Biological laws and kinds
within a conservative reductionist framework

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Abstract

This paper argues for the existence of biological kinds and laws. After a general discussion of biological laws (section I), I shall outline a conservative reductionist approach towards biological property types (section II). Within this theoretical framework, it seems plausible to argue for biological laws (to a degree) and genuine biological natural kinds (III).

I. Biological laws

John Beatty argues that biological generalizations are to some extent contingent and do not involve laws[1]. He construes the idea of laws as empirical generalizations without any exceptions (like "$\forall$x: if Fx, then Gx") and that contain a natural necessity; that are counterfactually robust.[2] Given this definition, he argues furthermore that biological generalizations that fit approximatively into the empirical and no exceptions framework are about genetically based traits that are subject to evolutionary forces. For instance, Mendel's first law or Hardy-Weinberg's law obtain only because of prior initial conditions that emerged *contingently* in the course of evolution, and could, thus, have been otherwise: "evolution can lead to different outcomes from the same starting point, even when the same selection pressures are operating."[3] Therefore, Beatty concludes that while empirical biological generalizations may correctly describe a causal relation over some period (from t_1 to t_2), they do not form laws in the sense that they are only true because of some prior initial conditions I (that

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[1] John Beatty, "What's wrong with the received view of evolutionary theory?", in: *Proceedings of the Biennial Meeting of the Philosophy of Science Association*, Volume Two: Symposia and invited Papers, 1980, pp. 397-426, John Beatty, "The evolutionary contingency thesis", in: G. Wolters and J. Lennox (Eds.): *Concepts, theories, and rationality in the biological sciences: The second Pittsburgh-Konstanz Colloquium in the Philosophy of Science.* Pittsburgh: University of Pittsburgh Press, 1995, pp. 45-81.

[2] Cf. John Beatty, "The evolutionary contingency thesis", op. cit, p. 53, footnote 9.

[3] John Beatty, "The evolutionary contingency thesis", op. cit, p. 57.

obtained at t_0). I shall come back to this argument later on[4].

However, the principle of natural selection is a particular biological generalization. Here the argument from different circumstances, or from the contingency of evolutionary development, may not apply. Instead, all the circumstances we need for there to be natural selection consist in this: a) *that* there are inheritable properties, which imply fitness differences; and b) that both the inheritance mechanisms and the fitness differences may be physically realized in different ways. Whether this degree of generality is sufficient to avoid the contingency argument depend on a deeper discussion of contingency[5]. Let us suppose that it is. Still, according to Beatty, the principle of natural selection seems to have been defined so that it lacks *empirical* generalizability, and consequently does not count as a law, if fitness has been defined in a tautological way. This is the case if the fitness of an entity at t_1 is only determined by the evolutionary effects (e.g. number of descendants) it brings about at t_2. To put it differently, fitness differences can only be trivially linked to evolutionary changes by the principle of natural selection if we can define some former state of fitness upon which evolutionary changes work as the cause of present evolutionary changes.

However, one may argue that this tautology only exists at an epistemic level and can be theoretically avoided, following Rosenberg[6], in distinguishing between the *operational* and the *conceptual* understanding of fitness[7]. Conceptually, we can understand the fitness contribution of a trait as its contribution to the organism's disposition to survive and its disposition to reproduce and both dispositions supervene locally on the physical properties of the organism and its environment[8]. The success (manifestation) of these dispositions to survive and reproduce depends on given environmental conditions, allowing us to attribute to a characteristic fitness function to any kind of organic trait:
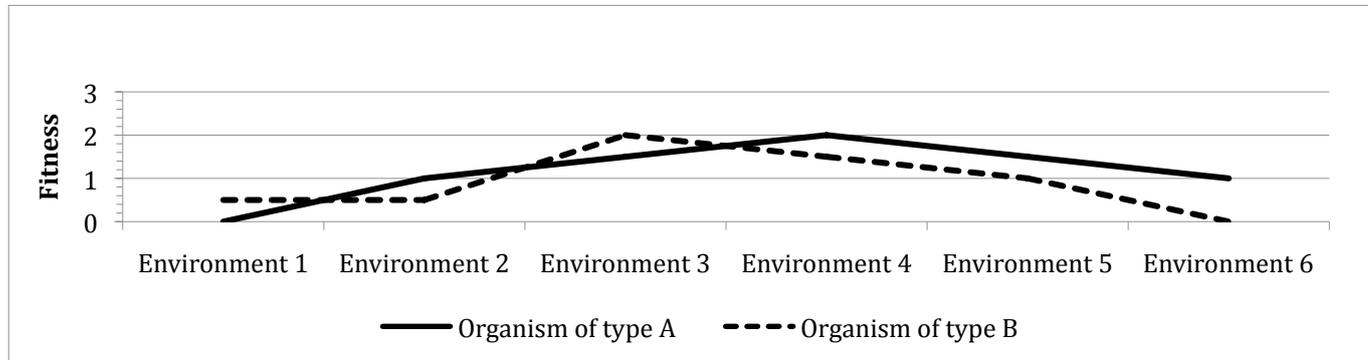

