

THE IDEALIZATIONAL STATUS OF THE CONTEMPORARY THEORY OF EVOLUTION

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1. Introduction: what is the contemporary theory of evolution?

This question belongs to the most important and at the same time most intriguing set of questions of contemporary evolutionary biology. So far there has been no simple answer so it represents a peculiar cognitive challenge to biologists and philosophers who are interested in methodological problems of this discipline.

The difficulties in answering this question seem to result from two sources. The first substantial source is the heterogeneous nature of theories (with respect to structure and scope) which compose knowledge about the course of evolutionary processes. The view that evolutionary processes can be described and explained within two approaches: population-morphological and population-genetic is prevalent. An obvious argument supporting this claim points to the fact that the vast majority of biologists who investigate evolutionary processes make use of the synthetic theory of evolution. And the latter functions in the research practice of evolutionary biology in the above-mentioned stylizations: in a morphological one -when an evolutionary process is described in terms of transformations of adaptive features of a population [Lastowski, 1987] and in a genetic one- when evolutionary changes are expressed in estimated values of changes of frequency of genes (resp. genotypes) in the genetic structure of a population [Lastowski, 1987]. The other source of the aforementioned difficulties comes from the methodological beliefs of researchers. They commonly believe that the fundamental method of biological cognition, perfectly useful in explanations of evolutionary processes, is a hypothetic-deductive method [Michod 1981]. Sometimes there are still those among evolutionists who believe in the inductive method as a foundation of biological cognition [Lastowski, Nowak 1982c]. But the majority maintain that a hypothetic-deductive method best explains research activities undertaken in contemporary theory of evolution.

The heterogeneous and complex nature of contemporary evolutionary biology manifests itself in beliefs held by researchers about where and how to apply descriptive, explanatory and prognostic procedures. The complexity of the theoretical structures of evolutionary theories does not follow from a considerable number of essential factors, nor does it follow from the complexity of mechanisms which regulate the course of evolutionary processes. It is mainly caused by

implicit theoretical assumptions (including philosophical ones) which compose biological knowledge. I shall briefly discuss some of them in further sections of the present text.

1.1. The conceptual sources of the contemporary theory of evolution: the ideas of Lamarck and Darwin

The contemporary theory of evolution originates from the historical core of the idea of evolution which was suggested at the beginning of the 19th century by J.B. Lamarck [Lamarck 1969]. He was the first to pay attention to two fundamental mechanisms of transformation of living organisms: (1) principles of pangenetic cross-breeding of races (the closed system of links in the process of heredity) and (2) the adaptation to changing environmental conditions [Lastowski1993]. There are, until today, supporters of certain parts of this conception, especially among French biologists (e.g. P. Grasse) [Lomnicki 1993]. I shall not analyze in detail the influence of Lamarck's views on the contemporary form of evolutionary knowledge. I shall confine myself to simply remarking that Darwin was highly critical of most of Lamarck's thought. Nevertheless, he fully appreciated his predecessor's arguments in favour of the natural character of evolutionary changes. But at the same time Darwin basically differed from Lamarck not only in his terms of the mechanisms of evolution but primarily in terms of the concept of the biological object that undergoes the evolutionary process. This difference is of a clearly philosophical nature. Lamarck refers to the notion of the individual, while Darwin makes use of the category of the multitude (of a set). The Lamarckian way of seeing an evolutionary object boils down to the indication of race, conceived of as a single organism and its specific features, as a real object of evolution, while for Darwin such an object is a population (set of organisms and their features -often understood in different ways) [cf.: Lastowski 1981, 1987, 1993; H.K. Reeve and P.W. Sherman 1993].

Perhaps all contemporary theories of evolution refer to Darwin's account of his category of the biological object. However, they differ with respect to the content of the notion. Historically speaking, three derivative evolutionary theories developed from classical Darwinian theory. First, the synthetic theory of evolution, which has the closest conceptual and structural links with Darwin's theory. Then, the ecological-population theory of evolution which developed from mathematical ecology, and genetic-population theory of evolution which came into being as a peculiar methodological extension of Hardy-Weinberg's law; both play a significant role in contemporary evolutionary biology. [Lastowski 1976, 1982a, 1987]. I shall present these schematically in further sections of this text.

1.2 Tasks of the present text: the reconstruction of the structure of evolutionary theories and the relationships between them

There are two main tasks of the present text. The first consists in the presentation of the theoretical structure of the above-mentioned evolutionary theories. I shall try to do this within the methodological framework of the idealizational theory of

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science. This methodological apparatus was first used to analyse biological theories in the seventies [Lastowski 1976]. The research was further extended in the eighties [Lastowski 1981; Lastowski 1982a; Lastowski 1982b; Lastowski, Nowak 1982c; Lastowski 1987] and in the nineties [Nowak 1993].

The earlier works critically examine the traditional account of the theoretical-methodological status of the theory of evolution. They show that it derives from a simple positivistic belief that the model of evolutionary cognition is based on imaging a biologist as a traveller who gathers observational data in person, analyzes them, makes comparisons, notices mutual relationships (e.g. recognizes affinity) between species and then, if necessary makes generalizations of empirical data [Jacob 1973]. Supporters of this view claim that, owing to these abilities, Darwin managed to formulate the law of natural selection and to build a theory of an evolutionary process explaining the mechanism of the origin of species. It is also on this basis that the majority of biologists assume that Darwin himself embodied such an ideal of biological cognition. This positivistic view still belongs to the methodological beliefs shared by many biologists-evolutionists. Curiously enough, these beliefs are accompanied by a faith in the explanatory significance of hypothetic-deductive methodology. This view was criticized in the works which discussed the real status of an evolutionary theory [Lastowski, Nowak 1982c; Lastowski 1987; Nowak 1993]. I shall discuss basic reasons for rejecting it in section 2 where I present a statement form of the theory of natural selection. Its theoretical as well as idealizational extension are the three already mentioned evolutionary theories. Each of them refers to a specific aspect of the course of an evolutionary process.

The other task of the present text consists in the presentation of a network of definite methodological relations which hold between evolutionary theories. They compose a structure: a map of methodological relationships in which the above-mentioned evolutionary theories are immersed which is one of the most important features of an idealizational structure of evolutionary biology. Its real cognitive significance consists first of all in its peculiar "grammatical" structure of evolutionary thinking. This conceptual network allows us to oppose effectively a traditional (positivistic, as well as falsificationist) view of the nature of evolutionary cognition. At the same time an idealizational form of evolutionary theories (understood as a map of theoretical-methodological relationships) can serve as a guide in the search for new developments in evolutionary knowledge.

2. The idealizational structures of main theories of evolution.

Before proceeding to the fundamental question concerning the form and cognitive features of evolutionary theories let us consider a preliminary problem: how long has idealization been applied in biology?

