts us is no longer the mechanism of evolution but the evolution of this mechanism. | "The greatest problem which confronts us is no longer the mechanism of evolution but the evolution of this mechanism. |
| This problem has been shifted from the developed organism to the germplasm, but has not been solved (C 515). | The problem has been shifted from the developed organism to the germ plasm, but has not been solved." |

## MODERN BIOLOGIC THEORIES

III: HEREDITY AND VARIATION (Thomson 66)

§6. *Discontinuous Variations.* (Thomson 82)

**Historical Note.**—The idea that organic changes might come about by leaps and bounds

9:8.1 The idea that biologic variations occur suddenly—by leaps and bounds—

instead of by the selection of smaller variations over a long period of time,

is not novel,

was not entirely new

though the evidence substantiating it is quite modern (T 83).

even at the time it was espoused and so forcefully promulgated by De Vries.

But the modern appreciation of the importance and frequency of discontinuous variations is mainly due to Bateson, who, in his *Materials for the Study of Variation* (1894), gave many instances of the sudden appearance of offspring which in some particular diverge widely and abruptly from their parents ... (T 83).

9:8.2 After all, it was probably Bateson (1894) who gave the mutation theory its firmest setting in relation to the larger problems of genetics.

[See T 594, re Johannsen's 1930 study of plant heredity.]

And it was about this same time that Johannsen began to recognize the appearance of *individual* new departures as a starting point for subsequent stable "pure lines" of inheritance.

Mr. Bateson (1905, p. 577) notes that Marchant in 1719 was the earliest to comment on the suggestiveness of sudden changes,

9:8.3 According to Bateson, Marchant (1719) was the first observer to advance this theory of the brusque and sudden behavior of nature in the production of variations or new species, such as he saw in plants of *Mercurialis* with laciniated and hair like leaves which for a time established themselves in his garden. He suggested that species may arise in like manner."

which has now crystalized itself into the modern Mutation Theory;

Though the same conclusion has appeared inevitable to many, including authorities of very diverse experience, such as Huxley, Virchow, F. Galton,

although Huxley, Virchow, Galton, and even Darwin have, to a certain extent, recognized the possibility of these mutational or so-called "discontinuous" variations.

it has been strenuously resisted by the bulk of scientific opinion, especially in England (T 85).

Darwin also recognised that big steps may be taken suddenly—

9:8.4 Darwin clearly recognized this sort of variation,

*e.g.* in the origin of the large-crested Polish fowls and short-legged Ancon sheep,

as illustrated by the short-legged Ancon sheep,

but he thought that these discontinuous variations occurred rarely,

but he thought such abruptly appearing variations rarely occurred,

and would be liable to be swamped by intercrossing (T 83).

and that they would soon be wiped out by interbreeding.

This phenomenon did not seem overly to impress Darwin. His mind seemed to be occupied with and bent upon just one thing, viz., the overthrow of the idea of the origin of species by a distinct and special act of creation for each species.

IV: MUTATION (Walter 56)

1. THE MUTATION THEORY (Walter 56)

It remained for the Dutch botanist Hugo de Vries to analyze the character of mutations.

9:8.5 So it remained for the Dutch botanist, Hugo de Vries to marshal the evidence in support of the mutation doctrine,

[D]e Vries worked in silence for twenty years before he gave to the world the "Mutationstheorie" with which his name will forever be connected (W 56).

and in more recent times the theory has come to be generally known by his name.

[*Compare:* It is also noteworthy that, while the majority of zoologists disbelieve in modification-inheritance, the reverse seems to be the case with botanists (Thomson 194).]

In this connection we should say that mutation was generally and eagerly accepted by the botanist; but the zoologists have been slower to enthuse over the doctrine that species could in this way be so fully and suddenly produced,

but they have gradually come around to this viewpoint.

9:8.6 No one today, for a moment, doubts the fact that new species in both plants and animals originate from time to time. In fact, even in our own day and generation, such things have happened. The thing which is in dispute is not the fact of evolution, but the method.

