JOURNAL LA LIFESCI

VOL. 01, ISSUE 05 (043-040), 2020
DOI: 10.37899/journallalifesci.v1i5.245

Application of Gene Classification in Cytogenetics

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Article Info

Article history:
Received 7 July 2020
Received in revised form 16 July 2020
Accepted 19 July 2020

Keywords:
Gene
Mendelian Population
Heterosis
Mutual Affinity
Population Genetics
Evolution

Abstract

Generality and individuality are the inherent nature of everything, everything has both generality and individuality. Generality determines the basic nature of things, and individuality reveals the differences between things. According to the principle of dialectical materialism, the genes of organisms are divided into two types: General genes and individual genes. Genes shared by all biological individuals are called general genes, and genes unique to each individual organism are called individual gene. And use this classification method to discuss the three basic laws of genetics, heterosis theory and mutual affinity, and population genetics and biological evolution. It is concluded three basic laws of genetics are only relative to individual genes, unit traits controlled by general genes are not restricted by three basic laws of genetics, and the proportion of individual gene and general gene between parents has a decisive influence on the mutual affinity of parents and heterosis of hybrid generation, and the gradual process of the evolution of life from simple to complex, from low-level to high-level, is achieved by that the mutations to generate firstly new individual genes, and then the favorable individual genes are generalized, which the individuality genes are transformed into general genes that the individual characters can be transformed into the common characteristics of the population, and the process of natural selection is just to fix the favorable individual genes, make the traits controlled by them change into the general characteristics of this population, and to eliminate the unfavorable genes, and eliminate the unfavorable traits.

Introduction

In the course of Mendel's long-term research of the genetics law of peas, he finds that many traits of peas, such as the color of the beans, can be passed on to the next generation regularly, furthermore, the concept of "Hereditary Factor" Piney (1957) is put forward, and found the law of uniformity and law of independent assortment, based on which the genetics was initially established. After more than a century of exploration, the objectivity of this hypothetical "factor" has not only was confirmed by experiments, and its structure and role in living bodies are becoming increasingly clear. It should be mainly due to the American geneticist Thomas Hunt Morgan who brings genetics to the level of cytology, forming a great achievement in the theory of genetic chromosomes in the 20th century. On the basis of Mendel's two laws, Morgan put forward the chain and exchange of genes and found the genetic genes are arranged in a straight line on the chromosomes. It can be said that in the twentieth century, the development of genetics has attracted worldwide attention; the establishment of the concept of genes and their theories has opened the window for mankind to understand and control life. So, are all unit traits governed by three basic laws of genetics?

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

In other words, do three basic laws of genetics apply to all genes in organisms? In fact, Mendel only observed 7 pairs of relative traits in pea during the plant hybrid experiment. Why do other unit traits not show the law of uniformity and law of independent assortment? This problem is obviously worth our further consideration!

Methods

In a Mendelian population, although there are different combinations of genes in different individuals, but all genes in the population are certain, and the genes among individuals can be exchanged freely. The sum of all genes in a population is called a gene pool, if we proceed from the world outlook of dialectical materialism, to divide all genes in a gene pool into two types: General genes and individual genes, on the basis of cytogenetics, we may explore again the three genetic laws, heterosis and mutual affinity, and population genetics and biological evolution on a new angle of view.

Results and Discussion

Classification of Genes

Dialectical materialism holds that generality refers to the universal nature of different things. While individuality refers to the special nature of one thing which is different from other things. Generality determines the basic nature of things; individuality reveals the differences between things. In the study of cytogenetics, we can divide all genes in a Mendelian population's gene pool into two types: general genes and individual genes according to the dialectical relationship between generality and individuality. Genes shared by all biological individuals are called general genes. A gene unique to an individual organism is called a personality gene, the general genes determine the basic characteristics of a species, while the individual genes reveal the differences of unit traits among individual organisms. The larger the population of organisms, the less the proportion of general genes, the greater the proportion of individual genes. On the contrary, the smaller the biological population, the greater the proportion of general genes and the smaller the proportion of individual genes. The traits that are controlled by general gene show the similarity between every individual of a population, while the individual gene makes each individual have its own characteristics.