It is commonly accepted in biology that the publication of Darwin's theory was a theoretical breakthrough. Indeed, it was a theoretical breakthrough but what strikes us most are the means by which it was achieved. Normally a biological theory does not inform us about the cognitive tools a researcher was forced to appeal to when he was producing a new theoretical vision. The case of Darwin is

different [Nowak 1993, Lastowski, Nowak 1982]. It turns out that Darwin was forced to break completely with the existing picture of the biological world in order to proclaim new rules of succession (in time/history and space) of biological species. It was his grandfather, Erasm Darwin, who had presumed that biological species exhibit the specific capacity to transform from one to another and presumed that these transformations were imposed by the environment. It was this way of thinking that Charles Darwin followed ignoring the various descriptions of the variety of the living world. His main aim was to find a universal principle which would explain the emergence of new species. In answer to the problem why certain groups of organisms survive while others die, he claimed that it was "natural selection" that was decisive. He understood it as the principle which determines the survival of organisms (and of groups of them) with favoured biological characteristics (fitness) and which eliminates those which are harmful. Opponents to the idea of evolution responded immediately to his theory of natural selection. One of the fundamental objections against it was that it is impossible to observe the relation postulated by Darwin between any species and the conditions in which it lives. These opponents had overlooked the fact that Darwin's law of natural selection was a counterfactual statement and as such did not come under direct testing by observational data. This was, among other things, what the Darwinian turn consisted in [Lastowski, Nowak 1982]. Thus the theoretical revolution made by Darwin consisted in formulating an initial and, at the same time, basic model of the theory of the evolution of species. He considered natural selection as a basic relationship -a regularity to which all living organisms are submitted, while other factors (e.g. variety and changeability of hereditary characteristics, capacity, isolation, sex selection, etc.) to be of secondary importance and merely disturb evolutionary regularity.

But Darwin's theory represented more than the theoretical breakthrough [Nowak 1993; Lastowski, Nowak 1982]. It was a methodological breakthrough too since he formulated the fundamental model of the theory of natural selection [TNS]. During this construction he made use, not fully consciously, of an idealizational procedure for building a theory [Lastowski 1981, 1987; Nowak 1993]. Let me present below a brief reconstruction of the main elements of this model.

2.1 Darwin's theory of natural selection [TNS]

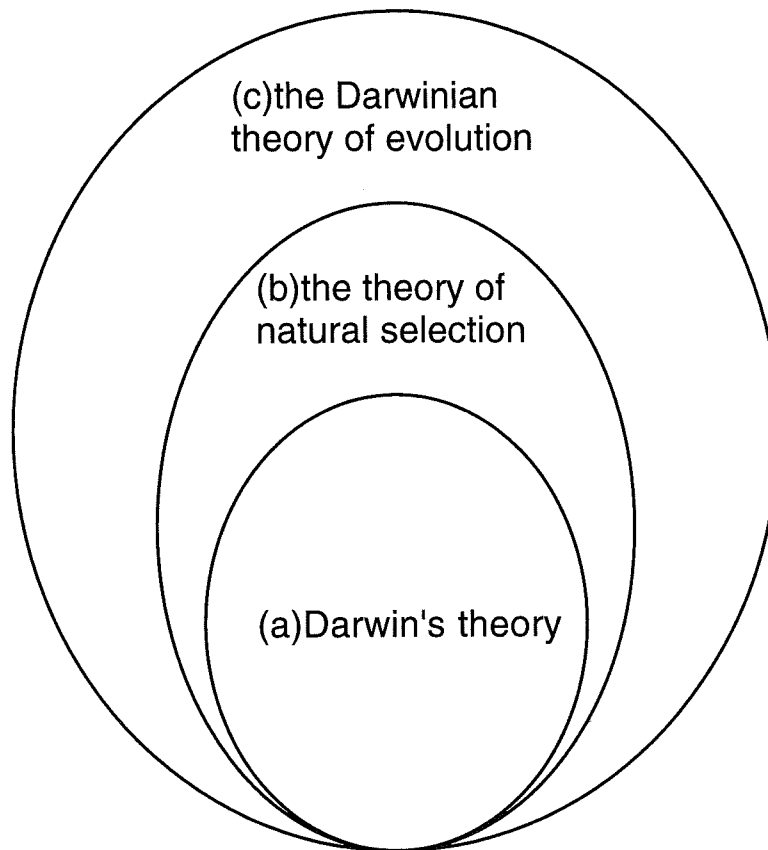
Biologists have repeatedly tried to answer the question about the content of Darwin's theory. The analysis of the title of his fundamental work *On the Origin* [Darwin 1959] seems to provide an introductory answer. The title of Darwin's work in its full form is as follows: *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. As can be seen, this title treats of two themes which are fundamental for understanding an evolutionary process: the existence of a species (of its races) and the origin of species. The first theme can be represented by the thesis: "favoured races, competing with one another, determine the existence of a species" says that the existence of a species is guaranteed by a permanent struggle for life, that is by

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competitive struggle and advancement of particular races (populations) which compose the structure of a species. Those fitter and better adapted to the circumstances in which they live increase the chance of survival by yielding a greater number of offspring. The second theme was expressed by Darwin in the form: "the origin of species out of those already living is the result of the mechanism of natural selection" This indicates a fundamental mechanism for the emergence of a new species. Both themes do not exhaust all the circumstances which accompany the process of evolution but determine the most essential of them. Darwin writes about it in the last sentence of his Introduction to *On the Origin* when he states: "natural selection was the most important although not the only factor of transformation of species" [Darwin 1959].

In the light of the above remarks an introductory answer to the question what is the content of Darwin's theory takes the form of a statement that it is a theory of the existence of species (theory of the struggle for life) and of the origin of species (theory of natural selection). Though in the remaining parts of his work Darwin introduced new elements in his theoretical framework by enumerating further essential factors which influence the process of the evolution of species. He points to, for example, isolation, sex selection, fitness of population and its capacity as co-determinants of the fate of a species.

It seems that Darwin's views on the evolution of species are expressed in three ways: (a) as the discovery of the essence of an evolutionary process of species. This discovery is exhibited in both theses indicated in the title of his work (this view is confined to the fundamental evolutionary relationships); (b) as the conception that not only considers basic evolutionary relations but also takes into account particularly important circumstances which accompany the struggle for life and natural selection (such as principles of hybridization of individuals, environmental conditions and their typical changes and isolation); (c) as the developed conception which by adding new essential factors (such as the capacity of a species, sex selection, density of a species, etc.) forms a complete theory. The conception that conforms to (a) can be conceived of as Darwin's theory in the strict sense, the one conforming to (b) is the theory of natural selection and that conforming to (c) is the Darwinian theory of evolution. Relations between these conceptions can be presented as an inclusion.



Thus Darwin's work contains three senses of the evolutionary mechanism but only two of them have been presented there more or less completely. The third, which is the broadest has only been outlined. Darwin left the completion of the whole theory to his followers. What is puzzling is how to extend (b) in order to effectively achieve (c)? An answer to this question was possible only when the synthetic theory of evolution was announced. That is when the genetic component was thoroughly studied (according to the chromosomal theory of heredity) and when interactions between mutation, recombination and changes of environmental conditions were taken into account as those factors which modify the process of the evolution of species [Lastowski 1987].

