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Modalities and Logic*

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***Abstract*—This article investigates the category of modality (necessity, chance and possibility) in history of philosophy, biology and logic. We study the first in the history of philosophy understanding of the types of modality of the ancient Greek thinker Democritus; identify the main use of the categories studied in modern natural Sciences for example biology; formalize of the modalities by means of modern logic.**

Keywords—category; modality; necessity; chance; possibility; biology; logic; philosophy

I. INTRODUCTION

Philosophical and natural science concepts are "necessary," "accidental", "possible", "will be", "always will be", etc. In logic those are called modalities and are used as operators, that is, functions whose application to statements forms new statements. Modalities are described by means of logical systems - sets of laws represented, more often than not, by axioms and inference rules [1]. Axiomatically constructed systems, as a rule, have the semantics of possible worlds (relational and neighboring) or algebraic ones. The article deals with these concepts and the role of logic in their refinement.

II. MODALITIES IN THE HISTORY OF PHILOSOPHY

Modalities have already been studied by ancient Greek philosophers. Since it is impossible to consider all the doctrines about the modalities of this period in the history of philosophy within the framework of the article, we confine ourselves to the views of Democritus. We shall rely on the books of Lurie [2] and Goran [3].

Democritus believes that all that exists is either necessary or accidental. Accidental, in turn, is one of the kinds of possible. There are three types of possible. The first is that which exists in most cases. The second is that there are a minority of cases, the third is what exists in half the cases. These concepts are refined based on the teachings of Democritus about atoms and possible worlds. As a result, following Democritus, we can state the following.

There are an infinite number of atoms. Atoms differ from one another in shape and size. Atoms do not have qualities and can not acquire them, they do not arise again and are not destroyed, do not divide and do not unite to form new atoms. All bodies are composed of atoms. The qualities of bodies are determined by the composition of the atoms and the way they are combined. The qualities due to the composition of atoms can be called belonging to bodies by nature. The qualities due to the way of joining atoms are not bodies by nature, because the bodies act on each other and the arrangement of atoms in the bodies varies from this. Qualities of the first kind can be called necessary according to Democritus. They belong to all bodies consisting of identical atoms, and always belong. Qualities of the second kind can be called random, since they do not belong to all bodies consisting of identical atoms, and not always belong. Democritus does not distinguish the possibility "belonging to all things, but not in all cases" and "not to all things (some), but in all cases." This from the point of view of his teaching about atoms simply can not be.

A possible world is both any atom and any body, including one of the imaginary worlds. Necessary is the shape and weight of atoms (they are unchanged in all possible worlds), as well as the qualities of bodies due to the composition of atoms.

The doctrine of Democritus on the conditionality of the properties of bodies by the composition, order and position of atoms pre-empts the achievements of modern chemistry and physics, but because it's too speculative and broad, it can not explain the specific properties of bodies by the concrete composition, order and position of atoms. Democritus categories for this reason are not effective.

III. MODALITIES IN NATURAL SCIENCE ON THE EXAMPLE OF BIOLOGY

Let's try to outline typical cases of using these categories.

Case 1. Population change as a result of gene drift.

A feature of biological science, if it is acquainted with literature, is the ambiguity of the terms used (at least some of them). Often this is due to the objective difficulty in determining them. For example, it is not possible to create a strict definition of the widely used term "gene". As a result of studying the nature of the gene, three possible definitions of the gene have so far been formulated.

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The gene as a unit of recombination. ...This is the smallest part of the chromosome that can be separated from adjacent areas as a result of crossing-over [exchange of parts between the chromosomes]. According to this definition, the gene is a large unit, a specific part of the chromosome that determines one or another sign of the organism.

The gene s a unit of mutation – ... the smallest part of a chromosome that is able to undergo a mutation. In other words, a gene is a composite part of a chromosome from the first definition.

The gene as a unit of function. Since it was known that the structural, physiological and biochemical signs of organisms depend on genes, it was suggested to determine the gene as the smallest part of the chromosome, which determines the synthesis of a certain product "[4].