Application of Gene Classification in the Study of Three Basic Laws of Genetics

In a population, the sum of the total number of general genes and the total number of individual genes is equal to a Mendelian population (Miller, 2001), that is, a gene pool. The gene frequency of the general gene is always 1, and the gene frequency of the individual gene follows the Hardy—Weinberg Law. Therefore, the three basic laws of genetics are only relative to individual genes, unit traits controlled by general genes are not restricted by the three basic laws of genetics, and they are identical in every biological individual. Traits controlled by the interaction between general genes constitute the basic skeleton of a biological population, which are shared by all biological individuals. In the case of the same population size, the more general genes are, the more complex the basic skeleton of a biological population is, and the higher the level of life evolution is. The traits controlled by the interaction between individual genes and general genes, between individual genes and individual genes, are unique to each biological individual, so that each individual has its own characteristics on the basis of the common characteristics of the population. The way of interaction between genes is different, and the characters expressed are also different.

Application of Gene Classification in Heterosis Theory and Mutual Affinity

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

Heterosis

Heterosis (Birchler et al., 2010) refers to the phenomenon that progeny of diverse varieties of a species or crosses between species exhibit greater biomass, speed of development, and fertility than both parents. Regarding the formation mechanism of heterosis, it can be mainly summarized into two hypotheses: dominance hypothesis and overdominance hypothesis. In the early days, Bruce & Jones put forward the dominance hypothesis that most dominant genes are beneficial to the growth and development of individuals, while relatively recessive genes are not conducive to the growth and development of individuals. In the hybrid F1, almost all the harmful genes are covered by their favorable genes, and heterosis appears. The overdominance hypothesis was first put forward (Schal 1911), which believed that heterosis is a developmental stimulation effect produced by the combination of gametes of different genotypes. Later, in 1918, E.M. Easter believed that the interaction of different alleles at some locus in heterozygotes had the function of stimulating growth, therefore, heterozygotes showed greater growth advantages than homozygotes, and the degree of dominance growth is closely related to the degree of heterozygosity between alleles. Both dominant and overdominance hypothesis attributes the formation mechanism of heterosis to the interaction of individual genes, while neglecting the influence of general genes and genome on the formation of heterosis.

The development of biological traits is the result of the continuous action of a series of biochemical reaction processes. The continuous action of this series of biochemical reaction processes inevitably requires the participation of the same number of enzymes. The one gene one enzyme hypothesis holds that a gene only participates in the production of one enzyme, and determines the specificity and phenotype of the enzyme, therefore, there must be multiple genes involved in the expression of biological unit traits, thus forming a " multigenic effect " phenomenon. The effects of each pair of genes are not the same size, some play a major role, and some have a small role. On the other hand, a gene can also affect the development of many traits, that is, "pleiotropism", it can be considered that a certain chemical change process occurs repeatedly in the physiological and biochemical reaction process of different character expression, so it can be said that every gene has different utilization frequency in organism. The utilization frequency of general genes is high, while the utilization frequency of individual genes is low. Because the heterosis is manifested in the comprehensive performance of in Growth, vital force, Fecundity, adaptation, withdraw rate and quality, and many other traits, the formation mechanism of heterosis is simply attributed to the interaction between individual genes, while ignoring the comprehensive effects of genome is obviously not comprehensive.

Cross Sterility

Cross sterility Owens & Miller (2009) refers to the inability to obtain offspring from crosses. The causes of sterility may be diverse. The situation due to incompatibility is called hybrid incompatibility, it is generally believed that organisms are closely related and have strong mutual affinity, so they can be hybridized, and if the genetic relationship between organisms is far, and the mutual affinity is weak, it shows hybrid sterility. Self incompatibility is formed in the long-term evolution of plants, which ensure genetic diversity and are conducive to evolution and adaptation to the environment. Self incompatibility is genetically controlled by specific multiple alleles. The nature of affinity is still unclear, but heterosis is produced by the cross between two biological individuals and is expressed through the hybrid generation

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

of these two individuals. Therefore, there must be a certain internal connection between the cause of heterosis and the mutual affinity of two individuals.

