Biological Finality in the Philosophy of Life and Organisms

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1. Introduction

Opening their landmark anthology on nature's purposes, Allen, Bekoff and Lauder state plainly that "the goal of accounting for "Nature's purposes" is arguably the most important foundational issue in the philosophy of biology" (1998: 2). This is not merely a *captatio benevolentiae* directed to the potential reader, but an idea rather widespread in biological literature. For instance, Woodger (1967: 456) claims that in any biological explanation the teleological relations are among the most important, whereas Mayr (1974: 98) writes that the "occurrence of goal-directed processes is perhaps the most characteristic feature of the world of living organisms". While teleology is absolutely pervasive in human thought and natural language (Nissen 1997, Boorse 2002), the history of the concept of finality in science is marked by wildly varying opinions and hot controversies. In particular, there is still "an evident and uncomfortable tension within the biological sciences over the role that teleological explanations might play" (Allen, Bekoff & Lauder 1998: 1), and the "vast literature on

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teleology is eloquent evidence for the unusual difficulties connected with this subject" (Mayr 1974: 92).

The question of biological finality has both a philosophical and a scientific side, and actually philosophy and natural history went hand in hand for many centuries, with similar ways of arguing and explaining nature.

On the philosophical plane, the discussion revolved around the problem of finality in the universe and its parts, its basic references being – in Western philosophy – Aristotle's and Kant's works. Today, to quote again Allen, Bekoff and Lauder's anthology, at the most basic level the dispute is "about the point of making teleological claims: Does attributing the function of pumping blood to a heart *explain* anything, or is it merely a shorthand description of certain attributes of the heart? Most of the selections in this anthology maintain that teleological claims in biology both describe and explain something, although opinions vary about exactly what is explained, and how" (1998: 2-3).

On the biological plane, the question is mainly about the concept of function, with a clear distinction between pre- and post-Darwinian debates. Three topics in particular have attracted the attention of biologists, namely, purposes in the human mind (after all, humans are organisms too), in organisms and in machines (as produced by certain organisms, not necessarily human).

Historically, as it often happens with biology, ideas and debates are characterised by a notable longevity (Mayr 1982) and pendular movements between opposite lines of thought (Jacob 1970: 24). This is also due to a surprising oblivion of past discussions, which leads the scholars to start again and again old discussions, if not to repeat the same errors[2]. In general, the modern history of the concept of finality is richer and more articulated than sometimes thought of; according to a vulgata that is still present, the rise of modern science in the XVII century coincided with, and largely consisted of, the abandonment of final causes; then, there would have been just some ideological resistance and conceptual inertia, particularly in biology. Actually, however, the history of the concept is more complicated; for instance, Canguilhem has found remarkable traces of teleology in Descartes'

[2] Just to make an example, in the whole anthology edited by Allen, Bekoff and Lauder (1998) there is just one quotation of Kant, included in Nagel's paper (1977).

mechanism (1965: 101 ff.), while Kant after his third Critique still worked on the concept of finality, changing his ideas to a notable degree (Mathieu 1991).

Today, the debate on finality and functions in biology is very lively, which implies that there is too much to read (Mahner & Bunge 2001: 75). However, there are different interpretations of the current state of the art: according to Boniolo (in Boniolo e Giaimo 2008: 261), after the last surge of interest for teleology in the second half of the XX century, the debate is now about to expire; on the contrary, recently Perlman (2004) was so bold as to speak of a philosophical resurrection of teleology, writing that there are striking signs "of the dramatic developments in taking teleology seriously. This is a far cry from the low philosophical regard teleology and functions had before the 1970s. It is this trend that makes the topic of ever growing concern and importance – teleology has come a long way toward rehabilitation" ([2010]: 160)[3].

To complicate the situation, there is the fact that finality involves various levels of enquiry. There is first an ontological question, about the possibility, reality, nature and existence of biological finalities; then there is the epistemological quarrel about the kind of knowledge and explanation that teleology may furnish; third comes the scientific side, for instance with the analysis of finality at different biolevels, from the organs to the organism and even to the whole biosphere; finally, there has always been a theological underpinning of the teleological thinking, about the relations between intentional purposes, finality in the universe and its parts, and God's plans.

Since I will leave apart this last aspect, I would just quote here a statement by Sommerhoff, a theoretical biologist we will eventually meet several times: "it will be generally agreed that statements about the existence of God imply statements about the purposiveness of some natural events. It follows that statements about the existence of God *do* have factual content. ... The positivistic assumption, therefore, that statements about the existence of God and normative ethical and aesthetic propositions have no factual content (in the sense used by the positivist) proves to be untenable. It is my belief that if we follow up

[3] A recent, curious resurgence of the interest for finality is in the field of research about posthumanism and transhumanism (Bolstrom 2008).

these lines of thought we may advance considerably towards the required synthesis in modern thought and towards a world-view which combines the conclusions of science with the essence of religion" (Sommerhoff 1950: 200). To counterbalance such statement, let us read a few words by Wilson, in his afterword to "the four great books" of Charles Darwin (Wilson 2006: 1483): "So, will science and religion find common ground, or at least agree to divide the fundamentals into mutually exclusive domains? A great many well-meaning scholars believe that such rapprochement is both possible and desirable. A few disagree, and I am one of them. I think Darwin would have held to the same position. The battle line is, as it has ever been, in biology. The inexorable growth of this science continues to widen, not to close, the tectonic gap between science and faith-based religion".

As it will by now clear, nobody could expect from a paper like this an exhaustive survey of the concept of biological finality. So, I have imposed on myself a series of limitations. The first refers to the subject that will be tackled. I will here try to accomplish an unusual task, that is, a review of the concept of biological purpose as (at least partially) distinct from that of function. Partly, this is a trick to avoid being submerged by the huge literature on functions, but partly because I feel some difference between the two concepts, as I will show below. Secondly, I have chosen only those texts that explicitly talk about finality, purposes, goals, aims, *telos* and like teleological concepts, leaving aside texts that only implicitly refer to them; besides, only incidentally have I quoted passages about teleonomy, again since this has become an autonomous subject, with an unmanageable literature. Finally, I have further limited myself mainly to the biological literature on life and organisms, and particularly that of the XX century. Partly, the reason is that this is the literature I know best (Ramellini 2006); partly, because the concept of biological finality particularly emerges when one looks at life and organisms as such, as general biological phenomena, apart from any detail which may regard only some taxa or biolevels. This choice implies that I have focused my survey on finality *in* the organism and *of* the organism, leaving apart evolution and a large part of ecology. Hence, the selection of authors and

works will be rather personal[4], and will here and there oversimplify the development in the thought of each scholar; however, any alternative choice would have involved equivalent, though different problems.

Within these boundaries, I feel that there is a slight bias in favour of the concept of biological finality; actually, to speak of life as an original, emergent, real phenomenon, and of organisms as living bodies which are not proper parts of other living bodies, thus being in some sense autonomous and independent, often leads to look favourably to finality and other teleological concepts. As Jacob once noted, "it is the idea of organisation, of totality, which requires finality, in so far as one cannot dissociate the structure from its meaning" (1970: 102, my transl.).

So, the reader will find here a service paper, which hopingly will furnish a basis for thinking about biological finality in the recent philosophy of life and organisms.

2. Defining Biological Finality and Some Related Concepts

Several authors have underlined that the concept of finality and the like are vague or ambiguous. This usually means that they are either ambiguous in the sense of polysemous or ill-defined, so the concept of vagueness, as implying borderline cases (Copi & Cohen 1990), can be left apart.