Figure 1.1 *Fitness function*

Of course, the attribution of such fitness functions is rather difficult in practice. This, however, is an epistemic problem. It remains that fitness is ontologically determined by the dispositions to survive and

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[4] For a critique, see: <u>Elliot Sober</u>, "Two outbreaks of lawlessness in recent philosophy of biology", in: *Philosophy of Science*, 64, 1997, pp. S458-S467; <u>Kenneth Waters</u>, "Causal regularities in the biological world of contingent distributions", *Biology and Philosophy*, 13, 1998, pp. 5-36.

[5] I sketch out one reply later on; for a more comprehensive discussion, see: <u>Mauro Dorato</u>, "Mathematical biology and the existence of biological laws", this issue.

[6] <u>Alexander Rosenberg</u>, "Supervenience of biological concepts", in: *Philosophy of science*, 45, 1978, pp. 368-386.

[7] See <u>Elliot Sober</u>, *Philosophy of biology. Second Edition*. Boulder: Westview Press, 2000, ch. 3, <u>Christopher Stephens</u>, "Natural selection", in: M. Matthen and C. Stephens (Eds.), *Handbook of the philosophy of science. Philosophy of biology*, Amsterdam: Elsevier, 2007, pp. 111-127.

[8] See furthermore: <u>Marcel Weber</u>, "Fitness made physical: The supervenience of biological concepts revisited", in: *Philosophy of Science*, 63, 1996, pp. 411-431.

reproduce, these dispositions are manifested under certain environmental conditions, and the principle of natural selection correctly registers the impact of fitness differences for evolutionary change. Thus, if we understand the principle of natural selection in this way, we can dispose of the non-empirical objection to it – for here it is surely an empirical effect on populations of organisms.

Following this reasoning, one could see no objection, following Rosenberg, to specifying the status of the principle of natural selection as a fundamental, non-derived law of physics[9]: the principle of natural selection is a fundamental law since it a) can explain physical facts and b) it cannot be derived from other physical laws because of the multiple realization of biological functions and thus of fitness (differences). In other words, the laws of physics need specific initial and boundary conditions to explain the distribution of the molecules (e.g. genes) at some later time, while the principle of natural selection can do so for infinitely many different initial conditions. This then suggests adding the principle of natural selection to the other fundamental physical laws.

Of course, as Rosenberg argues, if the principle of natural selection really is fundamental, then we can avoid any conflict with the principle of the completeness of physics by simply conjoining it to the physical laws[10]. However, at least in theory, there remains a categorial difference between the principle of natural selection and the (other) fundamental laws of physics that may seem, to a physicalist, like it calls for another act of reduction. If we decide not to adopt some kind of ontological property dualism (following Rosenberg's counsel), then we must say that the principle of natural selection and the (other) fundamental physical laws refer to the *same* properties, only in different manners. However, if this is our claim, we may question Rosenberg's argument from irreducibility to fundamentality. Furthermore, I argue later on that multiple realization does not actually present an obstacle to reducibility.