Gene Classifications and Heterosis

When crossing is carried out between two biological individuals, the ratio of individual genes and general genes between the parents has a decisive influence on the mutual affinity of the parents and the heterosis exhibited by the hybrid generation. The greater the ratio, the farther the relationship, and the lower the mutual affinity. In the range of affinity, the greater the ratio, the more genetic information obtained by the hybrid generation, and the more opportunities for genes interaction, and the higher the frequency of use of a single gene, so the greater the heterosis. The smaller the ratio, the less the amount of genetic information obtained by the hybrid generation, the fewer opportunities for gene interaction, the lower the frequency of use of a single gene, and the smaller the heterosis obtained by the hybrid generation. In a Mendelian population, the ratio of individual genes to general genes varies continuously, therefore, the mutual affinity between each biological individual and the heterosis shown by the hybrid generation also shows continuous changes. When the ratio of individual genes to general genes between two organisms is greater than the upper limit of the affinity range hybridization incompatibility occurs. The genetic information contained in the chromosomes of the gamete cells produced by them is quite different, and they cannot form a pairing relationship of homologous chromosomes in the process of meiosis that the hybrid generation produces germ cells, the synapsis of homologous chromosomes cannot occur, so germ cells cannot be produced (Sutton 1903). For example, the chromosome number of the horse is 64, and that of the donkey is 62. However, the ratio of individual genes and general genes is within the range of compatibility, so they can hybridize and produce Hinny or Mule who has hybrid vigor, however, the chromosome numbers of the two are different, so they can't form homologous chromosome pairing relationship and can't bear. When the ratio is less than the lower limit of the affinity range, the genetic information contained in the chromosomes of the gamete cells produced by them is nearly the same, the amount of genetic information obtained by the oosperm cells after the fusion is too small, the interaction between genes is less, the frequency of utilization of a single gene is low, and the harmfulness of recessive genes is fully reflected, the viability of the offspring is weak, and the individuals can not develop normally. Therefore, inbreeding coefficient is not conducive to the development of biological evolution and genetic diversity. Self-pollination can be preserved in natural selection, which is only an adaptation of plants to the lack of cross-pollination conditions.

Application in Population Genetics and Biological Evolution

Biological evolution is the process of continuous change and evolution of the population genetic structure, so population genetics theory plays an important role in the study of biological evolution mechanism, especially in intraspecific evolutionary mechanism. Gillespie & Gillespie (2004) Population Genetics is the science of studying the genetic structure and change laws of a Mendelian population, studying the distribution of genes in the population, maintenance and changes of gene frequency and genotypic frequencies. Mendelian population is a large sexual propagation's population composed of the same species. The individuals in the population are panmixia random mating and follow Mendelian genetic law. In this biological population, the sum of general genes and individual genes is equal to a Mendelian population. That is, a gene pool. On the perspective of gene classification, population genetics should take the individual genes in the gene pool as its

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

research object, and the relationship between individual genes and general genes should become a new perspective of population genetics research.

Application of Gene Classification in the Study of Law of Genetic Equilibrium

Hardy Weinberg Law means that under ideal conditions, the frequency of each allele is stable in heredity. That is to say, the gene equilibrium is maintained. The law is applicable to biology, ecology and genetics. The conditions: the population is large enough; panmixia random mating among individuals; no mutation; no selection; no migration; no genetic drift. Since general genes are shared by all biological individuals, their gene frequency is always 1, while the gene frequency of individual genes follows the "Hardy－Weinberg Law".