For instance, when Rosenblueth, Wiener and Bigelow (1943: 23; see also Sommerhoff 1950: 7) state that teleology "has been interpreted in the past to imply purpose and the vague concept of a *final cause* has been often added. This concept of final causes has led to the opposition of teleology to determinism", they mean that 'final cause' has been poorly or ill defined, a fact that has led to false, or merely semantic, disputes and oppositions. On the contrary, a proper semantic ambiguity is referred to by Allen, Bekoff and Lauder (1998: 5): "Among biologists, the term *teleology* is ambiguous. Some authors

[4] Personal, but hopingly not so much arbitrary. For instance, the fact that I will not mention Driesch and his entelechy depends on the fact that his works are mainly based on zoology and animal embryology, thus being less relevant in a paper like this, which is instead focused on general biology.

use it to refer only to those cases involving preordained goals (either Aristotelian internal purposes, or theistical external purposes) while others employ it generically for all uses of the notions of function, design, or adaptation".

A subtle example of ambiguity is offered by Miller's conception (1978: 39), according to which the purpose of a system "is the comparison value which it matches to information received by negative feedback in order to determine whether the variable is being maintained at the appropriate steady-state value". Here, three notions of finality seem to be interlocked: first, we have the purpose as a comparison value, i.e., a threshold involved in a negative feedback circuit; then, there is the purpose of determining whether maintenance holds; finally, the maintenance of a (genetically or behaviourally developed) steady-state is in itself a purpose.

Piaget (1967: 155-156, my transl.) has also recognised three historical stages in the development of the concept of finality, thus connecting the ambiguity of the concept to a historical deepening of its analysis: first, a precausal finalism was conceived, which confused internal and external finality; then came the mechanical-physical period, when finalism was rejected, but no alternative was offered; finally, we are now living in a period of models of self-regulation. These models maintain the valuable side of finalistic descriptions (rather than explanations), and give a causal explanation of the various oriented and self-correcting processes, that is, teleonomy: "in other words, today we can retain whatever positive the idea of finality contains, by replacing the notion of «final cause» with an intelligible circular causality".

Actually, there are two main readings for the concept of finality, respectively as a function or as a terminus.

Here and there, however, one can also find other ideas. For instance, Cuvier (1817: 6, my transl.) states: "Natural history has also a rational principle which is peculiar to it, and which it uses many times to its advantage; it is that *of the conditions of existence*, commonly called *of the final causes*. Since nothing could exist which does not gather together the conditions which make its existence possible, the different parts of any being must be coordinated in such a way as to make possible the whole being, not only in itself, but also in relation to the surrounding beings". In this passage, we can note that passage from the concept of cause to that of condition which, according to

Abbagnano (1971: 123) characterises the modern history of the concept of causality. In a sense, it is as if Aristotle's *aitia* were to revive: since the general concept of cause had been conflated with that of efficient cause by the Scientific Revolution during the XVII century, as a consequence there (re)emerged a conceptual need for other principles, reasons and foundations capable of giving a fuller account of the nature of bodies, and in particular of the organisms; those principles then came to be called conditions of existence, a notion which seems to be rather near to the old Aristotle's *aitia*.

Half a century later, Bernard (1878: 379, my transl.) claimed that "we do not have to worry about final causes, that is, about the intentional goal of nature. Nature is intentional in its goal, but blind in its execution". This appeal to intentions – in fact, to the intentionality of the whole nature – is a rather surprising idea for a XIX century experimental scientist, were it not for the fact that Bernard had a gut feeling for oxymorons and paradoxes. More interesting is the distinction between finality (the intentional goal) and processes (the implementation of the goal); the first appears analogous to a capacity, while processes consist in performing that capacity, as in Aristotle's distinction between first and second acts[5].

Cuvier's and Bernard's examples show that there is undoubtedly a large variation in the concepts of finality in biology; anyway, it is the concepts of finality as function or terminus that are the most widespread.

The first, which I will not diffuse upon, starts from the particular concept of proper function (Millikan 1989: 293), then it extends to functions, design and adaptation (Allen, Bekoff & Lauder 1998: 5), and it finally culminates in a most general notion devised by Neander (2012), according to which "There are some who would prefer to reserve the term "teleological" for genuinely purposive contexts in the

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[5] This distinction appears not to have been grasped by Mayr, when he says that extending "the term teleological to cover also static systems leads to contradictions and illogicalities. A torpedo that has been shot off and moves toward its target is a machine showing teleonomic behavior. But what justifies calling a torpedo a teleological system when, with hundreds of others, it is stored in an ordnance depot? Why should the eye of sleeping person be called a teleological system? It is not goal-directed at anything. ... one runs into serious logical difficulties when one applies the term 'teleological' to static systems (regardless of their potential) instead of to processes. Nothing is lost and much to be gained by not using the term teleological too freely and for too many rather diverse phenomena" (1974: 105-106).

most literal sense of "purposive" and to refer to biological functions as "teleonomic." But, on a broader construal of what it means for a concept to be teleological, a concept might be counted as teleological if it concerns what something is *for*, and the notion of what something was selected *for* counts as teleological in that sense".

As to the the concept of finality as a terminus, if we are concerned with all the organisms, we should first of all eliminate the possibility of immanently intentional finalities (as to any transcendentally intentional finalities biology obviously has nothing to say). Hence, if someone thinks that finality can only be intentional, he or she should immediately drop any possible talking about finalities. This is why Woodger (1967: 432) said that the "term 'purpose' should be confined to conscious human purpose. The purpose is some end or consummation that the man desires". Yet, things can be more subtle. Let us take for instance the elaborate notion by Mahner and Bunge (1997: 370):

"An action *x* of an animal *b* has the *purpose* or *goal y* if, and only if,

(i) *b* may choose *not* to do *x*;
(ii) *b* has *learned* that *x* brings about or enhances the chances of attaining *y*;
(iii) *b expects* the possible occurrence of *y* upon doing *x*, and
(iv) *b values y* (not necessarily consciously)".

They rightly call this an intentional view of purpose or goal, which is thus obviously restricted to some animals; that is, finality becomes a factual terminus (be it a state or an event) which an animal endowed with a plastic nervous system may choose not to pursue, and which is attainable and expectable by it, as well as valuable to it. Now, let us extend the concept of learning also to cover the genetic memory, in the sense that through natural selection those variants which are more capable to cope with their environment live better and leave more offspring; then, the species «learns» by trial (genesis of variants) and error (elimination of bad variants) which *x* may lead to *y*, and its member find themselves endowed with a «learned» genetic memory. So, this could establish an accord between Mahner and Bunge's intentional view of purposes and a more general notion of biological finality, though at the cost of a very strained analogical concept of learning. Now, the interesting fact is that this seems to be also Woodger's stance (1967: 440).

Usually, the terminus finality refers to is some state which the organ or the organism arrives at, or has the possibility to arrive at. This

view is particularly appreciated by systems theorists, starting from the seminal work by Rosenblueth, Wiener and Bigelow (1943): here, a goal is defined as "a final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event" (*ivi*: 18). This idea was then subtly formalised by Sommerhoff (1950), and arrived to Nagel (1961); as Boorse (2002: 69) summarises this line of thought, "a system S is 'directively organized', or 'goal directed', toward a result G when, through some range of environmental variation, the system is disposed to vary its behavior in whatever way is required to maintain G as a result. Such a system, it is said, shows 'plasticity' and 'persistence' in reaching G: when one path to G is blocked, another is available and is employed". In this sense, a goal is the result a directively organised system is directed toward. Bertalanffy (1968: 78-79) proposed a classification of the possible types of teleology; in the sector of dynamic teleology, which means a directiveness of processes, we meet with various concepts of terminal state; in fact, dynamic teleology is divided into:

- "Direction of events towards a final state which can be expressed as if the present behavior were dependent on that final state";
- "Directiveness based upon structure, meaning that an arrangement of structures leads the process in such way that a certain result is achieved";
- equifinality, that is, an equifinal state, meaning that the same terminus can be achieved starting from different initial states;
- "true finality or purposiveness, meaning that the actual behavior is determined by the foresight of the goal", that is, by a foreseen terminus state.