Below I shall first present a structure of the theory of evolution in the senses of (a) and (b) and then I shall proceed to its full version in the sense (c).

In order to be able to, reveal the essence of the mechanism of the origin of species one should radically simplify the phenomenon of evolution by reducing it to the relationship between two elements: the system of cross-breeding of living organisms (the system of hybridization) and the environmental conditions under which organisms live. But this does not suffice since additional constraints have to be imposed on this model. We have to assume that the system of crossings as well as environmental conditions do not change in time. Only in such a simple situation can a fundamental relationship of the theory of natural selection -the law of natural selection- be formulated [Lastowski 1987]. I shall confine myself to outlining

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here merely a fundamental structure of that conception. I shall neglect numerous epistemological and methodological questions which I dealt with in my earlier works [Lastowski 1981, 1982b, 1987, 1990, 1991, 1992, 1993] as well as those which were recently analyzed by Nowak [1993].

So let me pass on to the presentation of the fundamental structure of the theory of natural selection. I call the first statement of the fundamental model the law of natural selection because it states the main relationship which regulates the existence of a biological species. The law says

[NS] If environmental conditions in an area inhabited by a set of populations are constant and the effects of hybridization are constant and populations are one-generational, then that fraction of the set of populations survives which maximizes the criterion of adaptation to environmental conditions in this area.

If we take into account that biological species are multi-generational, then the above formulation **[NS]** will be transformed into a statement called in biology the "law" of stabilizing selection **[NSS]**

[NSS] If environmental conditions in an area inhabited by a set of populations are constant and the effects of hybridization are constant and populations are multi-generational, then that fraction of the set of populations spreads which maximizes the criterion of adaptation to environmental conditions in this area and the level of the criterion is constant.

We obtain the next statement of this theory when we further enrich its contents (by concretizing it in the sense ascribed to it in the idealizational theory of science) and introduce -separately- the positive and negative effects of hybridization. These evolutionary regularities are called progressive natural selection and regressive natural selection and are described in statements **[PNS]** and **[RNS]**. The former determines the spread of a population -its development, while the latter determines its descent, when its capacity falls and a species begins to become extinct. They assume the following form

[PNS] If environmental conditions in an area inhabited by a set of populations are constant and the effects of hybridization are constantly progressive and populations are multi-generational, then that fraction of the set of populations spreads which maximizes the criterion of adaptation to environmental conditions in this area, and the level of the criterion increases (i.e. it is easier for their descendants to spread).

[RNS] If environmental conditions in an area inhabited by a set of populations are constant and the effects of hybridization are constantly regressive and populations are multi-generational, then that fraction of the set of populations spreads which maximizes the criterion of adaptation to

environmental conditions in this area, and the level of the criterion decreases.

The above statements describe an evolutionary process which still takes place in constant environmental conditions. I have assumed here that minimal oscillations or changes in the living conditions of a species can be neglected as not exerting essential influence on the course of evolution. But when considerable changes of environmental conditions occur they are of great importance to the process of evolution and the fate of a biological species. It is the change of conditions that can contribute to the modification of adaptive fitness and result in the extinction of a whole species or a considerable part of it. But a reverse situation can also happen -although this seems to occur quite rarely- that a species will increase its capacity under new conditions. This is the subject of another statement of the theory of natural selection -the "law" of directionally stabilizing selection [**NSDS**].

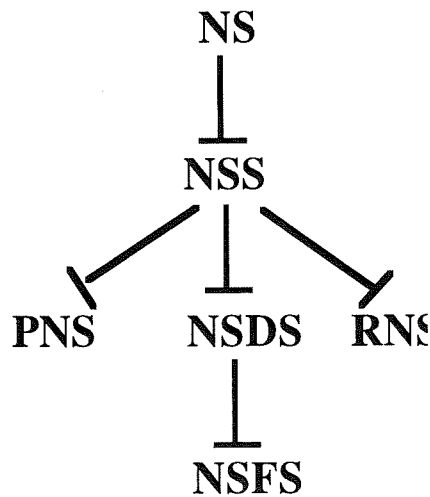
[**NSDS**] If environmental conditions in an area inhabited by a set of populations change in a uniform way and the effects of hybridization are constant and populations are multi-generational, then either all populations become extinct or there appears a fraction which satisfies the new criterion of adaptation and begins to spread under these new conditions.

But a uniform change of environmental conditions on the whole area occupied by a given species happens only in exceptional cases. Therefore we should consider a case with uneven change of conditions in the area occupied by a given species. In other words we can assume that environmental conditions change heterogeneously, i.e. in some subarea conditions change whereas in some other subarea changes do not occur. Such a situation initiates a process which in evolutionary biology is known as a "differentiating natural selection". It is described by the "law" of fractionally stabilizing natural selection [**NSFS**].

[**NSFS**] If environmental conditions do not change in the same way in the area inhabited by a set of populations and the effects of hybridization are constant and populations are multi-generational, then either in a certain sub-region all populations will become extinct or there will appear a fraction of them which satisfies the new criterion of adaptation and begins to spread under these new conditions.

These statements above compose the fundamental structure of the theory of natural selection. Its possible extensions -according to Darwin's own ideas- should take into account further factors of evolution, such as geographical or biological isolation, sex selection and others. But I shall confine myself to the above six statements. The most basic among them is the law of natural selection [**NS**]. It is the most idealized statement which pertains to an evolutionary situation of a purely theoretical character. The remaining statements are obtained as concretizations of the law [**NS**]. This theory structure can be presented in the following graphic form

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where: "——|" is a relation of concretization.

The theory of natural selection developed into a network of particular items of knowledge about evolutionary processes. A reconstructive part of the present text consists in displaying the network of conceptual relations (laws and theories) between different evolutionary accounts. The original part of this network -which initiated further developments -was presented by Darwin himself.

I shall now pass on to further conceptual extensions of the theory of evolution. The next theory is the synthetic theory of evolution formulated between the nineteen thirties and fifties.

2.2 The synthetic theory of evolution [STE]

According to distinctions drawn in the present text, the synthetic theory of evolution is a realization of the Darwinian idea of constructing a complete theory of the evolution of species. The outline of this theory refers to the Darwinian project in the earlier mentioned sense (c). That means that a hard core of the classical theory (i.e., the theory of natural selection) is retained in the structure of synthetic theory. But even this hard core has undergone transformation. Essential conceptual changes occurred in the course of the development of evolutionary knowledge from the classical formulation to the synthetic account, for instance, the notion of hybridization which applied to different sources of change of biological fitness. Owing to the development of experimental genetic research a chromosomal theory of heredity was formulated. On its basis, mutation and recombination were recognized as distinct phenomena and then introduced in the theoretical structure as factors which determine the changeability of biological fitness. They essentially modify formulations of the classical version of the law of natural selection. Therefore, they were considered in the idealizational reconstruction of statements of the synthetic theory. In the antecedents of these statements both these factors appear in the idealizing conditions. In effect, when the conditions are removed and

both factors considered as influencing populations' fitness also consequents of these statements are properly modified [Lastowski 1992]. Despite these modifications the synthetic version of the theory of evolution is similar to Darwin's own account (in senses (a) and (b)). But its global "picture" clearly differs from the initial form since it is more extended and takes into account circumstances that Darwin was unable to consider. In sum, the version of synthetic theory presented here still retains the formal structure of an idealizational theory. Its extensions are concretizations of an initial formulation of the law of natural selection.

