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Two dimensions of the biological function debate

(Dos dimensiones en el debate sobre funciones biológicas)

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ABSTRACT: This article adopts a minimal definition of biological usage to demonstrate that the debate over biological function encompasses two distinct dimensions: descriptive and prescriptive. In the descriptive dimension, biological usage serves as the final arbiter for evaluating different accounts of biological function. Conversely, in the prescriptive dimension, accounts are formulated despite biological usage. The main thesis of this article is that the descriptive/prescriptive distinction helps make better sense of the biological function debate from a novel perspective. This is elucidated by meticulously analyzing the two dimensions and subsequently providing a global overview of the debate.

KEYWORDS: biological function debate, biological usage, descriptive/prescriptive distinction, global overview.

RESUMEN: *En este artículo se adopta una definición mínima de uso en biología para mostrar que el debate sobre funciones biológicas presenta dos dimensiones, descriptiva y prescriptiva. En la dimensión descriptiva, el uso en biología ejerce como el árbitro final para evaluar diferentes teorías sobre las funciones biológicas. En cambio, en la dimensión descriptiva las teorías de formulan con independencia del uso en biología. La tesis principal del artículo es que la distinción descriptivo/prescriptivo nos ayuda a pensar en el debate sobre funciones biológicas desde una perspectiva novedosa. Esta tesis se elucida analizando meticulosamente las dos dimensiones y ofreciendo a continuación una revisión global del debate.*

PALABRAS CLAVE: debate sobre funciones biológicas, uso en biología, distinción descriptivo/prescriptivo, revisión global.

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1. *Introduction: A recent controversy*

In the biological function debate, recently Matteo Mossio, Cristian Saborido, and Alvaro Moreno advanced an influential organizational account (Mossio *et al.,* 2009; Saborido *et al.,* 2011; Mossio and Saborido, 2016; this account has recognizable predecessors, such as Schlosser, 1998 and McLaughlin, 2003). According to this account, "a trait type T has a function if, and only if, it is subject to organizational closure C in a differentiated self-maintaining system S" (Mossio *et al.,* 2009, p. 828). Further, this account provides three conditions for attributing a function to a trait type: "C1: T contributes to the maintenance of the organization O of S; C2: T is produced and maintained under some constraints exerted by O; C3: S is organizationally differentiated" (p. 828). Mossio and his colleagues' account relies on their theoretical work on organizational closure and is admittedly rather sophisticated. However, like most other accounts of biological function, this organizational account was immediately subject to criticisms from other philosophers (Artiga and Martínez, 2016; Garson, 2017).

Nevertheless, Mossio and his colleagues soon noted themselves that a particularly interesting challenge could already be found in an earlier contribution from Craig Delancey (2006), to which they felt compelled to offer a reply (Saborido *et al.,* 2011). This challenge created a small controversy within the biological function debate (Artiga and Martínez, 2016; Mossio and Saborido, 2016). This controversy can be stated as follows. As shown above, to account for biological function, Mossio and his colleagues (Mossio *et al.,* 2009) rely on the crucial concept of the self-maintaining system, to which a functional trait must contribute. However, as Delancey (2006) pointed out, since biologists do say that the function of sperm is "to inseminate an egg," (p. 94) this generates a difficulty for the organizational account. Sperm is at best a cross-generational (rather than intra-generational) trait, and it does not seem to have contributed to the self-maintenance of its paternal organism; in consequence, as Marc Artiga and Manolo Martínez (2016) nicely summarized, "OA [the organizational account] has the very counterintuitive consequence that sperm does not have any function" (p. 109).

Mossio and his colleagues took this challenge seriously and devoted an entire article (Saborido *et al.,* 2011) to offering "a philosophical reply to Delancey's criticism" (p. 585). In contrast to Delancey (2006)'s splitting account, which insists on "the difference between cross-generational and intra-generational teleofunctions," (pp. 87-8) Saborido *et al.,* (2011) endorsed a unified account "applying to both intra- and cross-generation functions" (pp. 585-6). Crucially, it emphasizes that "cross-generation functions contribute to the maintenance of systems which realize a self-maintaining organization in the very same sense as that of systems whose parts are ascribed intra-generational functions" (p. 586). In doing this, Mossio and his colleagues made more explicit a point that is missing (or very vague at best) in their original account (i.e., Mossio *et al.,* 2009): Self-production is a form of self-maintenance, by definition. Given this definition, sperm contributes at least to the self-maintenance of "the encompassing system composed by the reproducer and reproduced organism," (Saborido *et al.,* 2011, p. 600) "by contributing to the production of a new organism to replace the previous one" (p. 600). For this reason, it appears fine to say that sperm has a function.[1]

[1] Based on the response from Saborido *et al.* (2011), the controversy partly assumed a different direction, by focusing on the nature of the so-called encompassing system: Artiga and Martínez (2016) read

Admittedly, the reply in Saborido *et al.* (2011) is self-consistent; but this controversy strikes me as perplexing, and will lead me to develop a more general concern about the entire biological function debate. To start, this controversy hinges by and large on how to legislate a single function statement about sperm (namely, "the function of sperm is to inseminate an egg"): Delancey contended for a splitting account; Mossio and his colleagues defended a unified account. Moreover, the function statement about sperm belongs to what we call biological usage (to be more precisely defined in section 2) in the biological function debate, which often acts as the highest arbiter of selecting qualified accounts. As exemplified by the foregoing controversy, all accounts of biological function are required to capture at least some cases of biological usage, and a violation is often considered to be a vice.

My concern about the biological function debate comes in exactly at this point: It is not self-evident that biological usage should be the final arbiter every time. In the very least, although few philosophers in the biological function debate have questioned the status of biological usage, the cost of treating it as the final arbiter is rather high. As we have seen, Mossio and his colleagues took pains to clarify (or perhaps even modify) their account, only to render a single function statement ("the function of sperm is…") or at best a kind of function statements (cross-generation functions) legitimate. Yet, what if biological usage is put into doubt? In particular, what if Mossio and his colleagues were to prescribe their original, apparently narrower account in 2009 (self-production is not explicitly defined to be a form of self-maintenance), and sperm would then be denied any function?