We do not need a strict definition of a gene. We replace the definition with a description. In chromosomes that exist in pairs, there are areas that are codes of certain characteristics. These areas are called genes. Genes also exist in pairs. And, one section of the pair is located on one chromosome, and the other one on its pair. Such genes are called allelic, or alleles. For example, pairs of genes responsible for the length of the pea stem, alleles, may be AA, Aa, aa. The gene, indicated by an uppercase letter, is called dominant (overwhelming), and the designated lowercase letter is recessive (suppressed). Gene A determines the long stem of peas, and a - short. If chromosomes contain pairs of AA or Aa genes, then the pea has a long stem, and if aa, then short.

In the formation of germ cells (gametes), the double chromosomes diverge and only one of them enters the sexual cell, and with it only one gene from the pair (only one allele). After penetration of the spermatozoon into the egg, that is, after fertilization, the egg receives a double set of chromosomes, one half of the chromosomes is of maternal origin, and the other is paternal, that is, each pair of chromosomes contains one maternal gene and a second, paired gene, the paternal gene.

A set of genes of an individual is called a genotype. To simplify the description of the population change process as a result of gene drift, we will consider idealized individuals that contain only genes that are allelic relative to each other. These genes are responsible for one quality, varying in degrees, for example for color, for stem length, etc. We also admit that individuals have equal chances of mating and reproducing.

The provision that the genes are represented in pairs by each pair and when a germ cell is formed, one gene of the pair enters only one of these cells, and the other into another, is called the first Mendel law, or the distribution law.

According to Mendel's second law, called the law of independent distribution, the entry into the germ cell of a gene from one pair does not depend on which gene from the other pair has got into this cell, that is, the genes in the germ cell are combined at random.

Assume that a population (a group of organisms of one species occupying a certain territory and to a certain extent isolated from other similar groups) contains individuals of three genotypes (AA, Aa, aa), for example in the following proportion: 1/2 of the AA genotype, j -Aa And j - aa. As already mentioned, we assume that individuals select partners for reproduction in a random way and the individuals leave more or less the same number of offspring. In this case, it is possible to establish what proportion of these genotypes will be in the next generation. In the next generation, the original ratio will remain. The totality of all genes that have individuals that make up the population, (the genetic composition of the population) is called the gene pool. In the genotype of a single individual, there are only two allelic genes, there may be more than two genes in the gene pool, which may be allelic in the genotype of the individual. For example, there are three varieties of genes that determine the blood group of a person. These are varieties IA, IB and i. The first two are dominant, and the last one is recessive. Genotypes IAIA and IAcause blood group A, IBIB and IBi- group B. ii- group 0, IAIB- AB.

The population gene pool does not change if, in addition to the above, the following conditions are met: (1) there is no mutation of the genes and (2) the population is so large that random deviations in reproduction of the offspring can be neglected. The provision on the constancy of the gene pool of the population over several generations is called the Hardy-Weinberg law. This law is statistical and operates only in large populations. If the population is isolated and small, it is possible that some genes from the group of genes that may be allelic relative to one another, or a change in the quantitative ratio of these genes in the population, can be randomly deleted. This can happen even in cases where the gene causes some important for adaptation to the environment sign. The random change in the gene pool of a small population, which occurs in the manner described, is called gene drift. "... Such evolutionary changes are aimless, random and non-adaptive. It is possible that it is precisely the drift of genes that are responsible for precisely those curious and sometimes even strange differences, apparently having no adaptive significance, which can often be observed between closely related species inhabiting different regions of the globe "[5]. That is, finding themselves in isolation, individuals of the same species can change the gene pool as a result of gene drift.

When describing the drift of genes, the concept of randomness is used three times.

(1) The combinations of different allelic genes in the germ cell are called random (the second law of Mendel is the law of independent distribution).

(2) Individuals select their mating partners randomly.

(3) Changes in the gene pool in small isolated populations (gene drift) may occur in a random manner.

We will accordingly call these randomness's "randomness 1", "randomness 2", "randomness 3".

It is possible to form one concept for randomness's 1 and 2: an event is accidental if neither it nor its absence is determined by either external or internal factors. This concept of randomness corresponds to the third concept of randomness Democritus, randomness as equiprobability.

Randomness 3 can be described and explained by the theory of random mass phenomena. Randomness 3 should be understood as a violation of conditions for the reproduction of the gene pool under the influence of external factors (under the influence of changes in the conditions of existence of the population). Randomness 3 - is what arises under the influence of external influence on the cognizable object (on an individual, object, system, etc.).