The fundamental statement of the synthetic theory of evolution is also the law of natural selection. Its formulation refers to the traditional shape of the law [NS]. But the fundamental structure of the synthetic theory of evolution -in the idealizational reconstruction presented by me- consists of 26 statements. The law of natural selection [S-NS] is basic, then there are its extensions -concretizations- which describe more and more complex evolutionary situations.

Since it is impossible to present the complete form of the synthetic theory here, I shall confine myself to a short presentation of those parts of this theory which show close relations with the classical account as well as those which are new and specific extensions of this fundamental structure. I shall begin with the basic statement of the synthetic theory -the law of natural selection [S-NS].

[S-NS] If environmental conditions in an area inhabited by a set of populations are constant and the effects of recombination are constant and mutations do not occur and populations are one-generational, then that fraction of the set of populations survives which maximizes the criterion of adaptation to environmental conditions in that area.

It is easy to notice that the above formulation is almost identical with the statement [NS]. The essential change occurred in the antecedent of that sentence, that is, new essential but secondary factors are introduced. Further statements take a similar form. To those which determine the specific contents of this theory belong the following, among others

[S- NSSm1] If environmental conditions are constant, the effects of recombination are constant and mutations are neutral and populations are multi-generational, then that fraction of a set of populations spreads which maximizes the criterion of adaptation to environmental conditions, and the level of the criterion is constant.

[S-NSSm2] If environmental conditions are constant, the effects of recombination are constant and mutations are positive and populations are multi-generational, then that fraction of a set of populations spreads which maximizes the criterion of adaptation to environmental conditions and in which there emerges a sub-population of mutants with a level of adaptation increasing with the rate of mutation (mutants spread faster than other individuals).

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[S-NSSm3] If environmental conditions are constant, the effects of recombination are constant and mutations are negative and populations are multi-generational, then that fraction of a set of populations spreads which maximizes the criterion of adaptation to environmental conditions and in which there emerges a sub-population of mutants with a level of adaptation decreasing with the rate of mutation (mutants spread slower than other individuals).

.....

[S-PNSm2] If environmental conditions are constant, the effects of recombination are progressive, mutations are positive and populations are multi-generational, then that fraction of a set of populations spreads which maximizes the criterion of adaptation to environmental conditions and in which there emerges a sub-population of mutants with a level of adaptation increasing according to the rate of mutation (mutants spread faster than other individuals).

.....

[S-RNSm2] If environmental conditions are constant, the effects of recombination are regressive, mutations are positive and populations are multi-generational, then that fraction of a set of populations spreads which maximizes the criterion of adaptation to environmental conditions, the level of this criterion is decreasing, and in which there emerges a sub-population of mutants better and better adapting themselves to environmental conditions.

[S-RNSm3] If environmental conditions are constant, the effects of recombination are regressive, mutations are negative, populations are multi-generational, then that fraction of a set of populations spreads which maximizes the criterion of adaptation to environmental conditions, the level of this criterion is decreasing, and, at the same time, there emerges a sub-population of mutants with the level of the criterion of adaptation that decreases with the rate of mutation (mutants become extinct faster than other individuals from that fraction).

.....

[S-PNSm3K] If environmental conditions change in a uniform way, the effects of recombination are progressive, mutations are negative and populations are multi-generational, then either population will become extinct, or there will appear a fraction in a set of populations which will maximize a new criterion of adaptation to new environmental conditions and which will consist of mutating individuals.

These statements show how various are the evolutionary courses of populations, or rather better or worse adapted fractions of these populations. These are not courses chosen freely, for the choice depends on internal circumstances, genetic outfit and

both factors considered as influencing populations' fitness also consequents of these statements are properly modified [Lastowski 1992]. Despite these modifications the synthetic version of the theory of evolution is similar to Darwin's own account (in senses (a) and (b)). But its global "picture" clearly differs from the initial form since it is more extended and takes into account circumstances that Darwin was unable to consider. In sum, the version of synthetic theory presented here still retains the formal structure of an idealizational theory. Its extensions are concretizations of an initial formulation of the law of natural selection.

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It is easy to notice that the above formulation is almost identical with the statement [NS]. The essential change occurred in the antecedent of that sentence, that is, new essential but secondary factors are introduced. Further statements take a similar form. To those which determine the specific contents of this theory belong the following, among others

[S- NSSm1] If environmental conditions are constant, the effects of recombination are constant and mutations are neutral and populations are multi-generational, then that fraction of a set of populations spreads which maximizes the criterion of adaptation to environmental conditions, and the level of the criterion is constant.

[S-NSSm2] If environmental conditions are constant, the effects of recombination are constant and mutations are positive and populations are multi-generational, then that fraction of a set of populations spreads which maximizes the criterion of adaptation to environmental conditions and in which there emerges a sub-population of mutants with a level of adaptation increasing with the rate of mutation (mutants spread faster than other individuals).

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[S-RNSm3] If environmental conditions are constant, the effects of recombination are regressive, mutations are negative, populations are multi-generational, then that fraction of a set of populations spreads which maximizes the criterion of adaptation to environmental conditions, the level of this criterion is decreasing, and, at the same time, there emerges a sub-population of mutants with the level of the criterion of adaptation that decreases with the rate of mutation (mutants become extinct faster than other individuals from that fraction).

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[S-PNSm3K] If environmental conditions change in a uniform way, the effects of recombination are progressive, mutations are negative and populations are multi-generational, then either population will become extinct, or there will appear a fraction in a set of populations which will maximize a new criterion of adaptation to new environmental conditions and which will consist of mutating individuals.

These statements show how various are the evolutionary courses of populations, or rather better or worse adapted fractions of these populations. These are not courses chosen freely, for the choice depends on internal circumstances, genetic outfit and

possible recombination and mutation changes, as well as external ones, that is, on environmental conditions and various changes of them.

Here a theoretician-evolutionist meets a challenge: how to compare the "cognitive value" of clearly similar accounts of the theory of evolution [TNS] and [STE]. A separate interesting point is the question how to explain differences between them.