In contrast to Beatty and Rosenberg, Sober wants to leave open the question of whether laws are empirical or *a priori*[11]. Understanding *a priori* propositions as laws if they are about causal processes, Sober argues that the way biologists build their models gives support to the proposition that biological laws are *a priori*. For instance, Fisher's theorem of natural selection, which proposes a mathematical proof, is a law, according to Sober, because it supports counterfactuals and describes causal and explanatory relations. More generally, if we accept Sober's construction of laws, and we accept that evolutionary processes are governed by biological laws, then we can conclude that evolution is lawful. Of course, Beatty's contingency argument is aimed at just these elements of Sober's argument. After all, any (empirical or *a priori*) biological law that has the general form "$\forall$x: if Fx, then Gx" may be contingent on prior initial conditions I. However, this fact does not exclude reformulating the generalization in the form: "If I obtains at one time, then the generalization "$\forall$x: if Fx, then Gx" will hold hereafter", from actually being contingent on anything[12]. Such reformulated non-contingent generalizations are laws since a) they are about causal relations (between token of F and tokens of G) and b) causation demands the existence of laws.

[9] Alexander Rosenberg, *Darwinian reductionism. Or, how to stop worrying and love molecular biology*. Chicago: University of Chicago Press, 2006, ch. 6.

[10] See also: Marcel Weber, "Review of Alexander Rosenberg, *Darwinian reductionism. Or, how to stop worrying and love molecular biology*", in: *Biology and Philosophy,* 23, 2008, pp. 143-152.

[11] See: Elliot Sober, "Two outbreaks of lawlessness in recent philosophy of biology", op. cit.

[12] See: Elliot Sober, "Two outbreaks of lawlessness in recent philosophy of biology", op. cit.

However these claims about laws are straightened out, one may still ask whether these laws aren't physical ones, at least in the last resort. After all, following the completeness claim, physics has the most detailed means to spell out the causal relations that lead to situations where, to take Beatty's examples, inheritance conforms to Mendel's first law. Furthermore, any naturalistic approach would suggest that the emergence of life, for whatever reason it happens, must ultimately reduce to physical law, from which is then derived the application of the principle of natural selection. On this reading it seems that Sober's reply to Beatty's contingency argument depends on the physical laws that have to be incorporated into his proposed reformulations. Therefore, biological laws are non-contingent only to the extent that they are in fact physical laws (or at least derivative from such laws). This suggests that reductionism gives us the only convincing reply to Beatty's contingency argument. Without reducing biological laws to the ones governing chemical and physical interaction between physical elements, we have no coherent account that allow us to conjoin the two ends of the theory of biological law: on the one end, the claim that biology is able to formulate *a priori* laws that support counterfactuals, which can be applied to causal relations concerning living things that give us scientific explanations; and on the other end, the claim that the truth of these laws supervenes on the truth of physical laws that are empirical ones. Moreover, we also confront, here, a problem quite similar to the tautology problem of fitness, intrinsic to the claim that *a priori* laws are mainly *operational* abstractions of physical laws that are genuine natural ones.

One could resolve these dilemmas by having recourse to a biological version of *ceteris paribus* laws, which – the claim would go – are genuine laws because biological laws differ from physical laws only *in degree* of their ceteris paribus type but not in kind[13]. To make a clear link to our previous discussion, this argument holds that laws do not have to be universal (contrary to the position of Beatty and Rosenberg) without necessarily adopting Sober's particular position on *a priori* laws. Still, following Beatty, there is a difference between biology and physics – and I spell out this difference within a reductionist framework in the next section, where I also keep in mind, following Rosenberg, to avoid any conflict with the completeness of physics and ontological reductionism. In addition, I take Sober's reply to Beatty's contingency argument for granted. Within this framework, I thus analyse here in more detail a) the historical dimension of biology and b) *ceteris paribus* clauses in biology. Then, given the decomposition of all laws, physical and biological, into *ceteris paribus* laws, we must show that the difference in degree in relation to physical laws is such that c) these laws are distinctively *biological* ones.

a) Biology is a diachronic discipline about biological events – for instance, speciation – that are unrepeatable in practice because of the differences between any biological organism. This means that there are no *types* of historical events, which disallows forming corresponding laws that take types as their object. However, physical theories like cosmology are also diachronic in the above given sense, in that they concern unrepeatable events. So, in comparing cosmology and biology, if we take it for granted that both refer to causal relations governed, in the last resort, by physical laws, then the difference in their objects appears to be more of a difference in degree of complexity than a difference in kind. To put it differently, it seems that the

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[13] See: <u>Mauro Dorato</u>, "Mathematical biology and the existence of biological laws", op. cit., <u>Marc Lange</u>, "Laws, counterfactuals, stability, and degrees of lawhood", in: *Philosophy of Science*, 66, 1999, pp. 243-267; see also <u>Marc Lange</u>, *Laws & lawmakers*. Oxford: Oxford University Press, 2009.