Also in the wake of systems theory, though from a different viewpoint, stands the definition by Miller (1978: 39) which we have already quoted: the purpose of a system "is the comparison value which it matches to information received by negative feedback in order to determine whether the variable is being maintained at the appropriate steady-state value. In this sense it is normative. The system then takes one alternative action rather than another because it appears most likely to maintain the steady state". The appropriate internal steady-state is determined by a hierarchy of values developed through the information inputs of the genetic endowment or through behavioural changes brought about by rewards and punishments. However,

rather than a terminus, here the purpose is first of all the value of some magnitude, which stands as the threshold to be approached through negative feedback.

Another approach started with Wright (1976: 39), where "*S* does *B* for the sake of *G* iff:

(i) *B* tends to bring about *G*
(ii) *B* occurs because ... it tends to bring about *G"*.

For instance, the heart acts for the sake of survival, since its action tends - that is, it enhances the probability - to bring about the survival, and since its acting occurs because it tends to bring about the survival; so, the goal becomes the terminus which some action tends to bring about, and where that action occurs because it tends to bring about it. Millikan (1989) criticised this view, asking how strong the tendency for *S* to count as purposive must be, and how strong has a tendency to be to count as a tendency. However, I cannot precisely see the point of her critique about the modal character of Wright's ideas: for instance, even a sick heart acts for the sake of its bearer's survival, though with lesser efficacy with respect to a healthy heart; only a completely blocked heart would not contribute to survival; in that case, however, we could not even use Wright's definition, because in that case the heart would simply not do *B*.

Finally, more recently Boorse has seen the terminus as the effect of a causal chain. He proposes a weak functional statement: where *X* is a type and *x* is a token, "Given system *S* directed to goal *G* at time *t*, one can say that *X performs the function Z* in the *G*-ing of *S* at *t* if and only if at *t*, the *Z*-ing of *X* is a causal contribution to *G*" (2002: 70).

Such performance holds even for accidental functions and for functions performed only once; for instance, a phone call in the next room may save me from a truck crash into the room where I was sitting; so, telephones may perform the function of saving lives, which seems to me an exaggerated view. Then, Boorse claims that a "trait *X*'s contribution to a goal, then, if made sufficiently often, becomes the function of *X*, or *X*'s function, if it is *X*'s only regular contribution; and is a function of *X*, among *X*'s functions, otherwise" (*ivi*: 72). So, according to Boorse the goal is a terminal effect of the causal contributions of the function(s) of the system, with a crisp distinction between a goal *G* and a function *Z*.

Around the central concept of finality we find a series of other teleological notions, which we can briefly examine.

Most of them refer to processes, activities or behaviours, probably as an attempt to focus the attention not only on the final terminus, but also on the changes resulting in it. This link to the processes is particularly evident in Waddington, according to whom, if a big number of components interact with each other, and in particular if they act non-linearly, some buffering or chreodic behaviour should result:

"The name 'chreod' has been suggested to refer to a canalized trajectory which acts as an attractor for nearby trajectories. It is an interesting question to discuss how far the existence of chreods is necessary and how far it is merely an empirical result of the operation of natural selection" (1975: 221). "A chreod, as we have defined it, is simply the most general description of the kind of biological process which has been referred to as 'goal directed'. ... I have spoken of such phenomena as 'quasi-finalistic'" (*ivi*: 223). Thus, words like chreod do not lay much "stress on the final state but draw attention to the whole time trajectory" (*ibidem*).

The notion of canalisation was also used by Thom ([1976]: 294), claiming that "a finalist process is characterised by the existence of an aim, a final state toward which the organism tends along some convergent funneled route (cusped canalization), and most finalist processes in biology show this behavior"; however, Thom also noted that cusped canalisation may also arise spontaneously, apart from finalistic processes. In a more formalised way, Beckner (1976: 209-210) regarded

"any goal-directed activity as defining an activity Φ of a system S which is privileged in two ways: (1) any narrowed line in the net-organization of S which contributes to Φ is a function in S (thus admission of goal direction extends the range of admissibility of function ascriptions); and (2) the vocabulary of success and failure is applicable to S, to Φ, and to the parts (and their activities) of S.

All language which essentially exploits these conceptual schemes I regard as teleological language".

Canalisation and the narrowing of the possibilities of a system imply some control on the relevant processes, as it had already been noted by Rosenblueth, Wiener and Bigelow (1943: 18):

"Active behavior may be subdivided into two classes: purposeless (or random) and purposeful. The term purposeful is meant to denote that the act or behavior may be interpreted as directed to the attainment of a goal ... Purposeless behavior then is that which is not inter-

preted as directed to a goal. The vagueness of the words *may be interpreted* as used above might be considered so great that the distinction would be useless"; so, "We have restricted the connotation of teleological behavior by applying this designation only to purposeful reactions which are controlled by the error of the reaction — i.e., by the difference between the state of the behaving object at any time and the final state interpreted as the purpose. Teleological behavior thus becomes synonymous with behavior controlled by negative feedback, and gains therefore in precision by a sufficiently restricted connotation" (*ivi*: 23-24).

In almost identical terms, Miller (1978: 40) calls teleological process "the internally determined control process of the system which maintains one of its variables at a given steady-state".

But, as Mayr has aptly noted, the "truly characteristic aspect of goal-seeking behavior is not that mechanisms exist which improve the precision with which a goal is reached, but rather that mechanisms exist which initiate, i.e. 'cause' this goal-seeking behavior. It is not the thermostat which determines the temperature of a house, but the person who sets the thermostat. It is not the torpedo which determines toward what ship it will be shot and at what time, but the naval officer who releases the torpedo. Negative feedbacks only improve the precision of goal-seeking, but do not determine it. Feedback devices are only executive mechanisms that operate during the translation of a program" (1974: 100). So, Mayr proposes to stress the source of control, and claims that a "teleonomic process or behavior is one which owes its goal-directedness to the operation of a program" (*ivi*: 98). Now, the metaphor of the program, derived from cybernetics and informatics, implies a reference to instructions and algorythms; thus, Bernal claims that "all the patterns of life are not planned, as we plan a machine or a work of art, on the basis of an idea or a model; but *prescribed* along various operational prescriptions which do not involve knowledge of the final product. This is the form which modern molecular biology has given to the 'final causes' of Aristotelian biology" (1967: 167).

Since the concept of teleonomy has given rise to an autonomous debate, we refer the interested reader to the relevant literature (Mayr 1974). We limit ourselves to note that the reference to a genetic program evolved through natural selection leads to some exquisitely evolutionary teleonomical notions like fitness or adaptation. So, Berta-

lanffy (1968: 77) ranges among the various types of finality a "Static teleology or fitness, meaning that an arrangement seems to be useful for a certain "purpose". Thus a fur coat is fit to keep the body warm", while Oparin (1961: 11) sees purposiveness itself as "adaptation of form to function". Finally, Lorenz (1966: 9) leads us back to the debate on function, teleology and evolution: "If we ask 'What does a cat have sharp, curved claws for?' and answer simply 'To catch mice with', this does not imply a profession of any mythical teleology, but the plain statement that catching mice is the function whose survival value, by the process of natural selection, has bred cats with this particular form of claw. Unless selection is at work, the question 'What for?' cannot receive an answer with any real meaning".