Given these questions in particular and my concern about the debate in general, I develop a reflection on biological usage of function terms and statements in this article, and recommend accordingly to distinguish the descriptive dimension of the biological function debate from its prescriptive dimension. The main thesis is that the entire debate can be better understood in light of the descriptive/prescriptive distinction. The goal of this article is, importantly, not to endorse or oppose any particular account of biological function, but to better understand all these accounts as well as the biological function debate itself as a whole. This article is organized as follows: Section 2 clarifies the meaning of the phrase "biological usage (of function terms and statements)" adopted in this article, section 3 considers the descriptive dimension of the debate, section 4 deals with its prescriptive dimension, section 5 provides a global overview of the biological function debate, and section 6 concludes this article by relating the biological function debate, perhaps surprisingly, to Kant's view of teleology in biology.

2. On Biological Usage of Function Terms and Statements

It is a brute fact that biologists have long been using function terms and statements in their discourse. The statement about the function of sperm is just one among many. If one opens up any mainstream journal in biology, he/she is sure to encounter many such cases of bi-

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it as including "a set of organisms of different generations of a single lineage" (p. 110) and decided that the organizational account is indeed etiological; but Mossio and Saborido (2016) strongly disagreed and maintained that the system indicates an organization "abstracted from time" (p. 263).

ological usage: Biologists talk about functions of genes, proteins, traits, organs, and many other biological entities. Philosophers often refer to such cases as constituting biological usage of function terms and statements. However, in biological function literature, philosophers could have different conceptions when they talk about "biological usage" (see below); therefore, to start, it is necessary to clarify what is meant by biological usage of function terms and statements in this article. Overall, this article adopts a minimal definition of biological usage, which indicates the collection of behavioral facts about *biologists choosing to ascribe functions to certain biological entities for their contributions to certain effects*.[2] For convenience, it is possible to conceive of biological usage as simply the set of function statements (the function of x is...) used by biologists.

Biological usage defined as such has its clear complement, namely, the set of function statements that are *not* used by biologists (or put it formally, the set of all possible function statements in biology minus the set of function statements used by biologists). Given that functions ascribed to biological entities often denote some of their effects, these statements are of two types. The first consists of function statements in which biological entities within the concern simply do not contribute to stated effects and are therefore empirically incorrect. The statement "the function of the heart is to breathe," for instance, belongs to this type. The second type comprises function statements in which biological entities within the concern do contribute to respective effects, but biologists would not treat such contributions as functions of those entities. For instance, although biologists might not judge the statement "the function of the heart is to make a noise" as empirically incorrect, they would take it to be inadequate and would choose not to utter that statement on most occasions. Further, it should be emphasized that few philosophical accounts of biological function are concerned with statements of the first type that unwisely commit biological fallacies, and those that are philosophically interesting often belong to the second type.[3]

More importantly, biological usage defined in this article does not include several components that are often associated with it in the biological function debate. First, what biologists think about their use of function terms is not considered to be parts of biological usage. While this does not imply that the opinions of biologists are less important, it does suggest that biologists have no higher authority than philosophers in judging different accounts of function. The chief reason for this conceptual delimitation is that what biologists think about their use of function terms only gives rise to their own accounts of biological

[2] As an anonymous reviewer has very helpfully pointed out, along the line of Ernest Nagel (1979), sometimes biologists use the terms "goal" and "function" interchangeably, and for this reason, it might be useful to consider even the inclusion of general teleological terms as part of biological usage defined in this article. Yet, even if this were the case, as will be clear at the end of this article, it would not affect the general conclusion that teleological terms and function terms are eliminable in biological discourse, and they are *not* indispensable to expressing biological knowledge. Indeed, all things said about function terms work perfectly for teleological terms in general. In addition, a recent analysis of Nagel's view on biological teleology (Chen, 2022) shows that Nagel would agree with the general conclusion drawn in this article.

[3] Moreover, it should be noted that under the definition adopted in this article, function statements used by biologists should (1) only talk about biological entities (so, stones and knives are excluded), and (2) only consider real biological situations (so, counterfactual function statements such as "the function of the heart of a swamp-cow/accidental lion is..." are excluded).

function (often very vague), which should also be judged by biological usage defined in this article. This delimitation of biological usage offers good news for the etiological approach. In the biological function debate, an objection commonly made to the entire etiological approach often appeals to the observation that few biologists have it in mind when they utter function statements.[4] This observation might be empirically correct in itself; yet, if biological usage is treated as the final arbiter, as long as biologists' opinions are not treated as parts of biological usage, other accounts have no clear advantage over etiological accounts. Etiologists can say it is biological usage itself rather than what biologists think about it that decides.[5]

Second, contra some advocates of the etiological approach, biological usage of function terms and statements defined in this article is also to exclude normative and explanatory intent. In other words, when biologists use function terms to make function statements, normative and explanatory implications are not treated as inherent features of these terms. Again, this is not to deny that concerns over normativity and explanatory power are important stimulants of the biological function debate; the point is rather that they should be considered in a different manner. Indeed, as will be clear in section 5, these constitute much-disputed non-descriptive criteria provided by philosophers to defend their accounts of biological function. Moreover, it should also be noted that this conceptual delimitation of biological usage is less friendly to the etiological approach. In the biological function debate, a major virtue claimed by etiologists is that their accounts are in a better place to make sense of the normative and explanatory implications of function terms.[6] Yet, in this article, since normative and explanatory features are not treated as inherent in function terms, etiological accounts have no clear advantage over others, even if biological usage is treated as the final arbiter.

Overall, I adopt in this article a minimal definition of biological usage of function terms and statements, which includes merely behavior facts about biologists ascribing func-

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[4] For instance, as a major philosophical critic of the etiological approach today, Arno Wouters complained that "no etiologist has ever provided a detailed discussion of a real example of the use of etiological functions in biology," (2005, p. 144) and elsewhere he even claimed that, for this reason, "the [etiological] approach taken by the authors to tackle the question how function talk in biology…is legitimate is fundamentally flawed" (2003a, p. 233). Yet, for biologists who are more or less committed to the etiological approach, see Doolittle (2013).

[5] For instance, Justin Garson in his recent monograph *What Biological Functions Are and Why They Matter* (2019) expressed this spirit vividly: "…even though I care about how biologists use 'functions,' I'm not too interested in what biologists say functions are" (p. 23). Elsewhere Peter Schwartz (2004) put it in more sober words that the project to explicate biological usage is "philosophical" rather than "psychological" in nature, and its goal is not to "search for criteria of application in people's minds" (p. 146).