[*Compare:* In modern phraseology, the occurrence of variations is a fact of life so general that we must replace the adage "Like begets like"

While it is known in general that like begets like,

with the more cautious statement "Like tends to beget like" (Thomson 74).]

yet occasionally like begets unlike,

a diverse individual appears, and such a unique individual sometimes becomes the founder of a new biologic line—a new species or race of plants or animals.

9:8.7 There are, then, three distinct views of the origin of species:

1. The so-called Darwinian, which seeks to account for the development of new species by

[*Compare:* **A New View of Evolution.** —As is well known, Darwin believed that specific differences and adaptations were slowly brought about by the consistent selection of small continuous variations in a profitable direction....

Over and over again, both before and after Darwin, naturalists had suggested that sudden emergences of new structures with no small degree of completeness ... must be of evolutionary importance (Thomson 370).] [See UB 58:6.3-4.]

the natural selection of small and continuous variations over a long period of time.

2. The doctrine of the sudden appearance of new species—of their springing full-fledged into existence, and this teaching is in turn divided into two groups, as follows:

[See UB 58:6.3-4.]

a. The special creation doctrine—the teaching that not only life, but its various specie manifestations, had origin in a special and supernatural act of creation.

[See UB 58:6.3-4.]

b. The mutation theory—the doctrine of the spontaneous and spectacular appearance of a new species as the result of certain changes in the hereditary factors of the germ plasm,

[Compare Newman 13.]

as foreshadowed by Aristotle,

more recently promulgated by De Vries, and later espoused by Bateson.

# PLANT MUTATIONS

IV: MUTATION (Walter 56)

6. PLANT MUTATIONS FOUND IN NATURE (Walter 63)

The oldest known authenticated case of a plant mutation is the often cited instance of the "fringed celandine," *Chelidonium laciniatum,*

9:9.1 The oldest known authentic case of plant mutation is that of the fringed celandine,

which made its appearance in the garden of the Heidelberg apothecary Sprengel in 1590 among plants of the "greater celandine," *Chelidonium majus.*

which was observed in 1590, in the garden of the Heidelberg apothecary, Sprengel.

The fringed celandine bred true at once and is now a widespread and well-known species.

This fringed variety of the species has ever since bred true, and is now both well known and widespread.

The purple beech has appeared historically as a mutant among ordinary beeches upon at least three occasions in widely separated localities,

9:9.2 The purple beech has appeared within historic times, and in three widely separated localities,

and it has always given rise to a constant progeny.

and has, in each instance, given rise to new and constant offspring.

The "Shirley poppy," notable for its remarkable range of color, of which in turn produce double flowers.

9:9.3 The Shirley poppy, well known from its unusual range of color,

originated from a single plant of the small red poppy, *Papaver rhœas,* which is commonly found in English cornfields.

sprang up as a mutant from a single plant of the small red poppy so common in English fields. (See Fig. 17.)

Instances are known of double flowers among roses, azaleas, stocks, carnations, primroses, petunias, etc.,

9:9.4 A further instance of mutants will be recalled as the case of double flowers among roses, azaleas, carnations, primroses, etc.,

arising from single flowering plants, the seeds of which in turn produce double flowers (W 63).

which arise before one's eyes from single flowering plants, whose seeds in turn unfailingly produce double flowers.

V: REVERSION AND ALLIED PHENOMENA (Thomson 119)

§8. *Reversion of Retrogressive Varieties* (Thomson 138)

Sometimes, however, the apparently lost ancestral character re-appears, as when the smooth nectarine, a "variety" of peach, becomes downy ... (T 135-36).

9:9.5 The case of the smooth-skinned peach—the nectarine—is a sport which sprang from an ordinary peach tree,

and is a typical example of mutation,

and further, the nectarine is probably a classical example of a regressive mutant—that is, one appearing as the result of the loss of a simple Mendelian factor which is responsible for producing the fuzz (down) on the fruit.

VIII: WILD FORMS AND DOMESTIC VARIETIES (Punnett 74)

One of the best pedigreed of all sports is the "cretin" sweet-pea,

9:9.6 But perhaps the best authenticated of all the sports is the "Cretin" sweet pea,

a monstrous form so called from its fancied resemblance to a gaping mouth with a protruding tongue (cf. Fig. 17).

a monstrous variety, so named from its fancied resemblance to the gaping mouth and protruding tongue of the Cretin.