2.3 The ecological-population theory of evolution [EPTE]

The ecological-population theory of evolution is an alternative approach -relative to the synthetic theory- to the problem of evolution of species. It refers to the Darwin's classical account, mainly to that part of his theory of natural selection that considers the concept of the "struggle for survival". It can even be said that ecological-population theory is a formal explication and further extension of this Darwinian category. The initial concepts of the theory are: the equilibrium of a population; its stability and instability; oscillations in capacity. The classical account is the proposal of V. Volterra [1931]. As E. Pianka [1974], along with M. Begon and M. Mortimer [1983] show, the reconstruction of the main statements of the ecological-population theory of evolution should start with Verhulst-Pearl's law as it describes the main ecological relation which determines the state of equilibrium of a population under given conditions of existence. I shall confine myself in this short presentation to basic statements and omit their graphic representations. The detailed discussion can be found in my book [Lastowski 1987]. The fundamental statement of Verhulst-Pearl's law refers to the evolutionary situation in which a species (population) living under given conditions reaches a certain capacity that is constant for the conditions in which it lives. This is called the carrying capacity. It can also be calculated or determined from the characteristic course of a logistic curve. It determines the moment in which a given species reaches the optimum of its capacity which means that it remains in a state of dynamic ecological equilibrium. The formulation of the law assumes the following shape [cf. Lastowski 1987]

[V-P] If there is no interspecies competition, all individuals of a given species are equivalent, carrying capacity of a population is constant and the rate of growth calculated for an individual is identical for every individual in a population, then the rate of quantitative growth is

$$dN/dt = rN \cdot (K - N)/K$$

where: dN/dt is the growth of capacity of a population, r is an index of the rate of growth (calculated on the basis of the difference between the birth rate and the mortality rate), N is the capacity of a species (population), K is the carrying capacity.

As can be seen, several simplifying assumptions were assumed in the above statement. They allow the determination of an optimal capacity for the phenomenon of the ecological equilibrium of a species; this is its ecological and evolutionary carrying capacity. Having determined this basic dependence we can proceed to

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analyse more complex relationships between a species and circumstances. Thus we can specify situations in which further factors begin to or cease to influence the initial capacity of a species (population). Other still more complex ecological situations will be considered below: (i) when in a given territory there are two species which compete with each other for the same type of food and (ii) when the two species are linked by the relation of a predator and prey -it means that the former (predator) feeds on the latter, whereas the latter (prey) acquires food independently of the former. These dependencies are described in the "laws" of Lotka-Volterra. The first Lotka-Volterra law states that [cf. Lastowski 1987]

[L-V*] If the individuals of two different species are equivalent and compete with each other for alimentary resources, the coefficients of their carrying capacity K_1 and K_2 are constant and the rate of growth r_1 and r_2 is a maximum, then the growth of the capacity of both competing species is described by the following equations

$$dN_1/dt = r_1 N_1 \cdot (K_1 - N_1 - \alpha N_2)/K_1$$

$$dN_2/dt = r_2 N_2 \cdot (K_2 - N_2 - \beta N_1)/K_2,$$

where the notation is the same as in the law [V-P] and the coefficients α and β describe the degree of competitiveness between the species.

The second law describes a still more complex situation

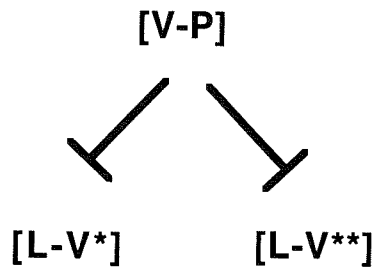
[L-V**] If the individuals of two species are equivalent and compete as predator and prey, the coefficients of the carrying capacity of these species are constant, the rate of quantitative growth is also constant, and stages of quantitative growth for both species are different, then the growth of the capacity of the species of predator and prey is described by the following equations

$$dN_1/dt = r_1 N_1 - p_1 N_1 N_2$$

$$dN_2/dt = p_2 N_1 N_2 - d_2 N_2,$$

where: N_1 is the capacity of the species of prey, N_2 is capacity of a population of predators, r_1 denotes the immediate rate of the growth of the capacity of prey (for each individual), d_2 is the mortality of a population of predators (for each individual), p_1 and p_2 are constants determining predacity. The product $N_1 N_2$ is the number of contacts between predators and prey, the expression $p_2 N_1 N_2$ is the maximum rate of growth of a species of predator, and the expression $p_1 N_1 N_2$ determines the decrease in the rate of growth of the capacity of the species of prey.

The three statements above are connected by certain methodological relationships. The relationship of the first kind is the relation of concretization which connects the law [V-P] with the statements [L-V*] and [L-V**]. Graphically it assumes the following form



The methodological hypothesis accepted here claims that the above presented structure of fundamental statements is a core of the ecological-population theory of evolution. The dependencies discussed here can be further complicated by the inclusion of more relations such as, for example, the relationships with trophic levels. That will make the structure of the theory very complex.

2.4 The genetic-population theory of evolution [GPTE]

In the traditional account, the genetic-population theory of evolution is not a clearly distinguished field of genetic knowledge. It is a part of population genetics which studies processes of the transformation of the genetic structure of species. It also analyzes both equilibrium states of the genetic structure of a species and situations when it is disturbed. Population genetics was founded upon Mendel's laws [Michod 1981]. As I remarked elsewhere [Lastowski 1976, 1982, 1987], the basic statement of this version of the theory of evolution is Hardy-Weinberg's law. It has two fundamental extensions: (a) the statements which describe transformations of the genetic structure of a population as the result of migration and/or mutation and (b) the statements which characterize transformations of the genetic structure of a population as the result of selection. I call extension (a) the theory of genetic polymorphism and extension (b) the genetic-population theory of evolution. As can be seen, I assume a clearly simplified version of the genetic-population theory of evolution. I do this in order to show its fundamental statements as well as their transformations with respect to secondary (though significant) factors which determine evolutionary changes in the genetic structure of a population. A "complete" picture of the genetic-population theory of evolution is much more diversified and complex [cf. Maynard Smith 1989]. The methodological analyses in the present paper are restricted to a simple form of this theory. But it suffices to disclose its peculiarities because only elementary knowledge from the field of population genetics is needed.

I will begin the reconstruction with the initial statement of Hardy-Weinberg's law. From a methodological point of view the formulation of the law is undoubtedly an idealizational statement since it refers to the genetic structure of a population (to be more exact, to its specific characteristics) and this population is conceived of as a "pure" theoretical object [Lastowski 1976, 1982a, 1987]. I present it in the following form

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[H-W] If in an infinitely numerous and randomly linked population there is no selection, mutation and migration, then the genetic structure of a population in subsequent generations is not subject to change (in the simple case of two alleles, the frequency of genotypes is in accordance with Newton's binomial distribution).

From an historical and theoretical point of view this statement is a starting point for a description of more complex situations including evolutionary ones. They are introduced by taking into account the effects of selection. I omit here the systematic reconstruction of this theory (It was presented in detail in Lastowski [1976, 1987]) and confine myself to several characteristic statements **[H- W_s_1]** describes the results of selection directed against all genotypes (a various degree of its intensity is allowed). **[H- W_s_2]** describes the results of selection directed against the genotype *aa*. **[H- W_s_3]** refers to selection which is directed against the allele *a*, and, finally, **[H- W_s_4]** determines the change of the genetic structure of a population when selection is directed against homozygotes *AA* and *aa* (the result is overdomination). These concretizations form the following sequence of statements

[H- W_s_1] If in an infinitely numerous and randomly linked population there is no mutation and no migration and selection is directed against all three kinds of genotypes, then the genetic structure of a population in subsequent generations changes in such a way that the frequency of genotypes declines in proportion to the degree of their selection.