[6] For instance, as one major advocate of the etiological approach today, Garson wrote in his 2019 monograph, "when biologists given functions to traits, they often use "function," explicitly, in a way that respects the distinction between function and accident, function's normativity, and its explanatory depth. Selection is the only thing in the world that can underwrite all of those features of ordinary biological usage…" (p. 102; also see Garson, 2018). As a matter of fact, the classical etiologist Larry Wright made this point clear even at the very beginning of the biological function debate: "Only an etiological analysis can make required sense of the function/nonfunction distinction" (1976, p. 92; see also later Millikan, 1989 and Neander, 1991).

tions to certain biological entities, or even more straightforwardly, function statements in biological discourse. Let me emphasize that this conceptual delimitation is not to promote my definition of biological usage to be the "true" or "best" definition, in contrast to alternatives mentioned above; rather, it is to serve our larger analytical purpose of understanding the biological function debate as a whole. After all, as implied above, those components that are excluded by my definition (such as biologists' opinions on their use of function terms, and normative and explanatory features alleged to be inherent in such terms) will not be ignored but considered in different manners.

In a way, the definition of biological usage of function terms and statements given above is specially designed to articulate the two dimensions, descriptive and prescriptive, of the biological function debate. Now let me start with the descriptive dimension.

3. The descriptive dimension: biological usage as the final arbiter

The recent controversy over the function of sperm is a standard example of appealing to biological usage of function terms and statements to select qualified accounts of biological function. Such an appeal has a long history, and even today most philosophers active in the biological function debate agree that an adequate account of biological function must be able to achieve some levels of descriptive adequacy regarding how biologists use function terms. This concern helps motivate the descriptive dimension of the biological function debate.

3.1 The logic of the descriptive dimension

Such a concern is already strongly present in classical articles, such as those by Robert Cummins (1975) and Larry Wright (1972, 1976). Cummins, in his 1975 article, before setting up his subsequently influential account, examined several alternatives and dismissed them as unsatisfactory for, among other reasons, their common failure in capturing "actual usage" (p. 756). For instance, when attacking Carl Hempel's analysis, Cummins cited biological examples. According to Cummins, Hempel suggested that "functions are to be identified with production of effects contributing to proper working order of a containing system" and in the context of living organisms, "to be in 'proper working order' is simply to be alive and healthy" (p. 754; Hempel, 1965, p. 306). But Cummins contended that Hempel's suggestion is untenable because, "there are cases in which proper function is actually inimical to healthy and life: functioning of the sex organs results in the death of individuals of many species (e.g., certain salmon)" (p. 754).

Similar to Cummins, Wright was also critical of earlier attempts to make sense of biological function. For instance, in a 1972 article (later incorporated into Wright, 1976), Wright attacked Michael Ruse's account of biological function (1971) in particular. According to Wright (1972), Ruse was committed to the following analysis of function statements in biology: "the function of x in z is to do y" equals the following two statements, (1) "z does y by using x,", and (2) "y is an adaptation" (Wright, 1972, p. 512; Ruse, 1971, p. 91). And by "adaptation", Wright interpreted Ruse as suggesting that "y is an adaptation…if and only if [z's] which perform [y] are more likely to survive and reproduce than [z's] which are identical with them in every other respect but which do not perform [y]"

(p. 512). But Wright judged Ruse's analysis to be inadequate with several counterexamples. In addition to those often-mentioned noise-making hearts and eyeglass-supporting noses, Wright raised a more technical one. What Wright had in mind was the anomalous condition in which a person's stomach and large intestine become welded together. Under this condition, the contents of the stomach are directly discharged into the lower tract. Although this condition does much harm to human health, Wright considered it to have survival value in the following scenario: If a person were to have a perforated ulcer at the welding point, which in normal cases cause serious infections in the abdominal cavity, the stomach-large intestine connection would luckily prevent these infections. Then, regarding Ruse's account, Wright argued that it would yield an unwanted result, that is, the attribution of the function of protecting the abdominal cavity to the anomalous connection.

Since Cummins and Wright, philosophers have been enthusiastic about enriching the biological function debate in essentially the same way. Importantly, the appeal to biological usage still dominates the biological function debate today. The controversy over the function of sperm is only one recent example; in addition, Garson's monograph *What Biological Functions Are and Why They Matter* (2019), as the most recent contribution to the biological function debate, criticized alternative accounts by giving a list of counterexamples (pp. 25-42, 47-57; also see Garson, 2008, 2017). For instance, when he dismissed what he called the organizational approach (including the organizational account of Mossio and his colleagues), he stated that "the organizational approach...faces a severe liberality problem... [that is], it generates too many functions" (2019, p. 48). In other words, the organizational approach, for Garson, legislates too many function statements that are against biological usage. Moreover, he endorsed his own generalized selected effect accounts because it stands, in his view, "without producing thorny liberty problems" (p. 102). Indeed, at the beginning of his monograph, Garson stated explicitly that biological usage is his most important criterion of selecting qualified accounts of biological function: "first and foremost, I think the best way to approach functions is to look at ordinary biological usage —that is, how biologists talk about them-as that talk is captured in sober scientific sources" (p. 23).

Nevertheless, although highly influential, the argumentative strategy commonly employed in the descriptive dimension rests on a rudimentary logic inherent in empirical sciences: Given a particular account of biological function, it is questioned, criticized, and considered inadequate when it fails to capture biological usage. These failures are of two types: Either the account prohibits a statement that is used by biologists (or put it formally, misplaces a statement within biological usage, understood as the set of function statements used by biologists, into its complement), or it permits a statement that is actually not (or misplaces a statement within its complement into biological usage). Often these failures are illustrated through clever counterexamples; and to solve these counterexamples, philosophers have produced more complex and elaborate accounts, often by taking in more restrictions (phrased as conditions) of using function terms.[7]

As we have seen, regarding the function of sperm, Mossio and his colleagues' unified account explicitly takes in self-reproducing systems. Indeed, the "self-productive complex

[7] As Mark Perlman (2009) put it vividly, "Among these various views, the counterexample game is now going strong —clever exceptions lead to revisions, extensions, exceptions, or rejections of the functional account" (p. 18).

systems" condition has already been added to a systems-theoretical account by Gerhard Schlosser (1998), who treated Ernest Nagel's classical systems account (1961, 1979) as too restrictive, because "many characters…that undoubtedly have a function are not subject to regulation by negative feedback" (Schlosser, 1998, p. 309).