It appeared suddenly in a large family belonging to a strain in which thousands of normal individuals had been accurately recorded over a period of several years.

This mutation appeared suddenly, among a large family of more than a thousand normal individuals that had been carefully observed for several years.

From its first appearance it behaved as a simple recessive to the normal form, and has continued to do so ever since.

From its first appearance it appeared to be recessive to the normal form, and has since continued such behavior.

It had more than 200 normal sisters, of which none that were tested threw any cretins (P 79).

Of more than two hundred normal sisters of those tested, none bred any of the Cretin type.

| | |
|---|---|
| | 9:9.7 It would rather seem that |
| In respect of the evolution of its now multitudinous varieties, the story of the sweet-pea is clear and straightforward. These have all arisen from the wild by a process of continuous loss. | the whole evolution of the vast sweet pea family has proceeded directly from the wild ancestor by a process of repeated and continuous loss of inheritance factors. |
| | It would seem that |
| Everything was there in the beginning, | everything found in any of the plants was there at the beginning, |
| and as the wild plant parted with factor after factor | but as the wild plant has, from time to time, parted with factor after factor, |
| there came into being the long series of derived forms. | there resulted this long series of new forms or mutant species; |
| | and well may we wonder whether the whole process of modern civilization is analogous— |
| Exquisite as are the results of civilisation, it is by the degradation of the wild that they have been brought about (P 81). | that we apparently advance by the successive loss of something which our primitive ancestors possessed. |
| IV: MUTATION (Walter 56) | |
| 7. LAMARCK'S EVENING PRIMROSE (Walter 64) | |
| The mutant *gigas* occurred once, in 1895. | 9:9.8 In 1895 a mutant gigas appeared, |
| From the seeds of this one plant were produced 450 true *gigas* offspring in the first year, | and from the seed of this one plant, 450 offspring breeding true were produced in the first year, |
| and the strain continues to breed true (W 65). | and ever since the strain has continued to breed true. |

| SOURCE | 9: THE TRUTH ABOUT HEREDITY |
| --- | --- |
| [See W 66-67.] | 9:9.9 De Vries had a wonderful experience with his seven elementary species of the primrose, the details of which space forbids our entering into. |
| | It should be explained, however, that |
| De Vries' experiments and observations have been repeated on a large scale and extended, notably by MacDougal in the New York Botanical Gardens | his experiments have been repeated, on a larger scale, by MacDougal of the New York Botanical Gardens, |
| and by Shull at the Carnegie Institution for Experimental Evolution, Cold Spring Harbor, Long Island, | and by Schull at the Carnegie Institution at Cold Spring Harbor, Long Island, |
| and his conclusions have been confirmed in all essential points (W 67). | and that both these investigators have verified his conclusions in all essential points. |
| A parallel case of a plant caught in the act of giving rise to mutations is that of the roadside weed Lychnis, reported by Shull, | 9:9.10 Schull has also called attention to the frequency with which the common roadside weed, lichnis, is characterized by mutations. |
| and the phenomenon is probably by no means as unusual as is generally believed (W 67). | |
| Mutations are doubtless much more common than has been generally supposed, and it is likely that they will receive more attention in the future than they have in the past (W 67). | Mutations are probably far more common than has formerly been supposed, |

The chief reason why such definite examples of mutation are so infrequently noted and recorded is because the attention of the investigator has generally been directed, not to them, but to gradual fluctuating variations which, according to Darwin's conception, furnish the material for the operation of natural selection (W 67).

but they have not been looked for.

XX: MUTATION (Morgan 247)

In plants the best evidence is that reported by Emerson for Indian corn.

