Functional Biology and Evolutionary Biology: A Different View of the Origin of Living Things

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Abstract

The distinction proposed by Ernst Mayr and François Jacob between functional biology and evolutionary biology is a fundamental key for a clear and conclusive treatment of two problems that, recurrently, are placed in the field of the Philosophy of Biology: that which concerns the possible character teleological of biological explanations and that relative to the autonomy of Biology in relation to Physics and Chemistry. Without supporting an alternative solution for any of these problems, we present that opposition showing its relevance for the treatment of such issues. Our idea is that they should not be raised without specifying which of the two domains of life sciences we are referring to.

Keywords: *Functional Biology; Evolutionary Biology; Philosophy of Biology.*

A. INTRODUCTION

Let us begin, then, by recalling that, from the publication of Cause and Effect in Biology in 1961 (Grosicki et al., 2018), to the publication of This is Biology in 1995, Ernst Mayr has always insisted on the idea that every living phenomenon, unlike what happens with inanimate phenomena, it can, or even should, be thought of in virtue of two different types of causes: the proximate causes that, being common to the order of the living and to the physical order, tell us how it is that something happens; and the ultimate or remote causes that, being specific to biological phenomena, tell us why it occurs.

That is to say: to the consideration of the proximate causes that explain to us how the individual organism works and is constituted, we must add the study of why the organism works as it does and has the form that it actually has (Xia, 2018). Thus, while the fulfillment and development in each individual organism of the processes ruled by its genetic program can be explained by virtue of proximate causes that, at least as far as Biology is concerned, can also be called "functional"; the origin and modifications of such programs are phenomena that must be explained by appealing to remote causes that, Darwinism involved, can be called "evolutionary" (Eder et al., 2018). A specific example of a biological phenomenon to be explained, such as sexual dimorphism, will be useful to illustrate this distinction (Kriventseka et al., 2019): its proximate cause could be identified with hormonal factors that would allow us to know how are these sexual differences produced; being that these hormonal factors can be, in turn, analyzed and explained in terms of molecular mechanisms. However, if, relatively independently of these opportunities that molecular biology gives us, we ask ourselves why this dimorphism is present or more accentuated in some species and absent or less accentuated in others, it is possible that the explanation due to proximate causes we are no longer satisfied.

We can, it is true, insist on it and affirm that this difference is due to the fact that in the case of dimorphism certain physiological processes are produced or accentuated (always explainable and analysable, of course, at the molecular level) that are absent or attenuated in the others cases. But, if we proceed in this way, we would simply be postponing the problem of determining why these physiological processes occur or are accentuated in one case and not in another; and, instead, we would be insisting on an increasingly detailed description of how this dimorphism occurs.

Therefore, there must be another set of causal factors, completely different from the previous one, that allows us to explain these differences; and, according to Kriventseva et al. (2019), that second set of causes, that of evolutionary or remote causes, could be constituted, in this specific case, by a network of selective pressures that, over thousands or millions of years of evolution, would have fostered a differentiated use of the available food resources. But the example would also be valid if the ultimate causes invoked were linked to the development of different protection strategies against predators, mating rituals, or any other type of factor that may operate as selective pressure (Hill et al., 2021).

The study of behavior is a field in which this duality is also present: the fact that insectivorous birds from temperate zones migrate in autumn to tropical or subtropical regions is the consequence of an evolutionary process of thousands or millions of years linked to the availability of food (Castro et al., 2018) and the reconstruction of these historical factors will reveal the remote causes of the migratory cycle of a certain species: its why. But if we want to know how, through the mediation of which device, each specimen of a species of migratory bird knows when to start its journey, I must carry out a neurophysiological study of the proximate causes of that behavior (Rives et al., 2021). Similar considerations could be made in relation to the start of a breeding season (Rosenberg & Zilber, 2018); and something certainly analogous could be formulated in relation to the beginning of a reproductive cycle of a plant.