Such examples also abound in the etiological approach. Here are two prominent ones. First, the vestige counterexample motivates the recent or modern history account of function within the etiological approach (Griffiths, 1993; Godfrey-Smith, 1994): a commitment to the history or selected effects account ascribes functions to vestiges, but this is against biological usage; then, according to the recent or modern history account, a trait which can be said to have a function must be selected in the recent past (vestiges were supposedly not). Second, the recent rock counterexample forces Garson's general selected effect account to explicitly place more restrictions on the concept of the population (Garson, 2019, pp. 106-8; Roux, 2020; Matthewson, 2015, 2020): first fitness interactions, second a high degree of linkage.

Finally, it should be helpful to clarify the relationship between the descriptive dimension characterized in this article, and two other agendas in biological function literature that have been depicted, at least by some (Millikan 1989; Neander 1991), as "descriptive." These are conceptual analysis and theoretical definition. Consider conceptual analysis first. In the literature, there are two versions of conceptual analysis, one, in the words of Schwartz (2004, p. 146), "psychological," the other "philosophical." Although both aim to find sufficient and necessary conditions for the use of function terms, the psychological version, characterized by Ruth Millikan (1989), attempts more to describe what biologists have in mind. According to Millikan, the psychological version of conceptual analysis is an agenda to "describe marks that people actually attend to when applying terms" (p.291).[8] In contrast, the philosophical version, endorsed by Cusimano and Sterner (2019), cares more about rules of correct use of function terms.[9] In the words of the two authors, conceptual analysis aims to find "necessary and sufficient conditions for a term's correct use" and standardize thereby "legitimate senses in which it can be used in practice" (p. 55). Given this clarification, although the psychological version is certainly descriptive, its objects are not cases of biological usage defined in this article, but *what biologists think about them*; the philosophical version, in contrast, appears to follow the logic of the descriptive dimension of the debate as depicted above.

Consider next theoretical definition, which, according to Millikan (1989), also has a "descriptive" goal, that is, "to describe a unitary phenomenon that lies behind all the var-

[8] Yet, it should be emphasized that Millikan opposes this psychological type of conceptual analysis. For her, it is "a confused program, a philosophical chimera, a squaring of the circle, the misconceived child of a mistaken view of the nature of language and thought" (1989, p. 290).

[9] Karen Neander (1991)'s notion of conceptual analysis lies somewhere between the two types. On the one hand, she agrees with Millikan (1989) that conceptual analysis aims to find "criteria of application that people have in mind" (Neander, 1991, p. 176); on the other hand, her view is also close to that of Cusimano and Sterner (2019), and she emphasizes that conceptual analysis is "in the business of conceptual, rather than empirical truths" (p. 177). Of course, Neander might not have found any contradiction between the two, because, as one anonymous reviewer has very helpfully pointed out, she could believe that conceptual truths are determined by what people have in mind when using relevant concepts.

ious sorts of cases in which we ascribe purposes or functions to things [biological usage]" (p. 293). Given the definition of biological usage used in this article, it is not difficult to show in what sense Millikan's "descriptive" theoretical definition is not descriptive (of course, only under the definition adopted by this article). As a matter of fact, like Wright earlier (1976) and Garson recently (2019), Millikan (1989) presupposed that those explanatory and normative features are inherent in function terms and that her etiological account is the best candidate to adequately "describe" this "unitary phenomenon" (1989, p. 293). However, biological usage characterized in this article does not treat those explanatory and normative implications as inherent features of function terms, Millikan's agenda of theoretical definition, in consequence, does not describe any unitary phenomenon. Instead, as will be clear in section 4, it is perhaps better to view the etiologist agenda of theoretical definition, as Peter McLaughlin (2003, p. 189) did much more explicitly for his own theoretical definition of biological function, as offering prescriptive rules. In that case, etiologists only "describe" a phenomenon that has already been prescribed by themselves. Finally, it is still possible to claim that the etiologist agenda of theoretical definition is descriptive, once we realize that, after excluding concerns over normativity and explanatory power, this agenda turns out to be identical to the philosophical version of conceptual analysis. After all, even if etiologists treat their etiological accounts, old and new, as theoretical definitions, these accounts still merely offer sufficient and necessary conditions of correct use of function terms, as conceptual analysts intend.[10]

3.2. A discussion of the descriptive dimension

In the descriptive dimension of the biological function debate, philosophers propose accounts of biological function, whose validity is tested against biological usage of function terms and statements. Philosophers not only accuse others' accounts of violating biological

[10] In addition, I also suspect that the unfounded faith shared by etiologists that they succeed in offering theoretical definitions rather than conceptual analyses results partly from a naïve view of the chemical concept of water widely entertained by philosophers: Theoretical definition aims to find the essence of water, that is, H_2O. Nevertheless, from the standpoint of a more sophisticated conceptual analysis, being H_2O is at best one key sufficient and necessary condition of being water in modern chemistry; moreover, it is misleading to assert that the essence of water is H_2O, unless it is also accepted that water has many other essences, that is, sufficient and necessary conditions of being water (in contrast to ice, for instance); furthermore, the history of chemistry indicates that scientists did offer, often with hesitations and careful considerations, conditions such as "being H_2O" to precisely define water, and these conditions replaced earlier vague conditions of being water; finally, in modern chemistry, "being H_2O" can be treated as a theoretical definition only because it helps establish a coherent theoretical system as well as account for a set of experimental phenomena (but not all!) (For a similar view, see Magnus, 2012, p. 2). For this reason, chemists today simply cannot do without "water is H_2O" in many circumstances. Overall, it might be useful to claim that, while chemists give the theoretical definition "water is H_2O (in certain circumstances)," philosophers are able to elucidate this definition through a historically informed conceptual analysis. For this line of arguments from philosophy of chemistry, see Van Brakel (2000), Laporte (2004), and especially Chang (2012). All these considered, it is clear that chemists provide the theoretical definition of water as H_2O in a distinct way compared to the etiological claim that biologists are "implicitly committed to" the etiological approach, "even if they don't know it yet" (Garson, 2019, p. 102).

usage but also improve their own accounts in light of it. Although accounts proposed so far are many, in its descriptive dimension the debate runs similar to the practice of empirical sciences. However, a second consideration shows that philosophers' practice in the descriptive dimension of the debate also diverges from a standard scientific endeavor.