3. Assessing the Content of Biological Finality

Now that we have sketched a sort of consensus definition of finality as a terminus, we can fill this concept up with some content, asking what does this terminus consist of?

Since we are dealing here with biological finality in the philosophy of life and organisms, the content of finality will be more or less centered on the organismic level, mainly consisting of self- or immanent properties. This does not exclude the possibility that from other viewpoints things could be different; for instance, in a more ecological reflection we could ask something about the function, role or finality of an organism in its biocoenosis or population.

Now, immanent organismic finality can be taken in two ways, as the finality of a part (organ) with respect to the whole (organism), or as the finality of the whole organism with respect to itself. This may lead to some confusion or contradiction, especially in the case of multicellular organisms, where we recognise life both at the cellular and at the organismic level. Take for instance Bernard's view on multicellular organisms; on one side, he states that vital phenomena "harmonise in view of a result which is the organisation and growth of the individual" (1878: 51, my transl.); on the other side, he also maintains that "*The organism is built in view of elementary life*" (*ivi*: 354, stress in the original), and that "the organs, the systems do not exist for themselves; they exist for the cells, for the countless anatomical elements which form the organic building" (*ivi*: 358); finally, in a concluding assessment reminding oneself of Kant's *Critique of Judgment* (II, 64),

he claims that in an organism "all is done by the anatomical element and for the anatomical element" (Bernard 1878: 367).

In general, two overarching finalities have been constantly put to the fore by biologists, that is, life and reproduction. They may be expressed under disguised form, like as a reference to identity (Weber & Varela 2008: 212) or self-expression (Goodwin 1998: 428), but that an organism's working is "directed to continuing either itself or other systems like itself" (Huxley 1912: 21), either to the maintenance of one's existence (life) or that of one's *phylum* (reproduction) are almost always implied. So, only some nuances differentiate one author from another.

Some of them stress more the importance of life. Weber and Varela (2008: 211, 215-216) first claim that "teleology is a primordial tendency of matter manifesting in the form of organisms. As an embodiment of intrinsic teleology an organism is, in a strong sense, a "natural purpose"."; then, they conclude that on "a material, concrete level we can observe in the organism the flip side of a mechanical causality which, *in fine*, is the final causality that is the basic process of life itself".

Other authors list both finalities. According to Oparin (1961: 10), the metabolic reactions are coordinated, resulting in a whole biochemical sequence which "is directed in an orderly way towards the continual self-preservation and self-reproduction of the living body as a whole". Boorse (2002: 69) writes that "all the gross behavior of organisms seems directed to two ultimate goals: individual survival and reproduction. Specific activities ... seem to be part of a way of life promoting Darwinian fitness".

On the contrary, Jacob (1970: 10, my transl.) stands firmly on the side of reproduction, in his opinion the basic *Logique du vivant*: "sure, the living being represents the execution of a plan, but one which no intelligence has conceived. It tends towards a goal, but one which no will has chosen. This goal consists of preparing an identical program for the following generation. It is to reproduce. ... Reproduction is both the origin and the end, the cause and the goal". And again, reproduction "works as the main operator of the living world. On one side, it is a goal for each organism. On the other side, it guides the purposeless history of the organisms" (*ivi*: 17).

A final remark is that a biological entity may have different finalities, hence a functional mutliplicity (Plantinga 1987-1988). This is

particularly relevant in evolution, where changes occur in the finality of an organ, giving rise to evolutionary bricolage (Jacob 1977) and exaptation (Gould & Vrba 1982).

4. Distinguishing Biological Finality from Some Related Concepts

As I told in the introduction, various authors feel that there is some difference between the concepts of finality and function, though they do not always succeed in explicating better their feeling.

As Plantinga (1987-1988) puts it, the fact is that "The notion of proper function is one member of a connected group of interdefinable notions; some of the other members of the group are *dysfunction, design, function* (simpliciter), *normality* (in the normative nonstatistical sense), *damage*, and *purpose*. There is initial reason to doubt, I think, that this circle of concepts can be broken into from the outside – that is, reason to doubt that any of them can be defined without reference to the others". Elsewhere, however, Plantinga seems to take function and purpose as synonyms: "Such organs have a *function* or *purpose;* more exactly, they have several functions or purposes, including both proximate and more remote purposes ... Under ordinary conditions your kidneys function a certain way: they respond in a certain way to circumstances, and they do so in order to accomplish their purpose or function, which is the removal of metabolic waste products from the bloodstream"[6].

The difference between finality and function can be found here and there, sometimes in an implicit way or as a simple statement not further elaborated on. So, Bernard (1878: 370, my transl.) wrote that "the *function* is a series of acts or phenomena which are grouped and harmonised in view of a certain result ... It is this result, which our spirit glimpses, that makes the link and unity of these component phenomena, and which makes the *function*". Since here function is meant of as a process towards a purpose-result, it cannot coincide with the purpose itself: the purpose is glimpsed by the spirit of the naturalist, while the process is performed by the organism; and even if Bernard

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[6] Here another distinction should be made, following a suggestion by Piaget (1967: 165 ff), namely, that between function (*fonction*) and functioning (*fonctionnement*): so, the kidney's *fonctionnement* has the *fonction* of removing waste.

says that it is the purpose that makes the function, this seems to mean - though not very clearly - that there is some difference between the purpose-maker and the function-made.

Eventually, however, processes have been prevailingly related to finalities, while capacities to functions. So, Rosenblueth, Wiener and Bigelow (1943: 24) say that "teleology is concerned with behavior, not with functional relationships", while Ruse (1973: 190) states that "to talk of the very fact of having a function is to say nothing at all about goal-directedness (unless one is specifically talking of the function of the actual goal-directedness of a system). Rather, talk of functions implies talk of abilities to survive and reproduce". Mayr even argues, as we have seen, that the eye of a sleeping person is not teleological, since it is not performing any goal-directed process; completely stationary systems cannot be seen as teleological, and they can only become such when in activity; however, he concedes that perhaps "this difficulty can be resolved by making a terminological distinction between functional properties of systems and strict-goal directedness, that is teleonomy of behavioral or other processes" (1974: 106). Thus, for these scholars a sort of Aristotelian distinction between first and second act lurks behind the distinction between functions as capacities and finalities as processes.

Another author who accepts the distinction between finality and function is Beckner (1976: 199), who claims that "functions must be fulfilled, whereas goals need not be reached"; for instance, a *Daphnia* swimming toward the surface of a pool has the arrival at the surface as its goal, though it might not succeed to accomplish it. As we have already seen, also Boorse (2002: 70) clearly distinguishes between goal *G* and function *Z*.

More difficult to grasp is the distinction proposed by Miller (1978: 39) between goals and purposes, two terms that are usually treated as synonyms. It seems that goals are external and likely to change constantly, while purposes are internal and remain the same; according to him, "It is not difficult to distinguish purposes from goals, as I use the terms: an amoeba has the purpose of maintaining adequate energy levels, and therefore it has the goal of ingesting a bacterium". As such, this seems a distinction between proximate and ultimate finalities, yet I cannot understand in what sense ingesting a bacterium is an external finality. Actually, there is an apparently similar distinction between two finalistic concepts in Rosenblueth, Wiener

and Bigelow (1943: 23), according to whom "purposefulness, as defined here, is quite independent of causality, initial or final"; however, this statement simply means that their concept of purposefulness does not imply any causation from the future. Also Piaget (1967: 113) notes that, if by finality we mean some self-regulating mechanism, it has nothing to do with causes, in the sense of final causes.