On the other hand, the distinction between proximate and remote causes is not only pertinent in relation to complex phenomena such as those referred to: even at the level of molecular structures we can question one or another of these types of causation. "A certain molecule has a functional role in an organism. How does it perform this function, how does it interact with other molecules, what is its role in the energy balance of the cell?", That is, Hasson et al. (2020) tells us, questions about proximate causes. In this sense, the anatomist who studies how a joint works shares his analysis pattern with the "molecular biologist who studies the function of DNA molecules in the transmission of genetic information". On the other hand, if we ask ourselves: why does the cell contain that molecule? What role did it play in the history of life? What changes did it undergo during evolution? How and why does it differ from homologous molecules? in other organisms?; it is because we are interested in the remote or evolutionary causes of the phenomena in question. Or put another way: "In the study of any biological phenomenon, whatever its level of complexity, we can pose two types of questions: what is its functioning? And what is its origin?.

Thus, the recognition of this difference between two possible ways of questioning the living should lead us, says Mayr, to present the sciences of life as divided into two general domains of inquiry : functional biology concerned with experimentally studying the proximate causes that, acting at the level of the individual organism, explain to us the how of vital phenomena; and evolutionary biology, occupied in reconstructing, by means of comparative methods and historical inferences, the ultimate or remote causes that, acting at the population level, would explain to us the reason for such phenomena. Being that, according to Mayr himself (1998a), this distinction would rescue, ultimately, that classic separation between Medicine and Natural History that, in the end, would have been much more penetrating than the one that arises from the application of "those recent labels of convenience" such as zoology, botany, mycology, cytology or genetics.

Let us not think, however, that Mayr has tried to propose a classification that allows us to characterize each and every one of the different disciplines and specialties in which biological research is organized and institutionalized, as being, now part of functional biology, now part of evolutionary biology. The demarcation between these two domains obeys an epistemological distinction between two different modes of questioning; and the separation between different disciplines is never exclusively based on epistemological issues. Thus, as Sackton et al. (2019) recognizes, within the same disciplinary domain and in relation, even, to the same topic to be investigated, questions related to proximate causes can intersect and articulate with questions related to remote causes or evolutionary; and no one could question, neither the legitimacy, nor the necessity, of that intertwining (Arnold, 2019). The marked self-sufficiency of these two domains of Biology that Schrader & Schmitz (2019) points out is not, nor could it be, absolute (Osnas et al., 2018).

However, if we classify the different biological disciplines according to the greater or lesser preponderance that, in each one of them, the study of proximate causes or evolutionary causes acquires; we can think of all of physiology (organ physiology, cell physiology, physiology of the senses, neurophysiology, endocrinology, etc.), almost all of molecular biology, functional morphology, developmental biology, and physiological genetics as domains of biological biology functional. Meanwhile, paleontology, behavioral ecology, and population genetics might be better categorized as domains of evolutionary biology where interest in remote causes outweighs interest in proximate causes. In other cases, discrimination would be more difficult and forced (cf. Mayr, 1998b, p.135-137).

B. METHOD

This research uses qualitative research with descriptive analysis approach by comparing the views of functional biology with evolutionary biology as an approach to determine the origin of living things. The presentation of the data in this study uses a qualitative approach with the type of secondary data collected through a literature study.

C. RESULT AND DISCUSSION

1. Proximate Causes and Remote Causes

Let us begin, then, by recalling that, from the publication of Cause and Effect in Biology in 1961 (Taylor & Larson, 2019), to the publication of This is Biology in 1995, Ernst Mayr has always insisted on the idea that every living phenomenon, unlike what happens with inanimate phenomena, it can, or even should, be thought of in virtue of two different types of causes: the proximate causes that, being common to the order of the living and to the physical order, tell us how it is that something happens; and the ultimate or remote causes that, being specific to biological phenomena, tell us why it occurs.

That is to say: to the consideration of the proximate causes that explain to us how the individual organism works and is constituted, we must add the study of why the organism works as it does and has the form that it actually has (Parisi et al., 2019). Thus, while the fulfillment and development in each individual organism of the processes ruled by its genetic program can be explained by virtue of proximate causes that, at least as far as Biology is concerned, can also be called "functional"; the origin and modifications of such programs are phenomena that must be explained by appealing to remote causes that, Darwinism involved, can be called "evolutionary" (Reiter et al., 2018). A specific example of a biological phenomenon to be explained, such as sexual dimorphism, will be useful to illustrate this distinction (Kristensen et al., 2019): its proximate cause could be identified with hormonal factors that would allow us to know how are these sexual differences produced; being that these hormonal factors can be, in turn, analyzed and explained in terms of molecular mechanisms. However, if, relatively independently of these opportunities that molecular biology gives us, we ask ourselves why this dimorphism is present or more accentuated in some species and absent or less accentuated in others, it is possible that the explanation due to proximate causes we are no longer satisfied.