The first issue concerns biological usage itself. In the biological function debate, philosophers often appeal to function statements used in biological discourse to select qualified accounts of biological function. However, it is not immediately clear whether such statements are universally accepted by all biologists and constitute thereby a reliable source of reference. While all biologists might agree that sperm has a function, on other occasions they do disagree over whether particular biological entities have functions. A recent example concerns the role of junk DNA widely present in the human genome. Biologists in favor of the ENCODE (Encyclopedia of DNA Elements) project ascribe biochemical functions to those genomic elements traditionally treated as junk DNA and then declare the death of the very idea (Pennisi, 2012). Yet, several evolutionary biologists are critical of this move and defend the traditional junk concept (Doolittle, 2013, for a bit more detailed discussion on junk DNA, see section 5). Given this disagreement among biologists, it seems problematic to simply appeal to biological usage to decide whether junk DNA is functional. As Matteo Colombo expressed his doubt in a review of Garson (2019), "...how should these sources [biological usage] be weighed if they give us inconsistent answers?" (Colombo, 2020). In sum, unlike a standard scientific endeavor which often possesses a set of well-formulated and stable phenomena as explanandum, the biological function debate, given the ambiguities within its source of reference, rests somehow on shaky grounds.

The second issue also concerns biological usage. As we have seen, although biological usage defined in this article should contain vast function statements from biology textbooks and journals, the biological function debate appears to have covered a rather small amount of them. In consequence, while the descriptive dimension of the debate gives the impression of following the logic of empirical sciences, empirical materials that have been considered so far are surprisingly few. No philosopher has attempted anything that comes close to being a statistical survey (perhaps except Wouters, 2003b), which is the standard means of solving similar problems in empirical sciences. Rather, most philosophers in the biological function debate are more enthusiastic in discussing their carefully prepared case studies, often as "exemplars" of how biologists use function terms and statements. In all, in the descriptive dimension of the debate, although philosophers often treat biological usage as the final arbiter, they are often unwilling to consider more cases than they need (either to endorse their own accounts or to oppose other accounts).[11]

As can be anticipated, philosophers' common intent in presenting their case studies is to argue for accounts in their favor, and here arises the third issue with the descriptive dimension of the debate: In promoting their accounts, philosophers are often better at accommodating particular uses of function terms, rather than predicting them. As we have seen, Mossio and his colleagues modified their accounts to accommodate the

[11] The lack of attention to the vast amounts of function statements is perhaps an important reason for philosophers not to question the eligibility of biological usage as a reliable source of reference. After all, they only discuss several carefully chosen case studies, which are unlikely to disclose the ambiguities within biological usage.

function statement about sperm; non-functioning vestiges motivate the recent or modern history account; the rock counterexample forces etiologists to revise the concept of the population in their approach. Overall, it is rare to see accounts of biological function that highlight their predictive power. In consequence, the descriptive dimension of the debate, as it is practiced today, appears again radically different from a standard scientific endeavor.

The fourth issue follows from previous ones, and I call it the issue of underdetermination. This issue concerns primarily the scenario in which two or more accounts can make sense of the same function ascription and it remains underdetermined which account should be adopted. While this scenario is highlighted in current biological function literature as "within-discipline pluralism" (Garson, 2018), "integrative pluralism" (Cusimano and Sterner, 2019; see earlier Mitchell, 1993), or "local pluralism" (Malaterre, 2023)[12], it makes the biological function debate diverge even more from a standard scientific endeavor: There is little incentive to decide which account is better by appealing to more cases of biological usage; instead, a happy pluralism is celebrated.

Overall, these four issues as a whole suggest that in the biological function debate philosophers do not care about biological usage as they claim to do. While this phenomenon might not be surprising in itself because philosophers often attend more to conceptual rather than empirical matters, it becomes more salient when philosophers highlight their enterprise as a descriptive one concerning biological usage. Although philosophers commonly appeal to biological usage as the final arbiter, they never consider more cases than they need. Their highest concern is to defend their accounts against other accounts, as the best answers to the question of what biological functions are. Now, to better understand this concern, we need to switch to the prescriptive dimension of the biological function debate.

4. The prescriptive dimension: despite biological usage

4.1. The logic of the prescriptive dimension

For an idea of the prescriptive dimension of the biological function debate, consider again Mossio and his colleagues' original account in 2009 (in which self-production is not explicitly defined to be a way of self-maintenance), which supposedly grants no function to sperm. Now let us treat it as a stipulative definition and prescribe it to biological usage. Then, as can be anticipated, biological usage would change in accordance with that account, and it becomes illegitimate to ascribe a function to sperm. More generally speaking, if a given account is viewed as a stipulative definition that prescribes rules,

[12] Importantly, these new pluralisms distance themselves self-consciously from old pluralisms endorsed by Godfrey-Smith (1993), Amundson and Lauder (1994) and Griffiths (2006). The main difference, according to new pluralists, is that old pluralists still tend to be monists in more particular cases of using function terms and their pluralism amounts at best to "between-discipline pluralism" (Garson, 2018), "disjunctive pluralism" (Cusimano and Sterner, 2019), or "global pluralism" (Malaterre, 2023), but new pluralists have recognized that even in those particular cases, pluralism remains still adequate, as different accounts can help make sense of the same use of function terms.

whenever a violation of biological usage takes place, *it is the particular case of biological usage rather than the account itself that is mistaken*. In consequence, in the prescriptive dimension of the debate, biological usage is no longer treated as the final arbiter and any objection that treats it as such is entirely powerless. In a nutshell, to prescribe, despite biological usage!

In its essence prescriptivism is the opposite of descriptivism. Recall that in the biological function debate, on the one side lies biological usage which contains function statements used in biological discourse, on the other side is a variety of accounts of biological function. Now in contrast to descriptivism which treats biological usage as the final arbiter of selecting qualified accounts, prescriptivism treats a particular account as established and prescribes it to biological usage.

It should be noted that in the biological function debate few philosophers dare to disavow the authority of biological usage, except perhaps McLaughlin: "if we stipulatively define the term function in biology [...] then intuitive counterexamples to the usage prescribed by the definition have no force" (2003, p. 7). McLaughlin, moreover, opted consciously and publicly for prescriptivism in his endorsement of "stipulative theoretical definition" (p. 189). In contrast, other philosophers took at best an unconscious move towards prescriptivism. For instance, when challenged by the counterexample of accidental lions (whose heart functions well), arguably not even included in actual biological usage, Neander (1991) declared her strong commitment to "proper function" and insisted that "without history the usual biological/functional norms do not apply" (p. 180). In other words, Neander prescribed an etiological account and came up with a counterintuitive judgment that accidental lions have no functional hearts. Similarly, facing the liberty problem, Marcel Weber (2017) simply declared that "my response to this challenge consists in simply...accepting that all these functions exist" (p 4753). Finally, Garson (2019)'s recent claim indicated an even stronger sense of *a priori* certainty: Biologists are "implicitly committed to" the etiological approach, "even if they don't know it yet!" (p. 102).