Finally, Plantinga (1987-1988) has advanced a further idea: "Another important distinction is that between what a thing is *designed* to do (its *purpose*, say) and *how it is designed to accomplish that purpose* (its *design*, we might say). (Computers, as programmers know, do what you *tell* them to do, not what you *want* them to do.) There is a sort of ambiguity in the notion of working properly. On the one hand, a thing works just the way in which it was designed to work. My radio works properly when there is nothing wrong with it and it works just as its designer designed it to. But what shall we say when it works as it was designed to, all right, but has a very poor design and won't receive stations more than 500 yards away? Then it does not work very well, despite its functioning precisely in accord with its design plan."

5. Classifying Different Types of Biological Finality

Attempts at classifying and hierarchising the various types of finalities go back to Aristotle (e.g. *Phys.* 194a), and were systematised by his followers like Thomas Aquinas (e.g. *Summa* I, 65, 2) and the Thomists (e.g. Lorenzelli 1896: I, 208-209). Also Kant's discussion in his third Critique (II, 65) on the three types of generation in a tree, which are three distinct aspects of its being a natural end (*Naturzweck*), can be taken as a classification of biological finalities: first the finality of reproduction, then the finality of life, finally the finality of the organs.

Almost in an independent way, biologists have advanced their own classifications and hierarchies. Obviously, a hierarchy necessarily implies a classification, but not vice versa.

A first classification appears in Rosenblueth, Wiener and Bigelow (1943: 19). Purposeful active behaviour, that is, active behaviour which may be interpreted as directed to the attainment of a goal, is classified into two classes: feed-back or teleological, and non-feed-back or non-teleological. In particular, all purposeful behavior seems to require the negative type of feed-back; in fact, if a goal is to be at-

tained, at some time there is a need for some signals from the goal to direct the behaviour. Then, negative feed-back purposeful behavior may again be subdivided:

"It may be extrapolative (predictive), or it may be non-extrapolative (nonpredictive). The reactions of unicellular organisms known as tropisms are examples of nonpredictive performances. The amoeba merely follows the source to which it reacts; there is no evidence that it extrapolates the path of a moving source. Predictive animal behavior, on the other hand, is a commonplace. A cat starting to pursue a running mouse does not run directly toward the region where the mouse is at any given time, but moves toward an extrapolated future position" (*ivi*: 20).

So, purposeful active behaviour is thus classified:

1. non-feed-back behaviour, or non-teleological;
2. negative feed-back behaviour, or teleological:
   2.1 non-extrapolative or nonpredictive;
   2.2 extrapolative or predictive.

Bertalanffy (1968: 77 ff) offers a different classification:

1. static teleology or fitness, where a given arrangement seems to be useful for a certain «purpose». For instance, a fur coat is fit to keep the body warm.
2. dynamic teleology, that is, a directiveness of processes. This is divided into:
   2.1 "Direction of events towards a final state which can be expressed as if the present behavior were dependent on that final state";
   2.2. "Directiveness based upon structure, meaning that an arrangement of structures leads the process in such way that a certain result is achieved";
   2.3. equifinality;
   2.4. "true finality or purposiveness, meaning that the actual behavior is determined by the foresight of the goal".

In Bedau (1992) the classification also becomes a gradation. In grade 1, a thing performs a function which happens to be good (either for the thing itself or for the whole the thing is a part of); in grade 2, a thing performs a function because the function contributes to a result which happens to be good; in grade 3, a thing performs a function be-

cause the function contributes to a result which happens to be good and because the result is good; this is the finality traceable to a mind.

Plantinga's (1987-1988) distinction between proximate and ultimate purposes opens the road to a hierarchy of finalities: "organs have a *function* or *purpose;* more exactly, they have several functions or purposes, including both proximate and more remote purposes. The ultimate purpose of the heart is to contribute to the health and proper function of the entire organism (some might say instead that it is to contribute to the *survival* of the individual, or the species, or even to the perpetuation of the genetic material itself). But of course the heart also has a much more circumscribed and specific function: to pump blood. Such an organ, furthermore, normally functions in such a way as to fulfill its purpose; but it also functions to fulfill that purpose in just one of an indefinitely large number of possible ways".

An example of hierarchy of finalities is given by Boorse (1977: 556): "[T]he structure of organisms shows a means-end hierarchy with goal-directedness at every level. Individual cells are goal-directed to manufacturing certain compounds; by doing so they contribute to higher-level goals like muscle contraction; these goals contribute to overt behavior like web-spinning, nest-building, or prey-catching; overt behavior contributes to such goals as individual and species survival and reproduction. What I suggest is that the function of any part or process, for the biologist, is its ultimate contribution to certain goals at the apex of the hierarchy". Though there is some confusion between bodies like molecules and individuals, processes like muscle contraction and sets like species, this hierarchy of finalities seems to be linked to some hierarchy of biological levels of organisation, and Boorse himself supports this feeling, when he writes that "Each level's output is directed to goals that serve as input to the next" (2002: 70).

However, some authors are suspicious about any hierarchisation of biological finalities. As Morin (1980: 404, my transl.) claims, "Every *computo* is done according to a goal (*en fonction d'un but*). The internal and external operations the living machine accomplishes correspond to goals which can be extremely diversified. But all these convergent goals are engrained within a finality which integrates them all: *to live*. One lives to live". Yet, this finality is equivocal in various senses; for instance, one *must* live as well as it *wants* to live; besides, it is unclear which goal has the priority, to the point that the finality of

living becomes an exemplary problem of complexity: "In fact, life has many goals, but one could not discern a grand intelligible Goal, clear and unequivocal, which could be the Goal (*But*) of these goals" (*ivi*: 405). At first sight, it would appear that the primary finality is to reach homeostasis; yet, even this state of rest requires a lot of activity, until activity itself becomes a finality in its own right. Besides, these finalities enjoy a circular relationship, which makes them at the same time means and end (*fins*) of each other. So, we have to bear a great uncertainty about the «true» finalities of life: "though the innumerable goals (*buts*) are clear and distinct, the ends (*fins*) are ambiguous, circular, cycling, concurrent, antagonist, and the general end (*fin générale*) is either inexistent or indiscernible. The wanderings inherent in living are due to its immersion, not only into the aleatory, but into a finalistic uncertainty" (*ivi*: 407). "In other terms, *the finality of life cannot be expressed but in the seeming tautology of living to live*" (*ivi*: 408, stress in the original), a formidable finality indeed, but without any foundation and ultimately insufficient to define life itself.

In a less philosophical way, similar concerns had been also set out by Haldane (1931: 73). In a discussion on Bernard's views, he said that "the maintenance of normality in the blood is not an end by itself, but can be regarded as means towards ensuring normal functioning and structure in the various parts of the body. We are only reasoning in circle, however, if we regard the concerted action of the various organs of the body as the cause of the blood's normality, and at the same time regard the blood's normality as the cause of the concerted action and normal structure of the organs. The normality of blood composition is only one aspect of a specific normality which expresses itself generally in the life of an organism, and which hangs together and maintains itself as a whole". Yet, while Morin sees in such forms of circularity the mark of an unavoidable or even positive complexity, Haldane thought that the tautology was to be eliminated. And, in my opinion, this is a rather easy task, provided the temporal parameter is taken in consideration: for instance, the renal processes cause the expulsion of waste and the reabsorption of useful chemicals; then, the useful chemicals cause metabolic reactions, which afterwards cause further processes in the kidneys, and so on.