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Ginsburg & Jablonka (2019), that second set of causes, that of evolutionary or remote causes, could be constituted, in this specific case, by a network of selective pressures that, over thousands or millions of years of evolution, would have fostered a differentiated use of the available food resources. But the example would also be valid if the ultimate causes invoked were linked to the development of different protection strategies against predators, mating rituals, or any other type of factor that may operate as selective pressure (Du Plessis et al., 2019).

The study of behavior is a field in which this duality is also present: the fact that insectivorous birds from temperate zones migrate in autumn to tropical or subtropical regions is the consequence of an evolutionary process of thousands or millions of years linked to the availability of food (Marletaz et al., 2018) and the reconstruction of these historical factors will reveal the remote causes of the migratory cycle of a certain species: its why. But if we want to know how, through the mediation of which device, each specimen of a species of migratory bird knows when to start its journey, I must carry out a neurophysiological study of the proximate causes of that behavior (Louca et al., 2018). Similar considerations could be made in relation to the start of a breeding season; and something certainly analogous could be formulated in relation to the beginning of a reproductive cycle of a plant.

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Thus, the recognition of this difference between two possible ways of questioning the living should lead us, says Mayr (1998a, p. 87; 1998b, p. 137), to present the sciences of life as divided into two general domains of inquiry : functional biology concerned with experimentally studying the proximate causes that, acting at the level of the individual organism, explain to us the how of vital phenomena; and evolutionary biology, occupied in reconstructing, by means of comparative methods and historical inferences, the ultimate or remote causes that, acting at the population level, would explain to us the reason for such phenomena. Being that, according to Mayr himself (1998a, p. 87), this distinction would rescue, ultimately, that classic separation between Medicine and Natural History that, in the end, would have been much more penetrating than the one that arises from the application of "those recent labels of convenience" such as zoology, botany, mycology, cytology or genetics.

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However, if we classify the different biological disciplines according to the greater or lesser preponderance that, in each one of them, the study of proximate causes or evolutionary causes acquires; we can think of all of physiology (organ physiology, cell physiology, physiology of the senses, neurophysiology, endocrinology, etc.), almost all of molecular biology, functional morphology, developmental biology, and physiological genetics as domains of biological biology. functional. Meanwhile, paleontology, behavioral ecology, and population genetics might be better categorized as domains of evolutionary biology where interest in remote causes outweighs interest in proximate causes. In other cases, discrimination would be more difficult and forced (cf. Mayr, 1998b, p.135-137).

2. Two Traditions

Let us note, on the other hand, that this difference in the type of questions that we can formulate in relation to the living is also associated with a difference in the methodological strategies that we can follow in the study of one or another type of causation. Indeed: “proximate causes occur here and now, at a specific moment, in a specific phase of the cell cycle of an individual, during the life of an individual”; being that, both due to its current character and due to the fact that its effects are recorded at the level of the individual organism, the type of factor that is pointed out as the cause of the phenomenon to be explained lends itself to a type of experimental manipulation similar to that operates in the field of Physics and Chemistry. For this reason, the main technique used by the biologist who studies proximate causes is the experiment and, in this sense, his research strategy is the same as that of the physicist and the chemist.

The same does not happen, however, with the study of remote causes. These not only "have acted for long periods, and more specifically in the evolutionary past of the species" (Mayr, 1998b, p. 137); but they also present the peculiarity that their effects are recorded at the population level and not at the individual level (Mayr, 1998a, p. 88; Jacob, 1973, p. 186). Thus, questions such as "why do desert animals usually have the same coloration as the substrate?" or “why do insectivorous birds from temperate zones migrate in the fall to subtropical or tropical regions?” (Mayr, 1998b, p. 133), when they do not demand a description of the proximate causes of these phenomena, they must be answered based on factors and evolutionary processes that, due to their population dimensions and because they are often absent in the present, do not they can usually be investigated with experimental methods (Mayr, 1998b, p. 86). In these cases, the study of living beings can hardly do without those comparative procedures that can be characterized as forms of controlled observation (Mayr, 1998a, p. 48).