Perhaps the best and most recent evidence of mutation in plants is that of Indian corn reported by Emerson,

Emerson has shown that when a race of corn (*Zea mais*) having red cobs and red seeds is crossed to a race having white cobs and white seeds only,

and having to do with the behavior of species with red cobs and red seeds when crossed with white cobs and white seeds,

it being observed that

the two original combinations appear in the second ($F_2$) generation giving plants with red cobs and red seeds and plants with white cobs and white seeds.... Now striped seeds with white cobs sometimes mutate to red seeds and red cobs.

striped seeds with white cobs sometimes mutate to red seeds and red cobs,

The new combination (red and red) acts as a unit toward the other combinations.

and this form seems to act as a stable unit toward all other combinations.

Therefore a single factor must have changed, for, if not, mutation must occur in two (or more) closely linked factors, *i.e.,* for seed and cob color at the same time, which is highly improbable (M 249).

## MUTATIONS AMONG ANIMALS

IV: MUTATION (Walter 56)

8. SOME MUTATIONS AMONG ANIMALS (Walter 67)

| SOURCE | 9: THE TRUTH ABOUT HEREDITY |
|---|---|
| [contd] In 1791 a Massachusetts farmer, by name Seth Wright, found in his flock of sheep a male lamb with long, sagging back and short, bent legs | 9:10.1 In 1791 Seth Wright, a Massachusetts farmer, found among his flock of sheep a male lamb with a long, sagging back, and short, bent legs, |
| resembling somewhat a German dachs-hund. | whose general appearance much resem-bled a German dachshund. |
| With unusual foresight he carefully brought up this strange lamb because it was an animal that could not jump fences. | This freakish lamb was carefully reared, |
| It occurred to this hard-headed Yankee that | and it occurred to this sagacious Yankee farmer that, |
| | since this short-legged lamb could not so easily jump a fence, |
| it would be much easier to get together a flock of short, bow-legged sheep, unable to negotiate anything but a low hurdle, | it would be highly economical to try to get together a whole flock of such short-legged sheep, |
| than to labor hard at building high fences. | rather than to spend so much time and money building high fences; |
| So it came about that this mutating lamb, | and so it came to pass that this wee mutant lamb, |
| in the hands of a man who appreciated labor-saving devices, | in the hands of the long-headed farmer, |
| became the ancestor of the Ancon breed of sheep. | became the ancestor of that vast Ancon breed of sheep; |
| Later on this breed gave place in public favor to another mutant, the Merino, | and at a latter date even this desirable breed gave place to another mutant, the Merino, |

| SOURCE | 9: THE TRUTH ABOUT HEREDITY |
|---|---|
| which produces a superior grade of wool (W 67-68). | one more desirable because of the fact that it produces a superior grade of wool. (See Fig. 17.) |
| [contd] Hornless cattle suffer fewer injuries from one another than horned cattle. | 9:10.2 Owing to the fact that hornless cattle do not so frequently injure one another, |
| It has consequently become quite a general practice among farmers to “dehorn” their stock surgically. | in the recent past it became quite a general practice among the farmers to dehorn their cattle by surgical procedure. |
| It is an obvious advantage to have cattle born hornless, | It is clear that it would be a great advantage if cattle could be born without horns, |
| and many breeds having this character are now established. | and this desirability has led to the establishing a number of breeds of hornless cattle. |
| | This came about after the following fashion: |
| In 1889 a mutant among horned stock appeared at Atchison, Kansas, | In 1889, a hornless mutant appeared among the horned stock of a farmer near Atchison, Kansas. |
| in the form of a hornless Hereford. | This hornless freak belonged to the Hereford species, |
| From this mutant has descended the well-established race of polled Hereford cattle, | and from the mutant has since sprung the whole vast race of Polled Hereford cattle, |
| constituting a bovine aristocracy with registry books and blue blood all their own (W 68). | which has grown into a sort of bovine aristocracy, with registered pedigrees and a blue-blooded, silk-stockinged standing all of its own. (See Fig. 17.) |
| [contd] Taillessness in cats, dogs and poultry, as well as hairlessness in cattle, dogs, mice and horses, | 9:10.3 Taillessness in dogs and cats and poultry, as well as hairlessness in cattle, dogs, mice, and horses, |
| | which subsequently bred true, |
| are further instances of mutations (W 68). | are further instances of mutations. |

Bateson (1894), in his "Materials for the Study of Variation," gives a detailed list of 886 cases of "discontinuous variations" among animals, many of which doubtless belong to the category of mutations,

9:10.4 Bateson gives a detailed list of 886 cases of "discontinuous variations" among animals, many of which doubtless belong to the category of mutations,

although several must be placed in the non-inheritable class of freaks (W 69).

although several must be placed in the nonheritable class of freaks.