Drift of genes is a random phenomenon. If there is no drift of genes, then the law on the constancy of the gene pool of the population for a number of generations is valid - the Hardy-Weinberg law. Note that it occurs in a large population, when no mutations occur and the second law of Mendel, the law of independent distribution, operates. The Hardy-Weinberg law states the necessity of the persistence of the gene pool of the population. How to characterize this concept of necessity? The nature of this concept is the same as the concept of Democritus: "it happens in all cases and always". Is it possible to talk about this concept of necessity as a concept of what is conditioned by the essence of the system? We think that it is possible. The phenomenon is the consistency of the gene pool for several generations. The essence (in this respect) is that this constancy is deterministic.

Thus, randomness (randomness 3) is what is conditioned by the external conditions of the existence of the system, necessity (necessity 1) is that which is conditioned by the essence of the system. We can consider these categories as paired. Randomness as equiprobability, as the nondeterminism of an event or its absence, will be called accident (1,2).

Case 2. Signs of the body that are necessary (adaptive) or random (non-adaptive) for its survival. The latter are sometimes called "useless." Necessary are those without which organisms can not exist under given conditions, and also those that give advantages to organisms for survival under given conditions. Random are those that do not give any advantages to the organisms for survival in these conditions. The provision on the inheritance of traits necessary for the survival of the body and the loss of features that are accidental for survival is the core of the theory of natural selection of Darwin and Wallace. Other provisions of this theory are: animals and plants possess the property of variability; if organisms of one or another species are born in larger quantities than which can find their sustenance, some organisms will die; Since more organisms are born than can survive, a struggle exists between them for food and the environment; The fittest organisms survive. Proceeding from this, it is possible to distinguish necessary for the survival of organisms and random for the survival of organisms signs in the sense that the external conditions of existence of organisms are due to the retention of these characteristics or not due. Let us formulate the concepts of necessary, random and impossible to survive signs. A symptom is necessary for organisms, if the survival of organisms possessing this feature is determined by living conditions. Under the organisms it is advisable to bear in mind the population, since in biology under the evolving unit is meant not the individual but the population. In addition, the system, with respect to which the question of necessity or accident, is solved, is the population together with the habitat. Therefore, the preservation of the characteristics necessary for survival over a number of generations is determined by the internal causes of the system. Do these internal causes (habitat) constitute the essence of the system. Apparently, yes. So, the indispensable feature for the survival of organisms is this, the preservation (but not the emergence) of which is determined by the internal essence of the system (the population considered together with the habitat). Let's call this necessity a necessity not by origin, or necessity 2.

The attribute is impossible (not by origin), if the system (population together with the habitat) determines the death of organisms possessing this feature. Let this impossibility 2.

A characteristic is accidental (not by origin), if the system neither determines its preservation nor its loss. "Darwin and Wallace allowed ... that animals and plants can have such changes that, under given environmental conditions, do not bring any benefit or harm to the body; These changes are not directly affected by natural selection, and their transfer to subsequent generations is determined randomly "[6]. We call this randomness a randomness (2,2).

It should be borne in mind that some signs that seem useless for the survival of organisms are necessary not by origin. The latter include the signs that are fixed in the population as a result of gene drift, accidentally (by origin). Thus, some of the "useless" features turn out to be a deterministic system (the population together with the environment), and others are not deterministic systems.

Case 3. Mutations.

"With the development of the theory of gene mutation steel term used to denote a sudden, abrupt random changes in the genes (or chromosomes) ... » [7]. The causes of mutations can be of two types: artificial and natural. Mutations induced by artificial means are necessary. In this case, it makes no sense to talk about determination by substance. This is, rather, the need for circumstances. Mutations caused by natural causes, in turn, are of two types. "Cosmic and other natural radiations falling on the Earth can be the cause of some of the observed spontaneous mutations; Other mutations can occur as a result of random "mistakes" as a result of gene replication » [8]. The first of the natural mutations are also random. First, they do not occur in all individuals, but only in some, and, secondly, they are caused by external circumstances, which might not have been. However, the explanation of mutations by natural causes of the first type is hypothetical. The mutation process itself is not observed, it seems to us that this type of mutation is not proved experimentally. What type of randomness is this? Most likely, this is an accident, similar to the randomness described above, 3 - with what is due to the external conditions of the existence of the system, if the system is understood as an organism. However, in case of necessity, we used the notion of "conditionality by external circumstances". How to distinguish between the concepts of randomness of the type discussed and the need for circumstances? Apparently, it is necessary to distinguish the types of conditionality. Conditionality, which is a determinism, and is not such. The phenomenon caused by external circumstances nondeterministically, can be called an accident by circumstances. Then the need for circumstances will be called a phenomenon, the existence or occurrence of which is determined by external circumstances.