unrepeatable character of historic events *per se* does not exclude the existence of laws[14]. However, the question is not so much one of the historical dimension of biology but whether these are underlain by genuine biological laws, just as general relativity or quantum gravity underlies cosmology. In the next section, I will outline how this may work in biology.

b) Biological laws are not universal since the existence of biological properties is spatiotemporally restricted. For instance, the principle of natural selection applies only to particular objects, living beings, and not to purely physical configurations. Biology always needs so-called *ceteris paribus* clauses in order to provide the applicability of its laws. Understanding *ceteris paribus* as "whenever the right condition obtains"[15] (in distinction to "all other things being equal"[16]), one may then ask whether this feature really distinguishes biological laws from physical ones. The view that it doesn't mainly contains two parts. First of all, a *ceteris paribus* clause contains the right conditions and biology cannot specify them in its own terms. However, this seems to be an epistemic difficulty rather than a conclusive objection to a possible existence of biological laws. Second, of course, biological laws depend on initial conditions. However, this does not distinguish biological and physical laws, since initial conditions are required in physics as well[17]. The fact that adjustable parameters in the initial conditions may be much more numerous in biological laws than in physical is once again only a difference in degree.

c) Following this line of argument, we still have to answer the question: what makes a law a distinctively biological one? After all, a complete *ceteris paribus* clause necessarily contains physical specifications. Still, a law may be called biological if it contains biological concepts that are irreducible to physics (or rather "irreplaceable" as I shall argue later on). And this seems to be the case, most philosophers agree, because of the multiple realization[18] of biological properties.

To conclude this section, it seems that if biological laws exist, they exist in the form of *ceteris paribus* laws. As I have argued, the view that biological laws differ only in degree to physical laws goes hand in hand with the irreducibility of biology due to multiple realization. In the following section, I will argue that this link is both unnecessary and moreover problematic. Multiple realization should not be seen as an irreducible impediment to reduction, nor should it be understood as an anti-reductionist argument. To the contrary, a conservative reductionist approach that embraces multiple realization as an *anti-eliminativist* argument gives us a stronger argument in favour of the existence of biological laws distinguished in degree from physical ones.

II. Conservative reductionism

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[14] See: Mauro Dorato, "Mathematical biology and the existence of biological laws", op. cit.

[15] Nancy Cartwright, *How the laws of physics lie.* Oxford: Oxford University Press, 1983, p. 45 (taken from: Mauro Dorato, "Mathematical biology and the existence of biological laws", op. cit.)

[16] See also: Stephen Schiffer, "Ceteris paribus laws", in: *Mind*, 100, 1991, pp. 1-17; Jerry Fodor, "You can fool some of the people all the time, everything else being equal: Hedged laws and psychological explanations", in: *Mind*, 100, 1991, pp. 19-34).

[17] See: Mauro Dorato, "Mathematical biology and the existence of biological laws", op. cit; Mehmet Elgin, "There may be strict empirical laws in biology, after all", in: *Biology and Philosophy*, 21, 2006, pp. 119-134.

[18] See also: Lawrence Shapiro, "Multiple realizations", in: *The Journal of Philosophy*, 97, 2000, pp. 635-654.

It is generally taken for granted that biological property tokens are identical with something physical[19]. Otherwise, at least one of the following widely accepted working hypotheses would be false: 1) biological properties supervene on complex configurations of physical properties[20]; and 2) physics is causally, nomologically and explanatorily complete with respect to biology[21]; and 3) biological properties are causally efficacious. Since, according to token-identity, biology and physics refer to the same entities, the problem of the autonomy of biology starts with explaining how their concepts, laws and explanations are related.