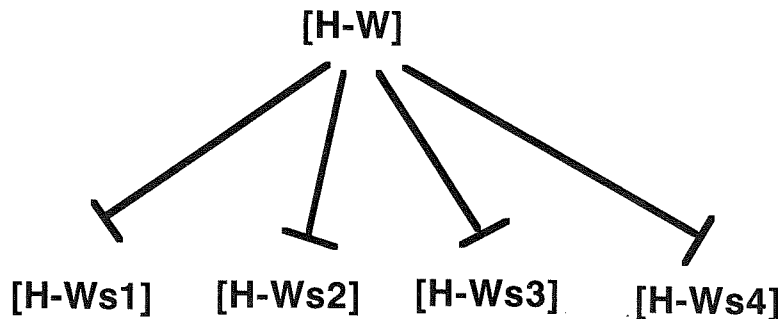
[H- W_s_2] If in an infinitely numerous and randomly linked population there is no mutation and no migration and selection is directed against the genotype *aa*, then the genetic structure of a population in subsequent generations changes in such a way that the frequency of the genotype *aa* drops by the value Δq for each handicapped allele *a*.

[H- W_s_3] If in an infinitely numerous and randomly linked population there is no mutation and no migration and selection is directed against the genotype *a*, then the genetic structure of a population in subsequent generations changes in such a way that the frequency of the allele *a* drops by the value Δq .

[H- W_s_4] If in an infinitely numerous and randomly linked population there is no mutation and no migration and selection occurs in the form of overdomination, then the genetic structure of a population in subsequent generations changes in such a way that the frequency of the homozygotes *AA* and *aa* drops by the value Δq .

These statements determine the fundamental structure of the genetic-population theory of evolution. They compose quantitative genetics because they define the measure of the frequency of genotypes and introduce appropriate corrections to them.

The graphic form of the structure of that theory is presented below



As can be seen, this theory of evolution also refers to the Darwinian conception, but only indirectly, by considering selection (or to be more exact, its various forms) as an important factor that influences the evolutionary process. Only the simplest cases have been indicated here; those which can be relatively easily determined and calculated. Complex cases are sometimes extremely difficult to calculate. Therefore researchers often content themselves with approximations. They take approximate values as satisfactory and postpone the precise determination of the frequency of genes or genotypes. This tactic can be also explained by reference to idealizational procedures [Lastowski 1987].

We can say that, in general, the idealizational account of science allows us to understand some forms taken by statements belonging to different versions of evolutionary theory. Furthermore, it allows us to demonstrate that the theoretical structure of evolutionary biology is not composed of units of evolutionary knowledge which are independent of one another but is composed of interdependent theoretical structures. The nature of these interdependencies between the evolutionary theories presented above will be discussed below.

3. Basic methodological relations in the structure of evolutionary knowledge.

3.1. Introductory remarks.

New theoretical proposals in the evolutionary flow of biological research are usually accompanied by an interesting phenomenon. Although it concerns the evolution of the animated world, the elementary unit of the process of evolution is treated rather differently in various scientific conceptions: in Lamarck's theory it is organisms that undergo evolution; according to Darwin it is a set of organisms differentiated as species (population) [Lastowski 1987]; for population genetics the unit of biological evolution is a set of genes [Lastowski 1987]. In brief, these three approaches determine three levels of evolution. Certainly there may exist other theoretical solutions but even then it seems that in the case interesting to us here they can be considered as possible modifications of the three alternatives above. One of the most common theories of biological evolution, the synthetic theory of evolution, treats population as the elementary unit of evolution, however, unlike Darwin, it includes the concept of genetic characteristics [Lastowski 1987].

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Biological theories which describe and explain the processes of evolution refer to different biological objects, and later I shall try to explain the differences between them. Using technical terms we could say that the variables of these theories range, at least in part, over different sets of objects. This very fact is sufficient to ascertain that relations which hold between these theories cannot be expressed in terms of the present version of the idealizational theory of science. This allows us to state that the following tacit simplification lies at the basis of the idealizational conception of science

(*) only intralevel domains are considered in science.

The counterfactual nature of this assumption appears to be quite obvious. The domain of the theory of evolution is not intralevel if three levels of evolution are studied:

- populations
- organisms
- genotypes

and such magnitudes as the frequency of a given genotype, which are supposed to depend on selection, among other factors, are taken into consideration.

It seems justified to reject the simplification (*) and introduce the following definition of the empirical domain of an idealizational theory

$$D(it) = ((it)U, F, Z),$$

where $(it)U$ stands for the sum of sets i^1U, i^2U, \dots, i^tU (for $t \leq n$), and at least certain magnitudes from the set F penetrate the mentioned sets of objects while at least certain relations of the type Z occur between them. When $t = 1$, the domain $D(it)$ is intralevel, when $t > 1$ this domain is interlevel (this results in the conclusion that at least certain magnitudes from the set F are interlevel too). In the extreme situation $p = t$, the domain will be defined as full (which will lead to the statement that at least a few magnitudes F are also full).

The methodological consequences of the fact that theories are formed on domains of the type $D(it)$ rather than intralevel domains of the D^i type result in the conclusion that these theories can be applied to explain interlevel domains and to search for a new type of methodological relationships which one has not been able to take into consideration as yet, based on the idealizational conception of science.

3.2. The concepts of concretization and dialectical correspondence.

In the idealizational theory of science the basic concept in which intertheory relations are considered is dialectical correspondence. Let it be given an initial statement

$$[1] \text{ if } U(x) \text{ and } p(x) = 0, \text{ then } F(x) = f(H(x)).$$

If [1] is rejected later and the factor q is identified as the source of deviations from [1] and, more exactly, deviations from the approximation of this theorem, [1] obtains a more abstract form

[2] if $U(x)$ and $p(x) = 0$ and $q(x) = 0$, then $F(x) = f(H(x))$.

And next a concretized form

[3] if $U(x)$ and $p(x) = 0$ and $q(x) \neq 0$, then $F(x) = g(H(x), q(x))$,

[4] if $U(x)$ and $p(x) \neq 0$ and $q(x) \neq 0$, then $F(x) = h(H(x), q(x), p(x))$.

Then, in accordance with a general definition of the relation characterized here, we can state that [2] corresponds dialectically because of the concretizing sequence ([3], [4]) -with the starting theorem [1]. As has already been claimed, this is the most elementary type of relation between (simple, linear) idealizational theories allowed by the idealizational theory of science.