Thus, it is necessary to distinguish between the types of conditioning - determinative and non-deterministic. If the phenomenon is determined by external conditions, then it is necessary in the circumstances. If it is conditioned by external conditions non-determinatively, then it is random in circumstances. A purely speculative assumption arises about the two types of conditioning by internal circumstances, including the conditioning by the essence of the system, determinative and non-deterministic. Let's try to test this consideration on biological material.

Mutational changes occurring in DNA lead to the synthesis of new proteins, which, in turn, causes the appearance of new signs of the organism. Thus, the genes that arise as a result of mutations, cause the appearance of new signs. Genetic conditionality of the signs may be necessary. This conditioning is the subject of a special discussion.

Mutations that occur without any apparent cause can in part be explained, as already said, by external influences (for example, cosmic rays). Some mutations of this type occur, according to biologists, spontaneously, without visible external effects, as a result of errors (failures) in the synthesis of DNA. The mutations of the latter species are random, occurring for no apparent reason. It is possible that they are caused by aging of genetic material. Here we can draw an analogy with the aging of mechanisms (in the literal sense of the word), which malfunction. To prove the aging of genetic material is hardly possible, although it can be assumed that in this case the mutational processes in the course of the historical development of life increase and this should be confirmed by studying the history of life on earth. However, we can assume that the possibility of spontaneous mutations "originally" is inherent in living organisms.

So, when describing mutations, the following concepts of necessity and chance are distinguished.

Necessity, by circumstances, is a phenomenon whose existence or occurrence is determined by external circumstances.

Chance by circumstances - mutations occur as a result of natural external causes, but not in all individuals, but in a minority, and conditioning is not deterministic.

Spontaneous accident is a mutation that occurs for no apparent reason, sometimes only in individual individuals.

Case 4. Genetic conditionality of body features.

This conditionality is used in predicting congenital or acquired ("sporadic") genetic abnormalities that can cause disease in children or in more remote offspring.

The concept of possibility, and implicitly, of chance, is used when characterizing the accuracy of the evaluation of the genetic abnormality and the connection with it of the pathological state of the organism: "... The accuracy of the risk assessment depends on whether an anomaly is accurately diagnosed, whether the type of inheritance is known, allowing to make empirical estimates. In some cases, the diagnosis is beyond doubt. For example, if an anencephalic is born in a family whose member suffers from a shoulder-lobular-facial muscular dystrophy, or in a family where members have an albino, the picture is clear enough for the specialist. However, often, before giving qualified advice, it is necessary to clarify the clinical and genetic diagnosis. For example, a disease that is defined in the clinic as progressive infantile muscular dystrophy is usually inherited as a trait linked to the X chromosome, but this is not always the case, and the pathological condition caused by the chromosomal abnormality may not be inherited " [9]. The possibility of inheritance and the possibility of the absence of inheritance is naturally understood as an accident in the inheritance of one or another characteristic.

By accident, it is understood here is not an unambiguous conditionality of the disease to the genocodes of the organism.

Conclusion on the degree of conditionality of the disease by the specificity of genes is carried out on the basis of studies that are in fact not different from sociological ones. Families with "defective" genes are investigated and the relative incidence of diseases of their members is established. That is, a random mass phenomenon is investigated - a set of families with "defective" genes. Naturally, all "events" - all such families can not be studied. In fact, a sample is made, in the implementation of which, the listed methodological requirements for statistical induction should be met. The relative frequency of occurrence of the symptom (the relative incidence of diseases) is transferred to the entire random mass phenomenon, that is, to the "population", and then to a separate family in the course of medical genetic counseling. Naturally, the solution of the question of whether or not to have children is carried out with very little information, since there are two weaknesses in this process. First, it is difficult to meet the methodological requirements that must be observed in sociological research, and the second - the transfer of the relative frequency of appearance of signs from a random mass phenomenon to a particular event is problematic.