6. Assessing the Value of the Concept of Finality in Biology

As it is widely known, the deepest divergences about biological finality, and indeed about any kind of teleological talk, revolve around the ontological status of finality and the epistemological value of teleological statements. Three positions can be identified, which can be called a negative, neutral and positive view, respectively.

6.1 The Negative View

Various authors think that biological finality is flawed with inconsistency, misunderstandings and errors; as such, it must be eliminated from theoretical biology and biophilosophy, lest it constitute an epistemological obstacle or an intrusion of pseudoscience (Lagerspetz 1959: 65).

According to Allen (2009), there still remain "various grounds for concern about the role of teleology in biology, including whether such terms are:

1. vitalistic (positing some special "life-force");
2. requiring backwards causation (because future outcomes explain present traits);
3. incompatible with mechanistic explanation (because of 1 and 2);
4. mentalistic (attributing the action of mind where there is none);
5. empirically untestable (for all the above reasons)".

I would like to partially modify this scheme. First, to posit a vitalistic force, a backwards causation or a mind amounts to posit some cause distinct from efficient causes; if we also add supernatural causes, we can gather Allen's points 1, 2 and 3 under a single heading, that is, the suspicion about non-efficient causes. Doing so, the mentalistic objection gets split into two sections: if it involves a supernatural mind, it is to be included in supernatural causation, while if it is a natural mind, it could be either immanent or external to the organism or the organ; however, to my knowledge nobody has made recourse to a natural but external mind in biology.

In sum, we can so classify the objections against biological finality:

1. it is incompatible with explanations based on efficient causation, because:
   (i) it requires vitalistic causation;

(ii) it requires backwards causation;
(iii) it requires supernatural causation (a supernatural mind).

2. it is compatible with explanations based on efficient causation, but:
   (i) it requires a natural immanent mind where there is none;
   (ii) (it requires a natural external mind where there is none).
3. it is empirically untestable.

In this way, it also appears more clearly the distinction between epistemological (1, 2, 3) and ontological (a, b, c) arguments.

Let us scrutiny some examples of these objections.

1a. Objections against vitalistic causation.

The recourse to vitalistic causation is rejected by Sommerhoff (1950: 10) in these terms: "living nature is not teleological in the sense of employing anything akin to 'finalistic causation', and the attempts of vitalists to account for the apparent purposiveness of vital activities by invoking mysterious 'purposive agents', 'vital forces', 'entelechies', or other non-material components alleged to be present in living matter, have faded out of the main currents of biological thought". To such non-material causation Sommerhoff contrasts his concepts of directive correlation or focal conditions. Though these also are non-material entities, we must remember that a directive correlation is a state of facts, not an agent or force or entelechy. On the contrary, an agent is something which acts, that is, something whose change cause a change in the history of something else; and while it is epistemologically legitimate to hypothesise the existence of any agent, unless and until it is found, it will remain just a hypothetical entity. Another problem is that to introduce a non-material purposive agent to explain or account for the purposiveness of a material purposive agent does not solve, but simply displaces, the problem.

1b. Objections against backwards causation.

If there is anything on which all authors agree, this is the elimination of backwards causation. Those scholars in particular who look with favour to the concept of biological finality are anxious to show that their view does not imply any temporal inversion. And actually, it is rather difficult to assess where and when this idea of a temporal inversion – and the corresponding objection – got out, since it seems that nobody has actually argued for it. Even in Aristotle, we do not

find any reference to future events acting back on the present; rather, coming from the ancestors a fixed essence eventually passes from the parent organisms to their offspring; such essence, which coincides with the form and the *telos* of the organism as a member of a given fixed species, is undoubtedly anterior from a logical viewpoint, yet chronologically posterior: "In order of time, then, the material and the generative process must necessarily be anterior to the being that is generated; but in logical order the definitive character and form of each being precedes the material" (*De Part. Anim.*, II, 1, 646a; ed. Smith & Ross 1912). So, when Rosenblueth, Wiener and Bigelow (1943: 23) claimed that teleology "has been discredited chiefly because it was defined to imply a cause subsequent in time to a given effect", it is unclear what definition did they refer to; equally difficult to understand is the concept of a pre-established harmony, where the organism has not any constructive activity, which Piaget (1967: 123) considers typical of the ancient finalistic explanations.

More nuanced is the position of, again, Sommerhoff. Once stated that "The interpretation of the process of organic 'becoming', in terms of the 'potential' or 'future' purposively forcing its way into the 'actual' or 'present' in the manner of such finalistic causation, has already come to be regarded as ... an absurdity" (1950: 10), one can examine the idea of a *future* goal the biological processes *now* strive towards; then, the "main difficulty which besets the metaphorical concepts we are accustomed to use in a description of the purposiveness of vital activities and organic order, is that they imply a reference to some future goal towards which the respective organic activity is directed, and that this reference seems to be an essential and unalienable part of their meaning. They are, to say the least, quasi-teleological" (*ivi*: 9). The solution of the difficulty resides, in Sommerhoff's theory, in that, "although we have defined the directive correlation ... in terms of a future event, ... there was nothing in the least teleological in this definition. Our definition of directive correlation does not in the least imply that this future event ... is a cause ... There is nothing teleological, in the sense of the future determining the present through some form of 'final causation'" (*ivi*: 56).

An echo of Sommerhoff's quasi-teleology is in Waddington's quasi-finality: "The earlier expressions 'teleological' and 'finalistic' are usually thought to carry an implication that the end state of the chreod has been fixed by some external agency and that the end state

is in some way operative in steering the trajectory towards itself. To avoid such implications I have spoken of such phenomena as 'quasi-finalistic'" (1975: 223).

1c. Objections against supernatural causation.

Paley's idea that the order and finality of the biological world clearly points to the direct action of God (1802) has vanished thanks to the work of Darwin: "The old argument of design in nature, as given by Paley, which formerly seemed to me so conclusive, fails, now that the law of natural selection has been discovered. We can no longer argue that, for instance, the beautiful hinge of a bivalve shell must have been made by an intelligent being, like the hinge of a door by man. There seems to be no more design in the variability of organic beings and in the action of natural selection, than in the course which the wind blows. Everything in nature is the result of fixed laws" (Barlow 1958: 87).

2a. Objections against a natural immanent mind.

Besides referring to a theistical harmony, finalistic explanations have appeared to many anthropomorphic (Mayr 1974: 94), or more precisely, as Piaget (1967: 124) argues, psychomorphic, in the sense that they attribute to the organism a power to foresee the external exigencies. On the contrary, biology abstracts from persons, hence from personal purposes; so, "purposes, and therefore teleological explanations, are also excluded" (Woodger 1967: xvi). However, for those animals which possess a plastic nervous system one can hypothesise that they have intentional purposes, which becomes a certainty for humans (Mahner & Bunge 1997: 370).

3. Objections about empirical untestability.

According to the analytic philosophers, empirical untestability is the mark of non-science; that is why they all thought that finality "was seen as an insidious metaphysical notion that was to be tossed out with the rest of metaphysics" (Perlman [2010]: 150).

6.2 The Neutral View

A second possibility is that the concept of biological finality, though not being a completely scientific one, can do no harm to biology and biophilosophy, or it can be amended in order to make it clear and rigorous. The boundary between the negative and neutral stances

is marked by an eliminativist consideration: if someone thinks that a given reason requires the abandonment of the concept of finality, that position will fall into the negative view, otherwise it will be an instance of the neutral one (and possibly of the positive as well). And actually, I have also gathered here some positions which – *pace* their authors – in my opinion do not imply by themselves the elimination of the concept of finality.