Let me start here with the argument that takes multiple realization to require an anti-reductionist stance, an argument that goes back to Fodor[22] and Putnam[23]. The principal point of the argument is that biological concepts cannot be bi-conditionally related to physical descriptions. They are not coextensive[24]. Therefore, biological functional explanations must constitute an autonomous and unifying explanatory level[25]:

Biological concepts (like "B") refer, because of functional similarities, in a homogenous way to biological property tokens that come under different physical descriptions (like "P_1" and "P_2"):
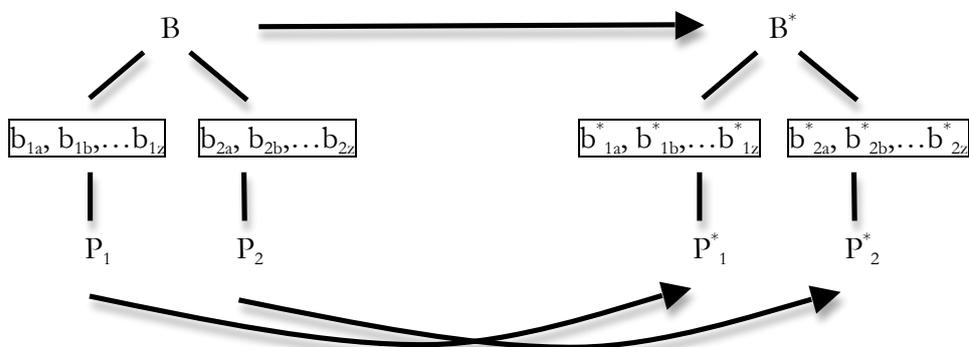

Figure 2.1 *Multiple Realization*

However, if no nomological coextension between physical and biological descriptions can be established, biological concepts would seem to not actually be about the *same* entities in the fine-grained sense, but are instead about *different* properties[26]. This then leads to a property dualism that contemporary anti-reductionists have tried to avoid, with its concomitant of making biological properties epiphenomenal. After all, it follows from token identity and the completeness of physics that for the biological property tokens b_{1a},

[19] See among others: Michael Esfeld and Christian Sachse, *Conservative reductionism*. New York: Routledge, 2011, ch. 2.6, Jaegwon Kim, *Physicalism, or something near enough*. Princeton: Princeton University Press, 2005, ch. 2.

[20] Alexander Rosenberg, "Supervenience of biological concepts", op. cit.; Marcel Weber, "Fitness made physical: The supervenience of biological concepts revisited", op. cit.

[21] See: David Papineau, *Thinking about consciousness*. Oxford: Oxford University Press, 2002, appendix.

[22] Jerry A. Fodor, "Special sciences (or: The disunity of science as a working hypothesis)", in: *Synthese*, 28, 1974, pp. 97-115.

[23] Hilary Putnam, "The nature of mental states", in: H. Putnam, *Mind, language and reality. Philosophical papers. Volume 2*, Cambridge: Cambridge University Press, 1975, pp. 429-440.

[24] Note that natural selection is generally taken to be the reason why there is multiple realization of biological property types: the causal powers of a given physical configuration, realizing a biological property that is pertinent for selection, depends on the environmental conditions. See: David Papineau, *Philosophical naturalism*. Oxford: Blackwell, 1993, p. 47; Alexander Rosenberg, "How is biological explanation possible?", in: *British Journal for the Philosophy of Science*, 52, 2001, pp. 735-760.

[25] See also: Philip Kitcher, "1953 and all that. A tale of two sciences", in: *Philosophical Review*, 93, 1984, pp. 335-373,.

[26] See Michael Esfeld, "Causal properties and conservative reduction", in: *Philosophia naturalis*, 47-48, 2010-11, pp. 9-31, Michael Esfeld and Christian Sachse, "Theory reduction by means of functional sub-types", in: *International Studies in the Philosophy of Science*, 21, 2007, pp. 1-17, Michael Esfeld and Christian Sachse, *Conservative reductionism*. New York: Routledge, 2011, ch. 5, Christian Sachse, *Reductionism in the philosophy of science*. Frankfurt: Ontos-Verlag, 2007, ch. III.

$b_{1b}, \ldots b_{1z}$, the fact of coming under a biological description B cannot signify some causal efficacy *beyond* what is spelled out by P_1 and, similarly, B applies as well to $b_{2a}, b_{2b}, \ldots b_{2z}$ that are completely described by P_2. So, B cannot be something causal *in addition* to what physics tells us; B is either an abstraction or epiphenomenal. Epiphenomenalism implies eliminativism as regards the scientific quality of B (and of biology in general) since no causal explanation could be based on it. If we reject epiphenomenalism, then it *has to be theoretically possible* to construct biological concepts that are bi-conditionally related to physical descriptions. This then means to take a reductionist perspective that avoids epiphenomenalism and eliminativism as regards biological abstractions, which satisfy the following desiderata:

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1. Avoiding the conflict with the completeness of physics and ontological reductionism.