There are anomalies that strictly determine some (or any) signs of the organism and don't strictly determine other signs. For example, the presence of an extra chromosome (chromosome 21), called Down's syndrome (the disease was discovered before the cause of it), causes infertility of men, but women with this disease sometimes have children. F. Vogel and A. Molski in the 3-volume work "Human Genetics" write: "Men with Down's syndrome are infertile, however, at least 17 women with this syndrome have had children. Among 19 such children (including one pair of ... twins) 7 have Down syndrome, 9 - normal, 2 - mentally retarded without Down's syndrome and 2 stillborn ... twin ... » [10]. That is, the possibility of having children in women with this syndrome is not great. (Possibility 2 in the sense of Democritus, "in a minority of cases").

About half of the children are normal. (Possibility 3 in the sense of Democritus, "half the time").

Patients with Down's syndrome have a 20-fold increased risk of death from acute leukemia. The reasons for this are unknown. (Possibility 1 in the sense of Democritus, "in most cases").

Thus, there are signs that are uniquely determined by chromosomal abnormalities (infertility in men with Down's syndrome), determined ambiguously (women with this syndrome have the opportunity to have children, the ability to have healthy children for women who are able to produce offspring, the risk of death from acute leukemia). It is about the possibilities that are established statistically. These possibilities and necessity are probabilities: it is very probable (the probability is more than 1/2), probably to a small extent (the probability is less than 1/2), is equally probable (probability is 1/2), and is necessary (probability is 1). Most often the probability is expressed by a number that is greater than 0 and less than 1. This terminology is used in the study of the genetic conditionality of organisms.

At the study of the genetic conditionality of the body signs, at least three concepts of probability are used.

The first concept is the concept of statistical (a posteriori) probability. This concept is used in statistical studies and its application in medical genetic counseling is described above.

The second concept is the classical concept of probability (the concept of a priori probability). "This concept is used in the event that we have no reasonable grounds to believe that the probability of an elementary outcome of some experiment should differ from the probability of other elementary outcomes. For example, when throwing a coin, we have no reason to believe that the loss of one side of the coin ("heads") should occur more often than the fall of the other side ("tails"): the coin is a symmetrical object and therefore a priori (prior to any experiment) , That the loss of each side is equally probable. Since there are exactly 2 equally probable elementary outcomes in this case, and in the sum of the probabilities should not exceed 1/2, the probability of each of the events ("the eagle fell out" and "the lattice fell out") should be exactly 1/2. In the case of a dice roll, because of its symmetry, we can a priori consider the probability of each of the outcomes equal to 1/6 "[11].

The third concept is the notion of approximate a priori probability. The notion of this concept can be made on the basis of the following text: "... The definition of the magnitude of the risk must be empirical [should be based on the concept of statistical probability]. In the same cases, when the data necessary for the empirical evaluation are not available, the theoretical model gives an idea of at least the order of magnitude of the risk. For example, if the disease is so rare that the data needed for the empirical evaluation does not accumulate, you can use the approximation developed by Edwards (1960). It lies in the fact that if the frequency of the trait in the population is p, its frequency for relatives of the first degree is of the order of `Öp. After the birth of the affected child, the frequency of this symptom in subsequent Sibs will be less than `Öp. For the characteristics we are considering, the frequencies are so low that only approximate values of p can be used ... " [12].

Here is another example of using the classical concept of probability: "If one of the parents is affected [the cases of autosomal dominant genes with constant penetrance], then he (or she) is heterozygous for this gene and transmits this gene in the middle half of the offspring; Those who have received this gene will be afflicted. Therefore, the probability of the appearance of afflicted children in the afflicted parent is 1/2. This probability does not depend on the presence of this anomaly in other children born in this marriage "[13]. (Penetration is "the proportion of individuals with a specific genotype, in which the phenotype corresponding to this genotype is manifested" [14]).

The study of medical genetic counseling allows us to state that the following concepts of necessity, chance and opportunity are used here.