Mutation, Migration and Natural Selection

On the viewpoint of the interaction between organisms and the environment, Darwin believed that the mutation, heredity, and natural selection of organisms can lead to the altering of adaptation of organisms. In biology, mutation refers to a change in the nucleotide sequences of the genome of an organism, virus, or Extrachromosomal DNA. Some mutations are heritable. For example, mutations in germ cells can be passed on to offspring, mutations can introduce new alleles into biological populations and increase population genetic variation. Small-scale mutations affect one or a few nucleotides in a gene, and large-scale mutations involve mutations in chromosome structure. Large scale mutation can greatly increase the proportion of mutant individual genes to population's general genes, If this ratio exceeds the upper limit of the range of mutual affinity resulting in cross incompatibility, the mutant will have reproductive isolation from the original population, thus evolving into a new species. After several generations of accumulation, small-scale mutations can also be reproductive isolation from the original population, thus leading to the evolution of new species.

Migration makes different populations mate and infiltrate foreign genes into each other, resulting in gene flow, which can change the gene frequency of the original population. And that, the proportion of individual genes and general genes between the two parents increases, makes the amount of genetic information obtained by the hybrid generation increases, the interaction between genes increases, and the utilization frequency of single gene increases, hence, the heterosis of hybrid generation enhances. With the migration, the environment changes, the selection conditions of the natural environment for species variation change, and the competition among the species occurs, and the fittest survive, its fundamental reason is the result of natural selection. Migration enriches the species of individual genes and increases the amount of genetic information of the gene pool. So migration is also an indirect cause of evolution.

Genetic Drifts & Founder Effect

Genetic drift is a random fluctuation of gene frequency due to the variation of the number of offspring of individuals with different genotypes in a small population. This fluctuation leads to the disappearance of some alleles and the fixation of others, which change the genetic structure of the population. The founder effect refers to that the gene frequency of a few individuals determines the gene frequency of their offspring. It is an extreme genetic drift phenomenon produced by a new population that is established by a few individuals.

The fluctuation of genetic drift leads to the disappearance of some alleles and the fixation of other alleles, which increases the frequency of some genes, it should be regarded as a process of generality of individual genes, that is, the process of transforming into general genes.

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

When the frequency of an individual gene rises to 1, it can be considered that it has changed from an individual gene to a general gene. The result of the transformation of individual genes into general genes is that the general characteristics of the Mendelian population increase, which makes the biological structure of the population become more complex and the existence form of life become more advanced. We know that the evolutionary process of life is a gradual process from simple to complex, from low level to high level, it should be realized by the generality of individual genes, which individual genes are fixated, its gene frequency rises to 1, and become general genes. Natural selection should be also through the fixation of favorable individual genes to make the traits controlled by them become the common characteristics of the population, and to eliminate the unfavorable individual genes, and makes the unfavorable traits are eliminated.

The process of life evolution (allaboutscience) is a gradual process from simple to complex, from low level to high level. The expression of biological traits is controlled by genes, if the structure of organisms is simple, that the number of genes controlling corresponding traits should be few, and the way of interaction is also simple (Wu & Lin 2006). If the structure of organisms is complex, then there must be many genes that control the corresponding traits, and the way of interaction is also complex In the process of evolution from low-level life to high-level life, there must be more and more kinds of genes to control the biological traits, and the interactive mode is also more and more complex. Then, how did the varieties of genes increase? With the current accumulation of knowledge, this question is not difficult to answer. Gene mutations are the main reason for the increase in gene varieties. Secondly, it is migration. Migration allows different groups to mate and infiltrate foreign genes with each other, leading to gene flow. Gene mutations increase the amount of genetic information in the gene pool in Mendelian populations, and increase the varieties of individual genes unique to biological individuals. Relative to the biology's environment, some of these gene mutations are beneficial to the organism, and some are harmful, the favorable individual genes are selected by the environment and fixed as general genes, and the unfavorable individual genes are eliminated by the environment. That is, by fix, the favorable individual genes, which are generated by mutations, change into general genes, so that the number of general genes control the population's general characteristics are more and more, accordingly, the structure of organism evolves more and more complex and advanced. In this way, organisms produce new gene varieties in the way of gene mutation, increase the varieties of individual genes in the gene pool, and then fix the favorable individual genes in the form of genetic drift, which realizes the generality of individual genes, so that the general characteristics of the population are more and more rich, the structure is more and more complex, and the level of evolution is higher and higher. We know that gene frequency is easy to fluctuate in a small population, but the population of new individuals who are produced by mutation is always small, and its fixed individual gene is always favorable gene, which helps them to adapt to the environment and be selected by the environment. Therefore, they can always develop into a large group.