The most easily amendable flaws are the verbalism that plagues many finalistic concepts of vitalism (Canguilhem 1965: 115), and the fact that - in the line of Hempel and Nagel - functional analyses are incomplete deductive-nomological explanations of the presence of some biological entity (Perlman [2010]: 150). In these cases, a better conceptual analysis of terms and explanations could lead to the acceptability of the concept of finality.

Other authors, more or less conscious of Kant's lesson about the regulative character of teleology, think that finality is in the scientist's eye. According to Bernard, finality is a "result glimpsed by the spirit", and "it is the spirit that grasps the *functional link* between the elementary activities; which lends a plan, a goal to the facts that it sees happen, and which perceives the realisation of a result of which it has devised the necessity" (1878: 370, 371, my transl.). Maturana and Varela first claim that living systems, "as physical autopoietic machines, are purposeless systems" (1980: 86), an ontological statement which falls in the negative view; however, they also advance an epistemological consideration, saying that purpose, aim, function are not "constitutive properties of the machine which we describe with them; such notions are intrinsic to the domain of observation" (*ivi*: 78); in a living machine, the connection between the "outputs, the corresponding inputs, and their relation with the context in which the observer includes them, determine what we call the aim or purpose of the machine; this aim necessarily lies in the domain of the observer that defines the context and establishes the nexuses. ... Thus, the notions of purpose and function *have no explanatory value* in the phenomenological domain which they pretend to illuminate, because they do not refer to processes indeed operating in the generation of any of its phenomena" (*ivi*: 86). Now, the epistemological argument seems less negative than the ontological one; and, as we will see later, Varela eventually changed his mind on the ontological status of finality. Thom goes as far as to say that there is a neurobiological basis for seeing finality in the or-

ganisms: humans possess archetypal chreods, that is, mental centers which organise the global fields regulating the various functions of the body; so, a "very contracting process with attracting final state in an animal is called finalist if its observation sets up, by resonance, one of these archetypal chreods in the mind of the observer" ([1976]: 295).

Another line of thought sees in the concept of finality a metaphor, an "as if" way of speaking, or a *façon de parler* "part of a Wittgensteinian language game, without any ontological significance" (Perlman [2010]: 150). For instance, so argues Dawkins (1982: 119): "The animal is behaving in what appears to be an organized, purposeful way, as if it was obeying a program, an orderly sequence of imperative instructions. ... natural selection cobbled together the equivalent of a hard-wired machine code program, by favouring mutations that altered successive generations of nervous systems to behave (and to learn to change their behavior) in appropriate ways. Appropriate means, in this case, appropriate for the survival and propagation of the genes concerned". Besides, in an organism all the limbs "conspire harmoniously together to achieve one end at a time ... and in nature behaves as if it had a single purpose" (*ivi*: 250).

Finally, according to various authors, teleological concepts, explanations and language constitute a complementary viewpoint with respect to accounts based on efficient causation and mechanisms. As Woodger put it, the usefulness or teleological character of adaptive structures is grounded in that they reflect environmental regularities and are useful mechanisms: "In this aspect there is no antithesis between teleology and mechanism. They simply represent two ways of regarding the same feature of the organism" (1967: 450). In a similar way, Bertalanffy (1968: 77) claimed that "the directedness of the process towards a final state is not a process differing from causality, but another expression of it". From his physical viewpoint, Bohr (1958: 92) argued that "the attitudes termed mechanistic and finalistic are not contradictory points of view, but rather exhibit a complementary relationship which is connected with our position as observers of nature"; even more based on physics are Thom's ideas ([1976]: 132, 280, 281): "von Neumann commented that the evolution of a system can be described in classical mechanics in two ways: either by local differential equations, for example, Lagrange's or Hamilton's equations, or by a global variational principle, like Maupertuis' principle of least action; and these two descriptions are equivalent, even though

one seems mechanistic and locally deterministic, whereas the other appears to be finalistic.

The same is probably true in biology: every epigenetic or homeostatic process is susceptible of a double interpretation, deterministic and finalistic"; the finalistic aspect is "immediately apparent to us (with reference to what we ourselves are and to our own behavior as human animals)", while the deterministic and mechanistic aspect escapes our attention, due to its very long time scale, its statistical character and the local tenuity of its decisive factors (metabolism and mutations).

A final comment by Canguilhem opens the road to the positive view of finality in biology and medicine: in pathology, even in case a causal explanation had been arrived at, the teleological judgment "would still preserve its independent value, particularly as to its practical application. Analysis and synthesis constitute a whole, without replacing one another" (1966: 180, my transl.).

6.3 The Positive View

The positive view is characterised by the acceptance of the concept of biological finality, on either epistemological or ontological grounds, or on both. As I told before, it has been principally embraced by biologists and biophilosophers who focus their attention on general biology, on what is common to all organisms, rather then working on limited sectors of biology, like molecular biology or entomology. That is, it seems that taking seriously in account the whole phenomenology of life and organisms leads to a favourable attitude towards biological finality.

The epistemological side of the positive view comes in two versions, which can be called a strong and a weak positive view.

According to the strong positive version, the concept of finality is indispensable, and *a fortiori* useful, in biology.

Rosenblueth, Wiener and Bigelow (1943: 18-19) write that "the recognition that behavior may sometimes be purposeful is unavoidable and useful ... although the definition of purposeful behavior is relatively vague, and hence operationally largely meaningless, the concept of purpose is useful and should, therefore, be retained". That is, they "consider purposefulness a concept necessary for the understanding of certain modes of behavior" (*ivi*: 23).

According to Sommerhoff (1950: 5) "the fundamental characteristics of observed life ... consist in the apparent purposiveness of vital activities and in the manner in which this apparent end-serving or goal-seeking quality integrates the part events of living systems into the self-regulating, self-maintaining, and self-reproducing organic wholes which we recognize as living individuals. That is to say, the distinguishing character of vital activities is their apparent subservience to biological needs which lie in the future, and to such fundamental biological ends as development, self-maintenance, or reproduction". So, "on the phenomenal level ... life is nothing if not just this manifestation of apparent purposiveness and organic order in material systems" (*ivi*: 6).

Bertalanffy (1968: 45) also recognises that one "cannot conceive of a living organism ... without taking in account what variously and rather loosely is called adaptiveness, purposiveness, goal-seeking and the like".

More recently, Boorse (2002: 63) has endorsed the strongest possible positive view, inasmuch as it "views goal-directedness as a property manifest in the behavior of, at least, all living organisms" and takes it as "an objective, non-mental property of all living organisms. It thus lets functional statements be literally true throughout the whole biological domain, not merely metaphorically true, heuristically useful, or the like".

The weak positive view claims that the concept of biological finality is more or less useful, yet not indispensable, in biology. Some authors have an oscillating position, at times admitting that finality is required, while elsewhere claiming that it has only a limited field of application, or merely a heuristic value.

For instance, Bohr (1958: 10) wrote that "the concept of purpose, which is foreign to mechanical analysis, finds a certain field of application in biology. Indeed, in this sense teleological argumentation may be regarded as a legitimate feature of physiological description which takes due regard to the characteristics of life"; "a living organism is characterized by its integrity and adaptability, which implies that a description of the internal functions of an organism and its reaction to external stimuli often requires the word purposeful, which is foreign to physics and chemistry" (*ivi*: 92). Woodger (1967: 440, 453) claims that it is difficult to avoid teleological talk in biology, since "living

organisms exhibit (in some measure at least) "internal teleology""; in any case, teleological notions have heuristic value (*ivi*: 429).