Thus, while "experimentation tends to facilitate the determination of proximate causes" (Mayr, 1998b, p. 137); the ultimate causes lend themselves more, although not exclusively, to a study based on methodological procedures similar to those already applied by Cuvier (cf.1992 [1812], p. 97) to Natural History (Mayr, 1998a, p. 48; 1998a, p.90). In this case, it is not the researcher, but nature itself, which, straining the limits of what is biologically possible, changes and combines the conditions in which living phenomena occur. In such a way that, by analyzing this web of combinations, the naturalist can establish the mode, magnitude and intensity with which one factor affects another; and it is these "experiments of nature" that, even today, as Mayr (1998a, p.48) points out, constitute the main methodological resource available in the study of the remote causes of biological phenomena.

Indeed, until the mid-nineteenth century, and before the experimental developments of Claude Bernard and the German school (Holmes, 1999, p. 74 et seq.), the organism was, in general, an object of observation but not strictly speaking, of experimentation; that is to say: the alteration of its order was not sought to analyze it (Jacob, 1973, p. 201). Until then, “organisms were considered as a whole in order to determine their properties and structures” and “they were compared with each other to determine their similarities and their differences” (Jacob, 1973, p. 201). Being that same combination of descriptive and comparative procedures that provides the empirical basis for that long argument that Darwin presents in The Origin of Species. "For Darwin as for Cuvier, nature experimented for the naturalist" (Jacob, 1973, p. 201).

Thus, starting in 1870 (Mayr, 1998b, p. 128) and as an effect of the very emergence of experimental physiology and the theory of evolution, a split and deep conflict is generated between what, following Laudan (1977, p. 78), Mayr (1980, p. 40) characterizes as two research traditions: that of the experimental biologists and that of the naturalists. The first are those researchers who, like Claude Bernard (1984[1865], p. 123), maintain that the limits of biological knowledge coincide with the limits of the experimental method; and the second are those who, defending the rights of Natural History, advocate the legitimacy of those traditional methods that experimental biologists dismiss as purely speculative (Allen, 1979, p. 181 et seq.).

The former, busy developing physiology and experimental embryology, claimed that the only legitimate inquiry is the one that leads us to the determination of the proximate causes of biological phenomena (Mayr, 1998b, p. 128). The latter, on the other hand, "with their almost exclusive interest in phylogeny" (Mayr, 1998b, p. 128), only gave relevance to the study of the evolutionary causes of vital phenomena. Thus, while Haeckel had intended that the domain of Natural History that is comparative embryology exhaust or, at least, establish embryology in general (Canguilhem et al., 1985, p. 42; Mayr, 1998b, p. 135 and 1998c, p.10; Hamburger, 1998, p.99; Churchill, 1998, p.115; Gayon, 1993, p.90); Even in the 1930s, Morgan could lambaste evolutionary biologists for not realizing that sexual dimorphism could be explained by physiological causes operating ontogenetically without resorting to evolutionary (read: Darwinian) speculation (Mayr, 1980, p. 11; 1998a, p. 93).

It is only with the advent and consolidation of what has been called the new synthesis that this schism between both research traditions has been overcome (Mayr, 1980, p. 40); and perhaps only in part: it is possible that it is still overdetermining the current conflicts between evolutionary biology and developmental biology:

To what extent do we think of organisms as the product of a plot of historical accidents and to what extent do we think of them as highly complex crystals whose shape obeys physical-mathematical regularities that govern their constitution? To what extent to consider organisms as problem-solving structures chiseled by natural selection and to what extent to think of them as obeying their own dynamics of self-organization? here is a double problem that seems to constitute a genuine aporia for the sciences of the living.

However, and beyond these last questions, the truth is that, without covering all domains of biological research, the neo-Darwinian synthesis supposed and stimulated an approximation and an understanding between experimentalists and naturalists that, far from abolishing the distinction between investigation for proximate causes and investigation for remote causes, it ended up legitimizing it. Today, Mayr (1998b, p. 128) tells us, we know that "we must seek answers to both types of questions" and for that we have to use different methodological strategies. Duality, on the other hand, does not relieve us of the requirement of coherence and systematicity: the answers to both types of questions must be compatible and, in principle, articulated with each other. There is no such thing as an incommensurability between functional biology and evolutionary biology.