In general, generality and individuality are the inherent nature of all things. There is a relationship between generality and individuality in the performance of traits among biological individuals. Accordingly, genes controlling biological traits can be divided into two types: general genes and individual genes. Genes shared by every biological individual are called general genes, and the gene unique to an individual organism is called individual gene. General genes determine the basic characteristics of a species, while the individual genes reveal the differences of unit traits among individual organisms. The larger the population of Biology, the less the proportion of general genes, the greater the proportion of

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

individual genes. On the contrary, the smaller the population, the larger the proportion of general genes and the smaller the proportion of individual genes. General genes make similarities between each individual in a population, while individual genes make each individual have their own characteristics. Dividing all genes in a gene pool into two types, general genes and individual genes, can make new explores on the three basic genetic laws, heterosis theory and mutual affinity, and population genetics and biological evolution on the basis of cytogenetics. The three basic genetic laws are only relative to the individual genes, and the unit traits controlled by the general genes are not restricted by the three basic genetic laws, and are completely consistent in all biological individuals. (Lander & Schork 1994). Traits controlled by the interaction of general genes constitute the basic skeleton of a biological population, which are shared by all biological individuals. The traits controlled by the interaction between individual genes and general genes, between individual genes and individual genes, are unique to each biological individual, so that each individual has its own characteristics on the basis of the common characteristics of the population. When cross breeding is carried out among different biological individuals, the ratio of individual gene to general gene between parents has a decisive influence on the affinity of parents and Heterosis of hybrid generation. The larger the ratio of individual gene to general gene, the farther the relationship between parents and the smaller the affinity. In the range of affinity, the greater the ratio of individual genes to general genes, the more genetic information obtained by the hybrid generation, the more opportunities for gene interaction, and the higher the frequency of use of a single gene, so the greater the heterosis. The evolutionary process of life is a gradual process from simple to complex, from low to high, this process is realized by the generality of individual genes which are transformed into general genes, that is, by genetic mutation to enrich the genetic information of the individual genes of the population, and then by genetic drift, the favorable individual genes are fixed, so that the traits controlled by them become the common characteristics of this population, and delete unfavorable genes, make the unfavorable traits controlled by it be eliminated, so that the species can evolve. Over and over again, the structure of organisms is becoming more and more complex, and the existence form of life is becoming more and more advanced.

Conclusion

During the growth and development of organisms, a variety of life phenomena occurs, these different life phenomena are manifested in the same organism, so there should be some inherent and inevitable connection between them. Therefore, when we study these life phenomena and reveal their internal laws, we should take the view of universal connection, and adopt a scientific world outlook and methodology, oppose the separation of various life phenomena, and adopt metaphysical, isolated and one-sided views and methods, because this view and method can only be taken out of context, and cannot reveal the true internal laws of life, but it is easy to lead people's thinking astray and confuse people. There are also contradictions between various hypotheses. For example, the phenomenon of heterosis is only shown by the cross between two parents, therefore, there must be an inevitable internal relationship between heterosis and mutual affinity, but the theoretical hypothesis on the two does not take this into account. The dominance hypothesis and the overdominance hypothesis of heterosis are contradicting with the view that "each allele is incompletely dominant or non-dominant" in polygene hypothesis of quantitative traits. Therefore, when studying life phenomena, using the dialectical materialist world outlook and methodology to understand and analyze problems can enable us to grasp the key to the problem as a whole, and to

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

understand and treat the problem from a higher level of rationality, so as to draw the right the conclusion.

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ISSN 2721-1304 (Print), ISSN 2721-1207 (online)