Then, what if all these accounts are treated as offering prescriptive rules? This possibility, I believe, points out a novel perspective of understanding the biological function debate: often philosophers intend their accounts to capture actual usage and state what functions are, but what they end up doing is to prescribe how function terms should be used. Here follows a radical implication of prescriptivism.

4.2. A radical implication: anything goes, no consequence

If the prescriptive dimension of the biological function debate is pushed to its extreme, there emerges a radical implication that I would call prescriptive pluralism: Anything goes, no consequence (for biological knowledge). As far as I see, this implication has not been explored by mainstream literature on biological function. For an illustration of this implication, it is useful to first return to the controversy over whether sperm has a function. As we have seen, one possible option for Mossio and his colleagues is to insist on their original account as a prescriptive rule. And, as long as we keep in mind that only the prescriptive dimension is to be considered, it follows that it is the statement that sperm has a function rather than the account that is mistaken. In other words, the original account prescribes that sperm cannot be said to have a function, although current biological usage indicates

the opposite. Now, the remaining question is, is there any fatal consequence of this radical prescriptive move?

Admittedly, this move has a big impact on actual usage of function terms. However, as far as biological knowledge itself is concerned, the question of whether sperm does have a function appears to have little significance. After all, biological knowledge consists of laws and facts about sperm and self-reproducing systems, and this cannot be denied by the two parties in disagreement. At best, the disagreement is only concerned with the question of whether a function should be ascribed to sperm. When sperm is alleged to have a function, maybe attention is drawn to biological knowledge about sperm and its contribution to self-production; yet, when sperm is denied of having a function, this does not diminish the significance of any related biological knowledge about sperm.

This argument, I believe, can be applied to most controversies in the descriptive dimension of the debate. Consider one mentioned in section 3: Some etiologists have advanced the recent or modern history account, through which a vestige is denied of having a function. Yet, if the classical selected effects account were prescribed and a function would thereby be ascribed to the vestige, the consequences of such a prescription would not be very fatal. While this goes radically against biological usage and is potential to create some confusion, it does not affect any related biological knowledge about the vestige (its selective history, its previous working mechanism, its current physiological features, etc.).

The same argument applies to even very peculiar accounts of function, like that of Lowell Nissen (for a recent similar move, see González de Prado Salas, 2017). Nissen's general conclusion regarding biological function is that "calling something a function… [implies] claiming external intentionality" (1993, p. 48). Current philosophers consider Nissen's view outdated or perhaps even absurd since biological entities are clearly not associated with any external intentionalities. However, it is possible to read Nissen's view as suggesting a strong prescription of how function terms should be used. As a prescription, Nissen's view is not entirely unacceptable, since it is simply irrelevant to most parts of biological knowledge, which are concerned with no external intentionality; with this prescription there follows the radical conclusion that most cases of biological usage today are illegitimate and should be eliminated.[13]

More generally speaking, if an account of biological function is read as a prescription, it will no doubt produce odd cases of using function terms (compared to standard biological usage); but radical prescriptivism insists that such cases will have to be accepted as enriching or even correcting biological usage. Concerning biological knowledge itself, importantly, this prescriptive move at most directs research attention to certain parts of it (by associating them with function terms); but at the same time, the significance of other parts cannot at all be denied. Overall, it is unlikely that any parts of biological knowledge will be affected by whether they are associated with function terms or not.

Therefore, prescriptivism is able to elevate all possible accounts of biological function, if treated as mere prescriptive rules, to an equal status, as far as only biological knowledge

[13] However, Nissen is not an eliminativist himself (Nissen, 1993). Being no eliminativist, insisting on the intentional account of function, and understanding well that in most cases biology does not deal with intentions, Nissen concludes finally that the presence of function terms in biological discourse "remains controversial," (p. 48) and also urges us to accept this limited conclusion.

(*not* biological usage) is concerned. Moreover, even eliminativism, i.e., the thesis that function terms in biological discourse could (but not must!) be eliminated, appears defensible. In point of fact, as the logical consequence of the intentional account of function, eliminativism depicts a counterfactual scenario in which biological knowledge were expressed without using any function terms, and consequently functions would not be ascribed to any biological entities.

5. A Global Overview of The Biological Function Debate

5.1. A variety of accounts and criteria

So far, in the biological function debate philosophers of biology have produced a variety of accounts. Meanwhile, in their defense of these accounts, philosophers also appeal to a variety of criteria. Clearly, the first and foremost criterion is of course descriptive adequacy; other than descriptive adequacy, philosophers have proposed a long list of non-descriptive criteria (for a summary of these criteria, see Wouters, 2005). Overall, these criteria help set up standards for evaluating and improving different accounts of biological function. As a result, controversies and disputes over these criteria, as well as efforts to meet these criteria by offering various accounts, constitute the entire biological function debate.

However, except for descriptive adequacy, most non-descriptive criteria in the biological function debate are themselves controversial and remain disputed. Consider, for instance, the criteria endorsed by the etiological approach. As mentioned in section 2, etiologists defend their accounts, because they think that, (1) a good account of biological function should make sense of explanatory and normative features of function terms, (2) the etiological account is the best candidate so far. As can be expected, disputes over these criteria generate another group of controversies, other than those motivated by concerns with descriptive adequacy. For instance, critics of the etiological approach have long questioned these criteria endorsed by etiologists: Some think that etiological accounts make little sense of explanatory and normative features of function terms (Cummins, 1975; Davies, 2000, 2001), others argue that there are also systems accounts that can do equally good jobs (Bigelow and Pargetter, 1987; Walsh, 1996).

Meanwhile, the controversy over the function of sperm also touches upon non-descriptive criteria. As we have seen, the unified account from Saborido *et al.* (2011) and the splitting account from Delancey (2006) are equally adequate from the descriptive point of view, because they both permit sperm to have a function. In this case, obviously, some more criteria are in need. Then, what is striking is that both Saborido *et al.* (2011) and Delancey (2006) appealed to the criterion of simplicity! According to the former, since self-maintaining systems are defined to include self-reproducing systems, the unified account is simpler and favored by "Ockham's razor" (Saborido *et al.,* 2011, p. 604). But according to the latter, "Ockham's razor cuts in favor of the splitting account alone," (Delancey, 2006, pp. 94-95) because the unified account simply "depends upon, and builds on top of, ...a structure-based splitting account" (p. 94) through an extended definition of self-maintenance.