VIII: THE MUTATION THEORY (Thomson 169)

**The only mutation, human or other, if mutation it can be called, known to have been persistent under natural conditions for a considerable length of time, of which I am aware, is the Hapsburg lip, an ungainly feature of the reigning house of Austria.**

9:10.5 **The only human mutation, if mutation it can be called, known to have been persistent under natural conditions for a considerable length of time, of which I am aware, is the Hapsburg lip, an ungainly feature of the recent reigning house of Austria.**

I imagine it would have disappeared long ago if the faces it marred had not belonged to an inbred imperial family (R 181, fn).

## INHERITANCE OF MUTATIONS

VIII: THE MUTATION THEORY (Reid 169)

**" ... Of the inheritance of mutations there is no doubt.**

9:11.1 **Of the inheritance of mutations there is no doubt.**

**Of the transmission of fluctuations there is no very strong evidence.**

**Of the transmission of mere fluctuations there is no very strong evidence.**

It is therefore **reasonable to regard the mutation as the main, if not the only basis of evolution.**

It has, therefore, seemed **reasonable to regard mutations as the main, if not the only basis of evolution**—

the origin of a new species—at least it is viewed in this way by De Vries and his followers;

**And the great service which Mendel has rendered to this branch of philosophy is the demonstration of the fact that**

**and the great service which Mendel has rendered to this branch of genetics, is the demonstration of the fact that**

**the mutation when once it has arisen is not likely to be swamped by interbreeding with the normal form,**

**the mutation, when once it has arisen, is not likely to be swamped by interbreeding with the normal form**—

provided that it is not injurious to the species...” (Mr R. C. Punnett, *Mendelism*, ed. ii., pp. 72-3).

unless it is recessive.

9:11.2 The new character which arises as a mutation has its representative in the germ cells, and once it has arisen, selection alone can eliminate it.

Says Professor Castle:

“Modification of characters by selection, when sharply alternative conditions (*i.e.* mutations) are not present in the stock, is an exceedingly difficult and slow process, and its results of questionable permanency.

9:11.3 Modifications of characters by selection, when sharply alternative conditions (i.e., mutations) are not present in the stock, is an exceedingly difficult and slow process, and its results of questionable permanency.

Even in so-called ‘improved’ breeds, which are supposed to have been produced by this process, it is more probable that the result obtained represents the summation of a series of mutations rather than that of ordinary fluctuating variations.

Even in so-called “improved” breeds, which are supposed to have been produced by the process, it is more probable that the result obtained represents the summation of a series of mutations rather than that of ordinary fluctuating variations.

For mutations are permanent; variations are transitory...” (Professor M. E. Castle, “The Mutation Theory of Organic Evolution, from the Standpoint of Animal Breeding.” *Science*, April 7, 1905) (R 169-70, fn).

For mutations are permanent; variations are transitory.

## EXPLANATION OF MUTATIONS

IV: MUTATION (Walter 56)

9. POSSIBLE EXPLANATIONS OF MUTATION (Walter 69)

[contd] It is apparent that the causes of mutations, since they occur regardless of the environment,

9:12.1 Since mutations are, apparently not brought about by environment,

are probably of an intrinsic or germinal nature.

they must, therefore, be due to intrinsic changes or alterations in the germ plasm.

It has been observed that

Evening primroses display the same mutants whether in Holland or America,

De Vries' evening primrose displays the same mutant behavior whether in Holland or in America,

in a wild state or under cultivation.

whether it runs wild or is under the strictest cultivation.

It would seem that

Mutations, like poets, are born not made (W 70).

mutants are like poets, they are born, not made.

[See 9:4.1.]