3. Two Modes of Interrogation

But of course, at this point of contrast between a biology that seems to share, at least partially, its methodological and conceptual foundations with Physics and another that still allows itself to use the methods, and even the language, of the old Natural History, It could be objected that what we are presenting here as two relatively autonomous domains of Biology are nothing more than two disciplines with different degrees of development or discourses with different status of scientificity; and this objection would not only be supported by what we have just said about the "ontological plasticity" of the language used by evolutionary biology, but could also be based on our recognition that, in this last domain of research, purely observational procedures predominate. Over the strictly experimental ones. It may even be thought that this is the reason for the contrast between, on the one hand, the scant discussion aroused by the procedures used and the results obtained, from Harvey to Watson and Crick, passing through Claude Bernard, in the study of the proximate causes of living phenomena (Mayr, 1998a, p. 89); and, on the other hand, the permanent questions about what happens in the study of evolutionary processes.

We must not underestimate, however, the rigor that can be accessed in the domain of controlled observation. On this point, as Mayr (1998a, p. 48) tells us, “the difference between the experimental and comparative methods is not as great as it might seem at first sight”. The latter can be just as scientific as the former; and the same can be said in relation to the results that are evaluated and validated with it. It is true that controlled observation, unlike experimentation, does not require the reproduction at will of the phenomena under study or the specific manipulation of variables; but it is similar to it in other aspects that are more relevant when it comes to evaluating the rigor or scientific nature of the research or the theories that are based on it.

Controlled observation supposes, in effect, two fundamental moments: the first one consists of the deliberate search for different situations in which a phenomenon manifests itself uniformly (in identical or different ways) or manifests itself in some cases but not in others; and the second of such moments is "the further examination of certain factors highlighted on these occasions in order to discern whether the variations of those factors are related to differences in the phenomena" (Nagel, 1978, p. 409). Obviously, that certain factors, and not others, are pointed out as relevant to explain the different variations of a phenomenon, is something that depends on a theoretical framework that, at least in part, is always rectifiable.

All in all, this is a difficulty, if you want to use the word, that also arises in experimental research: an experiment is always set up under a theoretical framework, more or less explicit, that determines both the nature of the variables that they will intervene, control and observe, as well as the type of interaction to which they will be subjected. It will always be the course of the investigation itself that will tell if our options were correct or sufficient. But, to the extent that those options have been adequate and our records of variations, and their putative effects, careful enough, "from the point of view of the logical role of empirical data in research" (Nagel, 1978, p. 409), it does not matter if the variations registered in the supposed determining factors of the changes observed in the phenomenon under study, were introduced by the researcher himself or were produced by nature.

Let us also insist that we are dealing with a simple distinction of degree: evolutionary biology can also resort, to a certain extent (cf. Brandon, 1997), to experimental or quasi-experimental; and, in our opinion, a comparative analysis of the type of variables and the way of manipulating and controlling them that occurs in the experiments carried out in each domain of Biology can be very useful to clarify the different notions of causality to which that we have alluded to here. The key question would be this: what is the difference between the questions we pose to an experimental population of flies or to a culture of bacteria and those that guide the experiments of a physiologist or molecular biologist?

For now, and reiterating what we have already said, we can remember that what we call here proximate causes constitutes the same type of causation to which inanimate phenomena are also subjected (Mayr, 1998a, p. 89). This allows the biologist to formulate the same type of question in relation to them that led to the discovery of physical laws (Mayr, 1998b, p. 133); and, this isomorphism in the way of questioning gives rise to an isomorphism in the way of answering that is not verified in the case of inquiry due to remote causes. This raises questions that, in addition to involving a category absent in the domain of Physics such as adaptation (Mayr 1998a, p. 93; 1998b, p. 133), lead us to the study of singular historical processes whose reconstruction, by not take the form of a nomologically patterned explanation, can be characterized as constituting a historical narrative.