Overall, in these controversies either the validity of a criterion itself is disputed, or the question of whether a philosophical account meets the criterion remains undecided. This

article does not intend to solve all these controversies.[14] Yet, in relation to the descriptive/prescriptive distinction, this article does want to point out that the criterion of descriptive adequacy is seldom subject to doubt. Indeed, as section 4 has shown, it is worth questioning this very criterion and taking an adventure in radical prescriptivism.

5.2. The logical structure of philosophical accounts

In the biological function debate, different philosophical accounts of biological function meet different criteria. However, as the radical implication of prescriptivism indicates, all these accounts share the same logical structure. On this Schwartz (2004) gave an excellent summary:

> [In the biological function debate] philosophers offer short lists of necessary and sufficient conditions for the application of the [functional] concept-where the conditions involve only acceptable physical or biological notions-and claim that the set of conditions captures the import of function statements. (p. 136)

Schwartz's summary should be treated with care. Indeed, *when philosophers advance their accounts (by whatever names: conceptual analysis, theoretical definition, stipulative definition, or even conceptual engineering!), ultimately, they only relate different parts of biological knowledge to function terms*.[15] Given this insight, it is perhaps safe to re-affirm the point that it matters little which account is prescribed to biological usage, as far as biological knowledge itself is concerned. Indeed, as Schwartz (2004) acutely puts it, adopting any particular account can never amount to "a discovery about biological facts or the content of bi-

[14] My own view is that controversies over these non-descriptive criteria are more concerned with definitional issues, and they cannot be solved in favor of one solution against others as most philosophers intend; rather, they can only be dissolved through clarification and elucidation. For instance, it seems that Saborido *et al.* (2011) and Delancey (2006) had no genuine disagreement since they held different conceptions of how the criterion of simplicity should be met; indeed, both are right that their accounts are simpler from their own perspectives. The case of etiologists is subtler. Yet, when they argue that selection creates norms, this is still best treated as defining or even re-defining the concept of the norm (as Nissen observed, "throughout she [Millikan] simply assumes that a history of natural selection generates the needed norms and purposes," 1993, p. 34). And it should be acknowledged that this definition is different from the commonly accepted intentional concept of the norm and that it also gives rise to odd consequences (e.g., earliest occurrences of a trait are denied of having any function, see Brunnander, 2011a).

[15] Within the etiological approach, philosophers have placed emphasis on the recent past (e.g., Godfrey-Smith, 1994), alternative types of selection (e.g., Garson, 2011, 2012), or the non-selective history in weak etiological theories (e.g., Buller, 1998). Within the organizational approach, philosophers have focused on plasticity (e.g., Enç and Adams 1992), negative feedback (e.g., Faber, 1984), self-reproduction (e.g., Schlosser, 1998), and self-maintaining networks (e.g., Mossio *et al.,* 2009). This consideration applies equally to the recent move contending that functions often come in degrees, as one could certainly define the idea of degree into relevant necessary and sufficient conditions: The etiologist Matthewson (2020) goes for "natural selection [coming] in degrees" (p. 38) and within the organizational approach Babcock (2023) turns to "degrees of…the amount of persistence and plasticity an entity or system exhibits" (p. 112). I thank one anonymous reviewer for his/her request of a clarification of this recent move.

ological notions" (p. 145); for biologists, at best it "reflects a decision about how to speak in the future" (p. 145).

It follows that philosophical accounts are unlikely to help biologists determine what biological functions are, in the same way that "water is H_2O" helps chemists determine what water is.[16] Yet, philosophers do not have to be disappointed, because the scientific utility of their accounts could be of a different and no less important kind. Since biologists do use function terms often in their discourse, it remains important to clarify which parts of biological knowledge are indicated by using these terms: To which biological entities, and under what conditions should functions be ascribed? Here philosophers' accounts could act as tentative options for biologists. With these accounts, biologists will be able to decide their epistemic means of determining whether a biological entity has a function, as depicted by Schwartz (2004), "in order for a function claim to be taken literally, the biologist should be willing to adopt a precise definition and present evidence that the relevant conditions are satisfied" (p. 144). Some recent contributions to the biological function debate have touched upon this use of philosophers' accounts. As the currently influential integrative pluralism shows, for instance, function terms can be related to many different parts of biological knowledge even in a single context: "evolutionary function," to "the existence of a trait," (often by natural selection) "causal role function," to "a system-level capacity," and "propensity function" to "the expected frequency of a trait in the next generation of a population" (Cusimano and Sterner, 2019, p. 55). Overall, since biologists often use function terms ambiguously, philosophers' accounts are potentially helpful to make them clear.[17]

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[16] Meanwhile, one must also be very careful to assert that "water is H_2O" determines what water is, or the essence of water. As already implied in footnote 10, the chemist determination that water is H_2O is justified, only because it helps establish a coherent theoretical system as well as account for a set of experimental phenomena (but not all!). Thus, "water is H_2O" acts more like a general theoretical principle in chemistry, although it is common among chemists to treat this general principle as having identified the essence of water (indeed, scientists often speak about general principles in their sciences as if they were concerned with the essences of related entities). However, this treatment can be misleading if the essence is received in a metaphysical fashion implying that the general principle has arrived at the thing-in-itself with the name of water and is therefore no longer open to further refinement. Indeed, as some (e.g., Weisberg, 2006) have pointed out, water is not H_2O in other circumstances, and at least it requires clarification whether heavy water (D_2O) should be treated as a subclass of water. This consideration applies equally well to an earlier terminological and conceptual change at the dawn of modern chemistry. In that case, pre-modern definitions of water were replaced by the more precise "water is H_2O", and this replacement involved certainly a decision over the chemist usage of the term "water." All these considered, one could say that the biological function debate is currently ensnared in a collection of similarly "pre-modern" definitions of biological function; and if philosophers want to find a theoretical definition for biological function like that of "water is H_2O", they need to search for a theoretical account with which to address a couple of novel experimental phenomena in biology. But very unfortunately, what philosophers are doing are quite different from what chemists did when offering "water is H_2O"; Considering that all philosophical interpretations of biological function share eliminativism as a common implication, it is hardly thinkable to find a definition for biological function as precise as that of "water is H_2O".