2. Biological concepts, laws and explanations are *about causally efficacious property tokens* ("*Cau*").

3. Biological concepts, laws and explanations are *theoretically not replaceable* ("*¬Rep*").

Figure 2.2 *Minimal desiderata*

In order to combine "*Cau*" and "*¬Rep*" (*Figure 2.2*), one has to consider multiple realization in more detail. According to it (as illustrated in *Figure 2.1*), not everything that comes under B would also come under a single physical description P_1. Here, P_1 is a placeholder for a detailed homogeneous physical description that only applies to a subset of entities that come under B. However, if local physical structures coming under one concept B are described in terms of different physical concepts (like P_1 and P_2), then there is a difference in composition among their structures. Each of these physical concepts is about a minimal sufficient condition (realizer) to bring about the effects that define B, *ceteris paribus*. In order to get from structures coming under P_1 to structures coming under P_2, one has to substitute at least one of the necessary parts of the biological trait to bring about the effects in question with a part of another type. Any such replacement implies a systematic difference in the way in which these structures cause the effects that define B, which means that we cannot replace a local physical structure of type P_1 by a local physical structure of type P_2 (thus obtaining a different physical realizer of B) *without* making a causal difference[27].

If the effects that define B can be brought about by two or more different configurations of physical properties (types of realizer), our claim is that we will still find a difference in the production of side effects that are systematically linked with the main effects in question over the entire trajectory of the trait's historical existence. Think of physically different genes[28] that all code for the same protein and thus come under one biological concept B. Such a case affords the possibility that different causal interactions with the physical environment within the cell will occur when these genes are transcribed and the proteins are synthesized. For any such difference in the causal sequence from the DNA transcription to the protein synthesis, there exists the possibility that the difference may become pertinent in particular environments[29] (see the illustration in *Figure 2.3*, where the physically different genes differ in environment 1 and 6, but are alike in environment 2 -

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[27] See also: <u>Jaegwon Kim</u>, "Making sense of emergence", op. cit. and <u>Jaegwon Kim</u>, *Physicalism, or something near enough.* op. cit., p. 26.

[28] Genes and functionally defined gene types should be generally understood as difference makers; see: <u>C. Kenneth Waters</u>, "Genes made molecular", in: *Philosophy of Science*, 61, 1994, pp. 163-185; <u>Kenneth Waters</u>, "Causes that make a difference", in: *Journal of Philosophy*, 104, 2007, pp. 551-579.

[29] See also: <u>Alexander Rosenberg</u>, *Instrumental biology or the disunity of science.* Chicago: University of Chicago Press, 1994, p. 32.

5). Consequently, that difference can *in principle* also be considered in *functional* terms – terms *proper* to the biological domain to which B belongs[30]. The upshot of this argument is that more precise functional definitions may, in theory, account for different reaction norms (fitness functions), and thus, physical differences. Against this background, for the concept B (that is multiply realized by P_1 and P_2), it is possible to conceive two functional sub-types B_1 and B_2 taking different reaction norms into account:
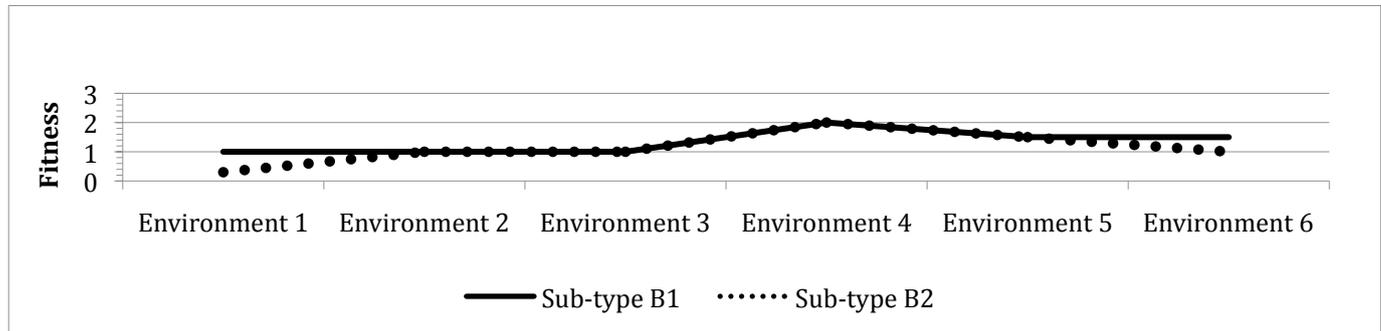