It should be noted now that the relation characterized here does not hold true, because of its definition, for any such two theories of biological evolution where one theory places its elementary unit of evolution at one level (e.g. population) and the other at a different level (e.g. genetic) . The same applies to other variants of the relation of dialectical correspondence including that which takes approximation into account . [Nowakowa 1975; Nowak 1980] or the operation of consequence [Nowakowa 1975] as well as relations of, for example, dialectical negation which in the idealizational conception of science are believed to link subsequent scientific theories. This can be explained by the fact that theorem [2] is equipped with the same realistic condition as theorem [1] and that means that the variable from [2] ranges over the set of the same objects as the variable from [1]. It has already been shown that a situation like that does not occur for those theories of biological evolution which refer to different evolutionary levels.

The above leads to the following conclusion: the definition of dialectical correspondence, or even more generally, the conception of the development of scientific theories in the idealizational theory of science, needs modification. In its present form it is not suitable for methodological reconstruction of at least certain developmental processes in the theory of evolution.

3.3. Intralevel and interlevel magnitudes

The reasons why the idealizational conception of science is, in its present form, unable to grasp relations between certain theories of evolution is due to the fact that it does not attempt to find explanations of phenomena taking place at different levels of complexity of matter. A tacit simplification which supports this conception is the consideration of objects of the same level of complexity. Saying that gives no explanation of the problem which we shall now try to present in greater detail. It is obvious that the decision as to which objects are simple depends on the type and aims of the research. Complexity means different things for a sociologist, economist or biologist. An economist looks upon a human being as a simple object whereas for an anatomist it is a system of great complexity.

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Let us begin with the intuitive understanding of the term "part". An object whose set of parts is empty will be called simple. An object the parts of which are all other objects creates the relevant universe. Objects which are found between the two extremes of the lowest and the highest complexity belong to those of intermediate complexity: an object of the i -th order has parts which are objects of, at most, $i-1$ -th order. Going back to the main subject of our considerations here, let us take into account a sequence of sets: ${}^0U, {}^1U, \dots, {}^nU$, where ${}^0U = U$ and the following conditions are fulfilled:

- (i) for each $x, y \in {}^iU$: neither x is a part of y , nor y is a part of x ;
- (ii) for each $x \in {}^iU$ there exist objects y_1, \dots, y_m , which constitute all the parts of the object x and are only of, at most, $i-1$ -th order.

However, for a certain $y_j, y_j \in {}^{i-1}U$ (where $j = 1, \dots, m$, and $i = 1, \dots, n$).

Intuition tells us that determining such sequences is essential when we wish to investigate relations between biological objects of different levels of complexity. For instance, when biologists distinguish an individual level of complexity, they consider among others the relations among individuals which allow for the characterization of a population level of complexity. When, however, they distinguish a genetic level of complexity, they refer to such relations which enable them to characterize the individual level of biological objects, etc. Generally speaking, objects of the $i-1$ -th order (individual level) are used for building the i -th level (biological object called population).

Before I go any further I should first comment on the condition (ii) which idealizes real situations. It is true, for instance, that the individual level iU does not consist entirely of genes; it contains other biological objects (being appropriate elements of sets from the distinguished sequence) such as enzyme, tissue, organs, etc. Such a simplification is acceptable here because the subjects of investigation in this case are not biological objects (population, individuals, genes) but theories which describe them. Therefore, a simplification in the nature of objects enables a more exact presentation of the relations between theories. Let us pass on now to establishing certain essential conceptual assumptions by determining a standard definition of magnitude [Kmita 1975]. F will be called an intralevel magnitude if the domain of it, Z_F , is a subset of any of the sets 0U or 1U or ... or nU . A distinction can be made between intralevel and interlevel magnitudes where interlevel ones have their domains across more than one set ${}^0U, {}^1U, \dots, {}^nU$. It can be stated then that F is an interlevel magnitude if Z_F is a subset of a certain sum ${}^i1U \cup {}^i2U \cup \dots \cup {}^inU$ and the products $Z_F \cap {}^i1U, Z_F \cap {}^i2U, \dots, Z_F \cap {}^inU$ are all non-empty. We shall say that an interlevel magnitude penetrates sets ${}^i1U, \dots, {}^inU$. If an interlevel magnitude penetrates all sets ${}^0U, {}^1U, \dots, {}^nU$ it will be called a "full interlevel magnitude" (then $i = n$), in other cases we can use the term "partial interlevel magnitude".

3.4 The procedures of aggregation and disaggregation

I will characterize the procedure of aggregation with a simple intuitive example. Let us suppose that a population of animals or plants is given. Its survival in a given

environment depends first of all on two factors: genetic characteristics (genotype) and morphological characteristics (phenotype). Adaptation of a population and its evolutionary persistence is determined, to use traditional biological terms, by both genotype and phenotype. So the structure of factors which determine fitness of a population understood in this way consists of factors which are "stretched" on objects belonging to two levels: a genotype level and a phenotype level. Thus the essential determined factors ("dependent variables") are the two-level ones of a genotype-phenotype character. But in their research practice supporters of the ecological-population theory of evolution explain the survival of a population by pointing to its favourable features (favourable phenotype). So they consider the factor which is located exclusively on a phenotypic level. Supporters of the genetic-population theory of evolution point to factors of a different kind. They strongly emphasize the fundamental importance of a genotype as influencing the fitness of a population. Thereby, they restrict the picture of an evolutionary process to a single level which is a genetic one. In both cases the evolutionary process and fitness of a population is described and explained by the appeal to factors of one level only. This means that in both theories the phenomenon of the fitness of a population is aggregated either to phenotypic or to genotypic factors.

The above simplification is not shared by the adherents of the synthetic theory of evolution [STE]. They try to conceive of the fitness of a population as being determined on two parallel planes, i.e. on a genotypic and a phenotypic one.

Let me present it more precisely. If we assume that the empirical domains of the theory are domains of the $D^{(it)}$ type, then the theorems describing them should include the theses of the types presented above. The theses may be factual or idealizational, respectively, in the sense of the model of the idealizational conception of science as considered so far. However, there appears the possibility for the conceptualization of a procedure, which is as yet unknown in the idealizational conception of science, in the introductory characterization of the initial form of theories implicitly belonging to milestones in the evolutionary flow of contemporary biology. Let us consider the following situation. The considered magnitude F is being determined by a magnitude which is known to be the interlevel magnitude $1-2H$. Yet, for the sake of simplicity it is counterfactually assumed that

(a) $1-2H$ is treated as if it were the intralevel magnitude $1H$.

Of the two components of $1-2H$, namely $1H$ and $2H$, only the former is being considered. This is what aggregation consists in. Under (a) a certain statement about F is put forward (aggregative statement). The latter is based on the simplification (a) and, therefore, must be "brought closer to the reality" by removing (a) and accounting for the very fact that the F is determined by the interlevel magnitude $1-2H$. Taking into account the influence upon F originating from the second component $2H$ is termed disaggregation of the initial aggregative statement about F . In aggregation one overlooks the fact that the magnitudes are interlevel and one ignores the interlevel relations, while in disaggregation taking that fact into account leads to the introduction of corrections which express such relations.