9:12.2 If, as previously suggested, the species goes through a life-cycle somewhat analogous to that of an individual, and that it is only during the reproductive phase of that species-cycle that mutations are thrown off,

Another reason why so few mutations have as yet been seen, is because the majority of organisms are not, during the short span of human observation, in the reproductive part of their cycles (W 71).

then this would explain why, during the short span of a human generation, there would be such an inadequate opportunity afforded to observe this reproduction era in a large number of plant or animal species.

9:12.3 It would seem, from the fossils we dig out of the ground,

Beecher has pointed out that, in paleontological times just before they became extinct, species often underwent extreme specialization in the form of fantastic shapes, an excessive number of spines or elaborate sculpturings on the shells as seen among the ammonites, belemnites, and trilobites,

and from the almost infinite variety of such minute organisms as the trilobite,

or of gigantic size as in the dinosaurs, plesiosaurs, and theromorphs (W 70-71).

and from the immense skeletons we unearth indicative of numerous gigantic species similar to the dinosaur,

that these almost infinite varieties in the way of species, must have characterized a fertile reproductive period in the cycle of their respective species—which was characteristic of the times—and, further, which presaged the speedy approach of the subsequent species-cycle—the old-age period—which was in turn followed by complete extinction of the species concerned.

The common fruit fly exhibits an unusual tendency toward mutation at the present time.

9:12.4 The mechanism of mutations is probably best explained by the chromomere hypothesis already referred to and which will be more fully considered in a later chapter, devoted to "Linkage and Cross-overs."

10. A SUMMARY OF THE MUTATION THEORY (Walter 72)

[contd] The main features of the mutation theory of de Vries may be indicated as follows:—

9:12.5 The main features of the mutation theory of De Vries may be summarized as follows:

*a.* New species arise abruptly regardless of environment without transitional forms,

and at present they are not known to arise in any other way.

9:12.6 1. New species arise abruptly, regardless of environment, without transitional forms.

*b.* New forms arise as unusual deviations from the parent form, which itself remains unchanged,

although it may repeatedly give rise to similar deviations.

9:12.7 2. New forms arise as unusual deviations from the parent form, which itself remains unchanged.

*c.* New mutations are, from the first, constant, that is, they produce their like.

They do not become gradually established as the result of natural selection.

9:12.8 3. New mutations are, from the first, constant; that is, they produce and reproduce their like.

*d.* Among mutations there may occur forms characterized by the addition of something new,—*progressive elementary species,*—

as well as forms lacking something present in the parental type,—*regressive varieties*.

9:12.9 4. Among mutations there may occur forms characterized by the addition of something new—progressive mutations,

as well as forms lacking something present in the parental type—regressive varieties.

*e.* The same mutation may arise simultaneously in many individuals instead of as a single "sport."

9:12.10 5. The same mutation may arise simultaneously in many individuals instead of as a single sport.

*f.* Mutations do not vary around an arithmetical mean with respect to the parent form, as is the case with fluctuating variations,

9:12.11 6. Mutations do not vary around an arithmetical mean with respect to form;

but they fluctuate around a new average of their own, thus forming a discontinuous series with the parent form.

they fluctuate around a new average of their own.

*g.* Mutations may occur in all directions, that is, they are not necessarily definite or orthogenetic (W 72-73).

9:12.12 7. Mutations may occur in all directions, that is, they are not necessarily definite or systematically progressive.

XXIV: THE MUTATION THEORY (Newman 346)

CRITICISMS (Newman 360)

[ ... Whether or not, however, the *Oenothera* situation be taken as valid evidence of the occurrence of mutations, the idea of mutations and their rôle in evolution will stand up on quite independent grounds. Numerous mutations have been observed in all sorts of animals and plants... —ED.] (N 360)

9:12.13 The fact of mutation has been established by numerous observers,

and it rests secure in the biologic thought of today, quite independent of De Vries' experiments.

[**Conclusion.**— ... When all is said, it is found that our knowledge of what actually causes mutations is almost nothing.

But as to the explanation of mutations, we must confess having little or no real knowledge.

We think we know something about the mechanism of heredity,

We assume that we know something about the mechanism of heredity,

but we do not know about the mechanism of variation... —ED.] (N 364)

but we must admit that little or nothing is actually known respecting the mechanism of mutation.