According to Ruse (1973: 176-177) "although biological thought does not presuppose a 'strong' teleology (i.e. a teleology postulating future causes), in a somewhat weaker sense biology has an untranslatable (although perhaps not unremovable) teleological element. In a very real manner, biologists do get explanatory understanding by reference to the future". Then, tackling the problem of the translatability from teleological to non-teleological statements, Ruse writes that "there is an irreducible teleological element in biology ... it is a genuine teleology in that we try to understand the world with reference to the future rather than to the past. We try to understand the eyes and the eggs with reference to what they will do, rather than (or, as well as) with reference to what went on before. ... since we find it illuminating to consider the organic world with respect to its future as well as its past, biology has an untranslatable teleological flavour ... One might just replace every functional explanation with a non-teleological explanation. ... However, it does seem to me that in a case like this, one is not translating a teleological explanation. Rather, one is replacing one's teleological explanation, with a different, non-teleological explanation. The teleology itself cannot be translated away" (*ivi*: 195-196).

Piaget (1967: 155-156) argues in favour of maintaining only some aspects of finality: in fact, the models of self-regulation both maintain the valuable side of finalistic descriptions (not explanations), and give a causal explanation of oriented and self-correcting processes, that is of teleonomy.

In conclusion, states Mayr (1974: 108), "Teleological language has been employed in the past in many different senses, some of them legitimate and some of them not. When the [suitable] distinctions are made ... the teleological *Fragestellung* is a most powerful tool in biological analysis". That is why biologists are again willing, as Pittendrigh (1958) had put it, "to say 'a turtle came ashore to lay her eggs', instead of saying 'she came ashore and laid her eggs'. There is now complete consensus among biologists that the teleological phrasing of such a statement does not imply any conflict with physico-chemical causality" (Mayr 1974: 92).

On the ontological side, first of all finality is what distinguishes organisms from nonliving bodies: "The peculiarity which distin-

guishes life qualitatively" is that metabolic reactions are sequentially coordinated and that "the whole of this sequence is directed in an orderly way towards the continual self-preservation and self-reproduction of the living body as a whole" (Oparin 1961: 10). This distinguishing property is due, according to Morin (1980: 403), to the fact that finality itself has emerged with life, as a complex finality or a complex of finalities.

In this sense, finality is a true property, tendency or way of being. So, Sommerhoff (1950: 14) claims he has demonstrated "that the purposiveness of natural events has an objective basis in time and space, and may in fact be regarded as a *physical* property". In short, his directive correlation "is the fundamental and objective system-property which in more or less complex forms underlies the phenomena of adaptation in nature and their purpose-like character" (*ivi*: 56).

Maybe, the most impressive position is that of Varela, who had begun his career – as we have seen above – claiming that living machines are completely purposeless. Then, he completely changed his opinion. As he wrote with Weber (Weber & Varela 2008: 201, stress in the original), "a meaningful description of the organism is only possible by taking teleology seriously: by accepting that *organisms are subjects having purposes according to values encountered in the process of living*". They find support in the last writings of Kant, who in the so-called *Opus Postumum* "gives teleology an apriori foundation in the subject experiencing itself purposefully as itself and also as connected to the world" (*ivi*: 206). Hence, "it is not our own constitution as subjects of reason ... that ... determines which object domain we must perceive to be teleological. Rather, the ground of our existence is originally teleological ... Teleology is not only a necessary way to *think* the living. The "teleological circle" is the fundamental (or constitutive) mode in which organic beings *live*. This is what Kant glimpsed at the end of his work" (*ivi*: 208). Thus teleology "is a primordial tendency of matter manifesting in the form of organisms. As an embodiment of intrinsic teleology an organism is, in a strong sense, a "natural purpose"." (*ivi*: 211).

Another author Weber and Varela refer to is Jonas, with his idea that freedom is rooted in the very biological properties of all organisms. Freedom or autonomy "is nothing other than true teleological behavior. Organic teleology results from the persistent gap between the realization of the living and its underlying matter" (*ivi*: 214). This

gap (which reminds me of Aristotle's resistance of matter to be informed by the final–formal cause), as well as the finality descending from it, make teleology the way an organism works; consequently, it is causality that follows from teleology, and not the other way round.

In conclusion, Varela's autopoiesis and Jonas' freedom "provide an empirical background for the *Leibapriori* found in the late works of Kant, and together they can resolve the paradoxes about organic purposefulness in the *Critique of the Power of Judgment*. Teleology, understood as intrinsic teleology, turns out to be an empirical feature of the organism, its *sine qua non* condition" (*ivi*: 216).

Among the reasons for accepting finality, the evolution of genetic programs by natural selection plays a primary role. In a famous statement, Jacob declared that "for a long time, the biologist has approached teleology as a woman he could not dismiss, but in whose company he would not like to be seen in public. To this secret liaison, the concept of program now gives a legal status" (1970: 17, my transl.); and concluding his essay, he noted that "natural selection imposes a finality not only upon the organism as a whole, but also upon each of its components" (*ivi*: 321). Previously, also Oparin had proposed similar ideas: "The 'purposiveness' which is characteristic of the organisation of all living things can only be understood if one understands the specific interaction between the organism and its environment in terms of the Darwinian principle of natural selection. This new biological law could only arise on the basis of the establishment of life and therefore lifeless, inorganic bodies lack 'purposiveness'. The striking exception to this rule is the machine" (1961: 13).

In sum, "there should be nothing surprising in the fact that wherever there is selection, there is teleology" (Griffiths 1993: 422).

Acknowledgments

This paper was written in the context of the First Summer School in Science and Faith (Roma, Pontifical Athenaeum 'Regina Apostolorum', July 14-19, 2014). I would thank the Dean of the Faculty of Philosophy, Father Rafael Pascual LC, for having invited me to take part in this event. The style revision is courtesy of my friend, Prof. Roberta Resta.

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Summary: This paper is focused on the concept of finality in the bio-philosophical study of life and organisms. After some methodological remarks, the definition of biological finality is addressed. There are, in fact, wide variations regarding the concept of finality in biology, although the notions of finality as function or terminus are the most widespread. Given the vast and independent literature on functions, this paper mainly focuses on finality as a terminus, that is, a state or condition a biological entity reaches, or has the possibility of reaching. For what concerns the content of this concept, biologists have stressed above all the importance of self-maintenance and reproduction. Then, various types of finality are classified. Finally, as to the ontological and epistemological value of the concept, it seems that in general biology there is a slight tendency in favour of its use.

Key words: General biology, bio-philosophy, philosophy of the organism, biological organism, biological life, biological finality

Sommario: L'articolo esamina il concetto di finalità nella biofilosofia della vita e dell'organismo. Dopo alcune annotazioni di carattere metodologico, viene affrontata la definizione della finalità biologica. Esiste un ampio spettro di concetti di finalità in biologia, tra cui i più diffusi sono la finalità come funzione e come termine. Poiché esiste un'ampia e indipendente letteratura sulle funzioni, l'articolo si concentra sul concetto di finalità come termine, cioè come qualcosa a cui un'entità biologica giunge, oppure ha la possibilità di giungere. Per quanto riguarda il contenuto di questo concetto, i biologi hanno sottolineato soprattutto l'automantenimento e la riproduzione. Segue una classificazione di diversi tipi di finalità. Quanto infine al valore ontologico ed epistemologico del concetto, sembra che nella biologia generale vi sia una leggera tendenza in favore del suo uso.

Parole chiave: Biologia generale, biofilosofia, filosofia dell'organismo, organismo biologico, vita biologica, finalità biologica, teleologia biologica, funzione biologica.