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It seems that procedures like those presented above, i.e. aggregation and disaggregation, were implicitly used in the theory of evolution. Hardy-Weinberg's law, for example, does not mention selection i.e. the effects of natural selection operating on the level of a population; ecological-population theory as seen by Lotka-Volterra leaves out the genetic effects which are noticeable at the genetic level. All this points to the fact that those methods may be found in evolutionary biology.

4. The scheme of methodological relationships between theories of evolution

I will try to survey the basic theoretical relationships between evolutionary theories discussed so far. What I claim is that they form a kind of network of theories. There is not enough space here to describe in detail all relationships that are worth consideration. Therefore, I will confine myself to a sketchy characterization of the network of the four theories of evolution. A fuller description can be found in Lastowski [1987].

4.1 The structure of the map of evolutionary theories

Let us begin with considering the relationship between the theory of natural selection [TNS] and the ecological-population theory of evolution [EPTE]. On the one hand, the essence of [TNS] is the law that determines the relationship between the characteristics of a species and the conditions in which that species lives. Obviously it is the law of natural selection. The essence of [EPTE], on the other hand, is the statement that determines circumstances in which that relationship between characteristics and conditions (that is natural selection) provides a species with optimal fitness, that manifests itself in the optimal capacity of a species. So there is a conceptual relationship between the law of natural selection [NS] and Verhulst-Pearl's law [V-P]. If we take into account more complex evolutionary circumstances and introduce appropriate corrections to that law, i.e. consider Lotka-Volterra's "laws" we will get a more subtle relationship with more accurate descriptions of: (i) the optimal conditions for the carrying capacity of a species; (ii) the time stages in which such competitive relationships between species occur so that the whole system could preserve relative dynamic equilibrium. I am inclined to call the relation occurring between [TNS] and [EPTE] *-the relation of intralevel correspondence*. Such a relationship tacitly assumed helps to describe various evolutionary situations [Lastowski 1993].

Relationships of a different kind occur between [TNS] and the synthetic theory of evolution [STE]. I shall point to two such conceptual relationships. The first of them is related to the fundamental statement of both theories. In both theories this is the law of natural selection. But in each this statement takes a different form. Comparing the basic law of [NS] with that of [S-NS] we can see that both have the same consequent but their antecedents are different. This means that the description of essential dependence called natural selection has not been changed and what has been changed consists in the conceptual modification of factors which determine the course of natural selection. It happened in such a way that a general

picture of a system of cross-breeding has been replaced with two factors: recombination and mutation which independently (but also in combination - in more complex situations) influence the final result of adaptation. From a methodological point of view we have here the relation of the *paraphrase* of the concept of heredity and the relation of *translation* introduced by the disaggregation of the concept of heredity. In other words, the phenomenon of heredity was decomposed into two concepts: recombination and mutation. Both paraphrase and translation have been defined in detail in Lastowski [1987]. Let us add that the appearance of mutation as a new factor in [STE] has significant consequences. I discuss it in Lastowski [1992]. The second conceptual relationship between [TNS] and [STE] is the decomposition of the concept of natural selection from a one-level into a two-level one. Thereby [NS] remains with [S-NS] in the following relationships: *dialectical correspondence, paraphrase and disaggregation*.

Another conceptual relationship occurs between Hardy-Weinberg's law [H-W] and the genetic-population theory of evolution [GPTE]. It consists in the transformation of a description of the state of genetic equilibrium into a description of nonequilibrium states by means of the acknowledgement of the influence of selection on a genetic structure of a population/species. From a methodological point of view it is the result of the application of the relation of *concretization* to [H-W]. This concretization is accompanied by the relation of *disaggregation* which basically retains, in the contents of the concept of selection, merely a simple "eliminative" effect of selection. This is shown in the form of handicap of some alleles or genotypes in comparison with other, normal ones.

There are also still other items on that map of conceptual relationships. One of them is the relation of *aggregative paraphrase*. It occurs between the law [H-W] and [STE] in such a form that [STE] describes transformations of a species/population in a genetic language in which mutation is defined as a way of changing the factors determining the evolution of species.

The kinds of conceptual relationships mentioned so far link the basic models of the four discussed theories. One can look for other theories of evolution and try to determine new types of relations. One can also extend an evolutionary picture by such factors as: behaviour, sexual behaviour (sex selection), kinship selection, altruism, etc. A certain special form of the theory of evolution has recently been proposed by Kimura [1983]. Namely, he has presented the neutralistic theory of evolution [NTE] in which genetic drift and neutral mutations are of fundamental significance: (cf. also: W. Makalowski [1991, 1992]). The problem of the relation between this neutralistic theory and the other theories in evolutionary biology has been discussed by W. Makalowski. In his works he additionally developed the synthetic theory of molecular evolution [STEM] and considered what kind of statements should occur in the theory of molecular evolution [Makalowski 1991, 1992].

4.2 Models of evolution

Apart from a network of conceptual relationships, one can also draw an outline of evolutionary models as well as to make an introductory classification of them. I

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shall content myself with a brief presentation how they can be arranged with respect to the above-mentioned theoretical-methodological relations. The classification of models of evolution proposed here should start with a division into fundamental models i.e. classical and nonclassical ones. The next step consists in the division of theories according to such criteria as (i) the fundamental components of a theory and (ii) the degree of complexity of the object that evolves. In effect we obtain the following classification of evolutionary theories

Theories of evolution

I. Classical

1. Darwinian

1.1. Classical Darwinism [TNS]

1.2. Classical extended Darwinism

[TED]

2. Neodarwinian

2.1. Classical neodarwinism [STE]

2.2. Extended neodarwinism [EPTE]

II. Nonclassical

1. Neodarwinian

(The genetic-population theory of evolution [GPTE])

2. Nondarwinian

2.1. Simple [NTE]

2.2 Mixed [STEM]

5. Recapitulation

I have attempted to show that the contemporary theory of evolution is not divided into separate, partially independently functioning units of theoretical knowledge, but that it is a system of components of biological knowledge. Elements of this system are connected to each other by means of theoretical-methodological relations. They are bound together in such a way that despite the fact of their belonging to distinct domains they provide knowledge which can be "merged" by a biologist-evolutionist, according to his cognitive needs. These problems become more and more often the subject of methodological studies. That is especially needed as contemporary evolutionary biology does not have at its disposal a reliable basis for methodological reflection although there are praiseworthy exceptions such as Wojcicki [1991]. He was the first to present Mendel's laws in the form of a formalized axiomatic system. It seems to me that a more effective way of theoretical and methodological research upon biological theories (especially theories of evolution) is the idealizational theory of science. The application of idealizational procedures results in a relatively clear global map of the network of basic theoretical statements of evolutionary biology. The system they form is not fully formalized nor axiomatized. But it renders, at least approximately, the structure of the content of this domain of biological knowledge. I would say that it is rather a system of a quasi-formal nature.

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