Necessity is an unambiguous determination of the disease by the genocode of the organism. The ambiguous conditionality of the disease with the specificity of the genetic material is an accident. Possible diseases are diseases that are determined not uniquely by genetic abnormalities. The possibilities 1, 2, 3 are used in the sense of Democritus. Most often, the possibilities are expressed by numbers greater than 0 and less than 1.

IV. General Concepts of Necessity, Chance and Opportunity

On the basis of the above cases of the use of modalities, one can formulate the most general concept of necessity. A necessary (property, relation, connection, event, etc.) is that it is uniquely determined by the internal factors of a thing, system, etc. Or external circumstances of their existence. The concept of unambiguous determination used here is illustrated by examples. Thus, the electrical conductivity of metals is unambiguously determined by the presence of free electrons in them, and some diseases are not uniquely determined by gene or chromosomal abnormalities, that is, with these anomalies, depending on certain circumstances, the disease may or may not occur (the examples were cited above). Unequivocal determinism exists objectively, which, in our opinion, takes place not only in biology, but also in other sciences, at least in natural sciences.

A synonym for the word "necessity", used to express the general concept of necessity as applied to future events is the word "inevitability". The understanding of the necessity as inevitability corresponds to the everyday and scientific use of the word "necessity".

How does this most common (generic) notion of necessity correlate with the understanding of the necessity of Democritus and biologists?

Democritus. Necessary is that inherent in things by nature, and therefore (strictly) determined by internal causes.

Biologists. Necessary is the sign of organisms, the preservation of which is determined by the internal essence of the system (the population considered together with the habitat); Necessity is what is conditioned by the essence of the system; Necessity is a phenomenon whose existence or occurrence is determined by external circumstances; The unambiguous determination of the disease by the genocode of the organism is a necessity.

All these concepts are specific in relation to the most general concept of necessity (the generic notion of necessity), formulated above.

From the generic notion of necessity, we turn to specific concepts.

We distinguish the following specific concepts of necessity.

Classical (essential) necessity is that which is strictly determined by the essence of a thing, system, etc. An example of an essence can be the genocode of the organism. For example, at least in some cases, the knowledge of the genocode of the organism does not require a search for a deeper essence of the organism.

Functional necessity: a feature is necessary if the conditions of the existence of its carrier are uniquely determined by the performance of certain functions by the bearer of the feature. An example of this notion of necessity is the notion of necessity not of origin, used in biology (the feature that is necessary for the survival of organisms, the preservation (but not the origin) of which is determined by the internal essence of the system (the population considered together with the habitat).

Necessity by circumstances - the phenomenon of existence or occurrence of which is uniquely determined by external circumstances.

Examples of such need are the artificially induced mutations described above, that is, by targeting chromosomes and genes. This concept is applicable to social phenomena.

Let us formulate the most general (generic) concept of randomness. Randomness is something that is not determined by internal factors of a thing, system, etc., nor by the external circumstances of their existence, or is determined, but not unequivocally.

The main types of randomness.

Classical randomness is a phenomenon that is not uniquely determined by the essence of an object, system.

Functional randomness: a characteristic is accidental if the conditions for the existence of its carrier are not deterministically determined or the performance of certain functions by the bearer of the feature is not determined. An example of such an accident is randomness, not by origin.

Randomness in circumstances is a phenomenon whose existence or occurrence is not uniquely determined by external circumstances.

The possibility is that the absence of something is not determined by either internal factors or external circumstances.

Based on this understanding of the possibilities, everything necessary is possible. The types of this possibility, apart from the possibility-necessity, are the possibilities characterized quantitatively by the theory of probability, that is, when we take as a measure the probability of numbers (rational) greater than zero and less than unity. Particular cases of opportunities in this approach are opportunities that are a generalization of Democritus' capabilities:

B1 - the sign is inherent in most subjects in most cases;

B2 - the sign is inherent in most subjects in the minority case;

B3 - the sign is inherent in a minority of subjects in most cases;

B4 - the attribute is inherent in half of the subjects in half the cases;

B5 - the sign is inherent in a minority of subjects in a minority of cases.

It remains to answer two questions.

First. How does the described understanding of randomness relate to its ordinary understanding as a small probability that, for example, an event will occur? In scientific cognition it is hardly expedient to consider an event, the probability of which is more than 1/2, not accidental. Then you will have to admit it is a necessity, which is wrong.