But it is precisely at this point that a militant anti-Darwinist like André Pichot (1987, p. 23; 1993, p. 935) can base his criticism on the legitimacy of this duality of the life sciences. For this author, modern biology is an incomplete science in which the Darwinian historical explanation operates as a simple complement, less rigorous and even less scientific, of the physical explanation offered by molecular biology. This, for its part, would be a rigorous but limited discipline that, managing to explain the functioning and constitution of the individual organism (Pichot, 1987, p. 24), leaves the explanation of the origin and history of the functioning and constitution program there. involved left to an indefinite series of contingencies whose elucidation would be the task of the fragile Darwinian explanation (Pichot, 1987, p. 9; 1993, p. 936).

Modern Biology, we could say, being on the path that will allow it to explain in physical terms the functioning and constitution of that autopoietic machine (Maturana & Varela, 1995, p. 69) that is the individual organism, would have renounced the Lamarkian ideal (Pichot, 1993, p.941;1999, p.259) to find a physical explanation for the constitution of the plane or the design of the machine; and, thus, he would have found in Darwinism a precarious resource to palliate or even hide that lack (Pichot, 1987, p. 23). The new synthesis would be the clearest product of that shameful conspiracy. Pichot, indeed, seems to share the description of the universe of the life sciences that Mayr and Jacob propose; but what the latter consider to be a legitimate pattern of functioning, Pichot presents as a symptom of a fundamental lack. But be careful: the articulation between molecular biology and Darwinism that Pichot supposes operating within the new synthesis may not be the one that Jacob and, above all, Mayr suppose exists between functional biology and evolutionary biology.

For Pichot, it is a question of a relationship that is more supplementary than complementary: the Darwinian explanation, as we said, would be called upon to correct a lack of the molecular explanation. In the best of cases, Pichot seems to think, Darwinism would constitute an auxiliary hypothesis that the current theory of evolution would use to make up for its limitations and whose (supposedly notorious) weakness would affect the entire theoretical edifice that it would come to complete (Pichot, 1987, p.24). But, what this author ends up saying is that the theory of natural selection operates as a stratagem of dubious legitimacy called to hide the lack of a genuine physical explanation of evolution such as the one that Lamarck would have known how to glimpse (Pichot, 1993, p. 845; 1999, p. 288).

For Mayr and Jacob, on the other hand, functional biology and evolutionary biology are not two sets of hypotheses that are added or come together to explain the same domain of phenomena; but two relatively autonomous areas of inquiry, each of which responds to forms of questioning that, as Pichot himself (1993, p. 844) acknowledges, are of a different order. For this reason, to the extent that Darwinism constitutes the foundation of evolutionary biology, we can say that it is not called upon to solve the problems of functional biology that molecular biology promises to solve. If the theory of natural selection does not serve to complete the physical explanation of how, in a certain physical environment, a certain type of living structure arises, it is simply because that how is not the type of question that Darwinism teaches us to ask and answer. The whys of evolutionary biology are not a complement to the hows of functional biology; these, in any case, are a limit for those.

All in all, in order for this hint of a reply to Pichot to be clear, it is necessary that we delve a little deeper into the contrast between functional biology and evolutionary biology. It is necessary that we look within this distinction between how and why to elucidate not only the principles that govern one or another way of questioning the living; but also to explain the structure and conceptual nature of the answers that, in both cases, we must give.

D. CONCLUSION

Based on the results of the analysis, it can be concluded that the functional biologist always knows which is that privileged state that must be reached and, therefore, can always consider organic phenomena as means to achieve a specific goal; and it is in this sense that it is possible to speak of a determined teleology. The evolutionary biologist, on the other hand, does not have that determination: even when he can assume that all organic structure is committed, directly or indirectly, to the achievement of differential reproductive success, he also knows that this goal occurs in nature in different ways very diverse. That is to say: this differential reproductive success depends on the resolution of an extremely vast and indefinite range of problems that, even in the case of a single species, can be as varied and heterogeneous as the problems of feeding, the escape of predators, caring for offspring or finding sexual partners.

It is true in any case that this diversity can be reduced, in all living forms, to a single fundamental problem: that of survival understood not as individual preservation but as preservation of one's own characteristics through reproduction. All other problems are, in the final instance, unfoldings of the latter. But, the real problem of the Darwinian explanation is to identify, for each organic structure, which is the specific unfolding of that fundamental problem in whose resolution, directly or indirectly, that structure is involved.

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