[17] However, it should be warned that heuristic values of function terms are often overstated and biologists themselves might not have recognized that they use function terms with so many implications.

This role played by philosophers' accounts can be demonstrated, I believe, in solving the controversy over whether junk DNA is functional. As mentioned in section 2, ENCODE biologists are rather generous to ascribe biochemical functions to genomic elements traditionally viewed as junk DNA, but some evolutionary biologists decline to do so. A philosophical solution to this controversy is provided by Germain, Ratti, and Boem (2014), who pointed out that ENCODE biologists are committed to, broadly speaking, the causal-role account of biological function, while opponents appear to presuppose the selected-effect account. This solution defends neither team of biologists; and it attempts to dissolve the controversy by clarifying presuppositions of each team. Indeed, this solution is clearly in the minds of some biologists. As W. Ford Doolittle put it exactly in the spirit of Schwartz (2004), the controversy is "not about facts at all but rather about the words that we use to describe what think the facts might be" (Doolittle, 2013, p. 5300).[18]

Finally, it follows from Doolittle's claim that the question of how function terms are used by biologists can also be treated as a social-linguistic —rather than biological— question. Here philosophers' accounts constitute a rich conceptual scheme to treat related questions. In this case, it is essential to specify the communities of biologists within the concern, then pick up a list of possible accounts in advance, and finally consider related statistical surveys with care (for a similar point, see Neander, 1991, p. 177). To the best of my knowledge, however, this has not been done (for a similar point, see Brunnander, 2011b).

6. Conclusion

This article uses the descriptive/prescriptive distinction to make better sense of the biological function debate, and it relies fundamentally on a refined definition of biological usage of function terms and statements. According to this definition, biological usage indicates only behavior facts about biologists using function terms and statements in biological discourse. This definition is minimal since it only takes in commonly agreed components of biological usage, and it does not contain those more controversial ones, like what biologists

In the case of Cusimano and Sterner (2019), although they were of course right that when biologists talk about protein function, they might be interested in different parts of biological knowledge (natural selection, biochemistry, and population genetics), it is perhaps a bit exaggerating to claim that function terms are important epistemic tools for biologists. After all, biologists can directly talk about those parts of biological knowledge without using function terms at all (hence eliminativism). As McLaughlin put it vividly, "biologists could in general probably get along fairly well, if they had to, without function terms by substituting either causal role or selective advantage or adaptive value" (2003, p. 10). In my view, for biologists, it is perhaps more important to avoid confusion when using function terms in communication, and here philosophers' accounts could offer the best service (see the junk DNA example below). As can be anticipated, *in the case of individual biologists, to avoid confusion, it is more useful to directly ask them about their particular usage of function terms and statements*. As Elliott Sober put it, "if a scientist or philosopher uses the concept of function in some other way, we should demand that the concept be clarified" (1993, p. 86).

[18] Controversies over counterfactual function statements can be similarly solved. For instance, critics of the etiological approach take it for granted that the heart of an accidental lion has a function, but this is because they presuppose ahistorical accounts of function; yet etiologists like Neander (1991) simply presuppose historical accounts and deny that an accidental lion has a functional heart.

think about their use of function terms, or the so-called explanatory and normative features alleged to be inherent in function terms.

This definition then helps clarify the two dimensions of the biological function debate. In the descriptive dimension, accounts are designed to capture (often limited) actual cases of using function terms; in the prescriptive dimension, accounts are (often unconsciously) used to correct biological usage. Although by accepting descriptive adequacy as a key criterion of judging different accounts, philosophers appear to follow the logic of the descriptive dimension, their accounts might also be read as prescriptive rules to direct how function terms should be used.

There follows a radical implication if the logic of the prescriptive dimension is pushed to its extreme. Indeed, if an account of biological function were prescribed at any cost, biological knowledge itself would be little affected, although biological usage of function terms and statements would change. As far as biological knowledge itself is concerned, it matters little which biological entities (and under what conditions) functions are ascribed to. As a result, philosophical accounts of biological function appear equal as none of them can affect any genuine biological knowledge. In a word, prescriptive pluralism (anything goes, no consequence!) turns out to be defensible.

Prescriptive pluralism resonates with the conclusion out of a global overview of the biological function debate: Philosophers' accounts at best relate different parts of biological knowledge to function terms. In consequence, the ascription of functions depends ultimately on whether certain biological conditions are satisfied. For this reason, function terms are then more or less "parasitic" on standard biological concepts. Strictly speaking, it is not even necessary to use function terms to express biological knowledge (eliminativism). Note that this is not to deny the presence of function terms in biological discourse, nor does it challenge the heuristic values of function terms in their reference to different parts of biological knowledge in different contexts. Yet, it should be emphasized that philosophers' accounts of function only help biologists clarify their use of function terms, or, at best, answer social-linguistic (rather than biological) questions about such linguistic habits.

Finally, there remains an intriguing question: If eliminativism holds, why have function terms not been eliminated by the history of biology? A once-popular answer, which was welcomed by philosophers in the early phase of the biological function debate, is that the presence of function terms in biological discourse indicates merely an anthropomorphic habit: The "standard" meanings of function terms appeal implicitly to intentional agents; when biologists deal with biological entities, their use of function terms is nothing but an anthropomorphic move in which biological entities are treated as if they were intentional agents; finally, the entire biological debate, in offering a variety of accounts, only obscures the anthropomorphic move behind the use of function terms.

However, this merely anthropomorphic interpretation, I believe, fails to do full justice to function terms in biological discourse. In particular, if the use of function terms indicated a mere anthropomorphic move, the entire biological function debate would appear to be a severe mistake. Yet, function terms do have some heuristic values, and the biological function debate, through producing various accounts, helps at least uncover those biological phenomena that are often associated with function terms. As we have seen, such phenomena are important phenomena of life: evolution, self-maintenance (plasticity and negative feedback), self-reproduction, and many others. Nevertheless, again, it is important

to note that function terms say nothing about these phenomena themselves, and it is never necessary to express these phenomena with function terms.

If we are satisfied with an analysis of the presence of function terms in biological discourse, my contention is that Kant's view on teleology in biology does not seem outdated: Teleology plays a merely regulative role, and it does not constitute any genuine knowledge in biology. To put it more explicitly, in its use of function terms, "reason certainly plays a role that is magnificently instructive and purposive in many respects"; yet function terms provide "no information at all about the origination and the inner possibility of these forms [organisms], although it is that with which theoretical natural science is properly concerned" (Kant, 2000, 5: 417).

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