Second question. How to deal with one of the understandings of the possibility (for example, one of Aristotle's possibilities), according to which the necessary is not possible. This understanding is legitimate, but this is another possibility. It is expedient for it to introduce a special name for the possibility, which we refrain from doing in this paper.

V. Modalities in Logic

In modern logic, a special language is used - the symbolic language [15]. Its application already in itself requires the specification of terms, in particular, modalities. We will try to apply this language to describe the modalities of Democritus. Denote the expressions "necessary", "random", "possible (in most cases)", "possibly (in a minority of cases)", "possibly (equiprobably)» respectively with the symbols H, C, B1, B2, B3. Let the meta-language implication ("if ..., then" ...) and the equivalence ("if and only if ..., then ...") are denoted respectively by the symbols ⇒, ⇔. The remaining symbols are ordinary. Then the connection between necessity, chance and the possibilities of the first two and three can be represented as follows:

(1) $HA \Rightarrow \neg CA$ (if A is necessary, then A is not random);

(2) $CA \Rightarrow \neg HA$ (if A is random, then A is not necessary);

(3) CA⇔ $B_1A \vee B_2A \vee B_3A$ (A by chance if and only if A is possible in any of the three meanings);

(4) HA ⇔ $\neg B_1A \wedge \neg B_2A \wedge \neg B_3A$ (A is necessary if and only if none of the three senses is possible);

(5) $B_1A \Leftrightarrow B_2\neg A$ (A is possible in the first sense, if and only if the absence of A is possible in the second sense);

(6) $B_2A \Leftrightarrow B_1\neg A$ (A is possible in the second sense, if and only if not possible -A in the first sense);

(7) $B_3A \Leftrightarrow B_3\neg A$ (A is possible in the third sense, if and only if in the third sense it is possible not -A).

The equivalence (3) implies the following consequences:

(3*) $B_1A \Rightarrow CA$ (if A is possible in the first sense, then A is random);

(3**) $B_2A \Rightarrow CA$ (if A is possible in the second sense, then A is random);

(3***) $B_3A \Rightarrow CA$ (if A is possible in the third sense, then A is random).

More important for clarifying the modalities is the construction of logical systems that are contextual definitions of modal concepts. Especially graphically these definitions are expressed in axiomatically constructed systems. The laws here are expressed by axioms and inference rules. Apparently, Lewis systems and some systems added to them are classical. These are the calculi S1, S2, S3, S4, S5 of Lewis and M (T) of Face Vrigt, and also K.

What modal concepts did Lewis mean? The possibility (operator à) he interprets as self-compatibility. The latter can be understood as logical consistency. At the same time, in one of the notes in the book "Symbolic Logic", written in co-authorship with Langford, it is asserted that this is consistency within the available knowledge. Apparently Lewis did not have a clear concept of modalities. Hence, there are many different logical systems. We consider that it is necessary to start from the logical systems themselves and to reveal the meaning of modal concepts defined by systems.

Without starting from modal calculi, and exploring the properties of logical necessity, logical possibility and logical possibility, Ivlev Y.V. constructed on the basis of the semantics of limited sets of state descriptions (semantics of OMOS) suggested by him, a logical system that proved to be adequate to the Lewis S5 calculus [16]. In this semantics utterances are interpreted as true and logically necessary, true and logically random, false logical contradictory, false and logically random. N.N. Bibliography. Limited to three interpretations: logically necessary (logically true), logically random (logically nondeterministic), logically impossible (logically contradictory) [17].

We consider it expedient, firstly, to identify the meaning of the modal concepts defined by the named and many other modal calculi; secondly, the construction of logical systems that will constitute contextual definitions of the modal concepts formulated above; thirdly, the study of modalities used in other natural Sciences, and also in the humanities, the generalization of the concepts thus revealed and the description of their logical properties through logical systems [18].

VI. CONCLUSION

In the article:

-an understanding of the modality categories of Democritus;

-the main cases of use of modality categories in modern biological concepts are revealed;

-a generalization of the concepts of different types of necessity, chance and opportunity, and on this basis the corresponding philosophical categories are formulated [see 19, 20];

-modalities in logic are considered.

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