Figure 2.3 *Fitness functions of sub-types*

For instance, consider a gene of *E. coli* whose expression is pertinent to the fitness function of the organism, and that is thus functionally defined in terms of biology. For instance, a genetic basis for cell-wall biosynthesis. Simplified, the gene tokens coming under B are defined by their characteristic expression of membrane proteins that are crucial for the cell growth of the bacterium before cell division, etc. Independently of our chosen level of genetic simplification, the gene tokens coming under B are identical with certain physical configurations (DNA sequences) that are described differently in terms of physics (by P_1 and P_2) since there are differences in the physical composition of the DNA sequences in question. Nonetheless, due to the redundancy of the genetic code, all these physically different DNA sequences code for proteins of the same type (or any other effect that is considered in the functional definition B). The crucial point here is that there are different physical paths to bring about the effect in B according to the physical differences between P_1 and P_2. These different ways to produce the effects (the proteins for instance) are systematically linked with possible side effects or reaction norms, as for instance differences in the speed or the accuracy of the protein production, of which we have more and more empirical evidences[31]. To sum up, depending on variations in the environmental conditions, the optimality of certain DNA sequences over others can become selectively pertinent. This, then, should be taken into account in more precise functional definitions and explanations (see *Figure 2.4* below)[32].

By means of these sub-types we attain concepts of biology that are nomologically coextensive with physical concepts and thus make it possible to reduce biology to physical theories in a functional manner (if we assume multiple realization) in three steps (see also *Figure 2.4*): 1) within an encompassing fundamental

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[30] With regard to more fine-grained functional concepts of the special sciences, see also: William Bechtel and Jennifer Mundale, "Multiple realizability revisited: linking cognitive and neural states", in: *Philosophy of Science*, 66, 1999, pp. 175-207.

[31] See among many others: Michael Bulmer, "The selection-mutation-drift theory of synonymous codon usage", in: *Genetics* 129, 1991, pp. 897-907; Daniel L. Hartl, Etsuko Moriyama and Stanley Sawyer, "Selection intensity for codon bias", in: *Genetics* 138, 1994, pp. 227-234; Ulrich Gerland and Terence Hwa, "Evolutionary selection between alternative modes of gene regulation", in: *Proceedings of the National Academy of Sciences of the United States of America*, 106, 2009, pp. 8841-8846; for more references and a more detailed consideration, see Michael Esfeld and Christian Sachse, *Conservative reductionism*, op. cit., ch. 3.2 and 4.3.

[32] See: Christian Sachse, "Conservative reduction of biology", in: *Philosophia naturalis*, 48-49, 2010-11, pp. 33-65, for more details why sub-types are no longer multiply realizable and why sub-types and the original types have the same substantial meaning.

physical theory P, we construct the concepts P_1, P_2, etc. to capture the differences in composition among the local physical structures that are all described by the same concept B; 2) B is more precisely articulated by constructing functional sub-types B_1, B_2, etc. of B, each of which captures the systematic side effects linked to the different ways of producing the effects that define B. To put it differently, the sub-types are constructed from B in such a way that they are nomologically coextensive with the concepts P_1, P_2, etc., using the functional model of reduction; (3) B is reduced to P via B_1, B_2, etc. and P_1, P_2, etc. Reducing B (and thus biology) here means that starting from P, we can construct P_1, P_2, etc. and then deduce B_1, B_2, etc. from P_1, P_2, etc. given the nomological coextension. One derives B *by abstracting* from the conceptualization of the functional side effects contained in B_1, B_2, etc. given a environmental context in which the functional side effects are not manifested or are not pertinent to selection[33]:

B $\longrightarrow$ B^*

B_1 B_2 B_1^* B_2^*

$b_{1a}, b_{1b}, \ldots b_{1z}$ $b_{2a}, b_{2b}, \ldots b_{2z}$ $b_{1a}^*, b_{1b}^*, \ldots b_{1z}^*$ $b_{2a}^*, b_{2b}^*, \ldots b_{2z}^*$
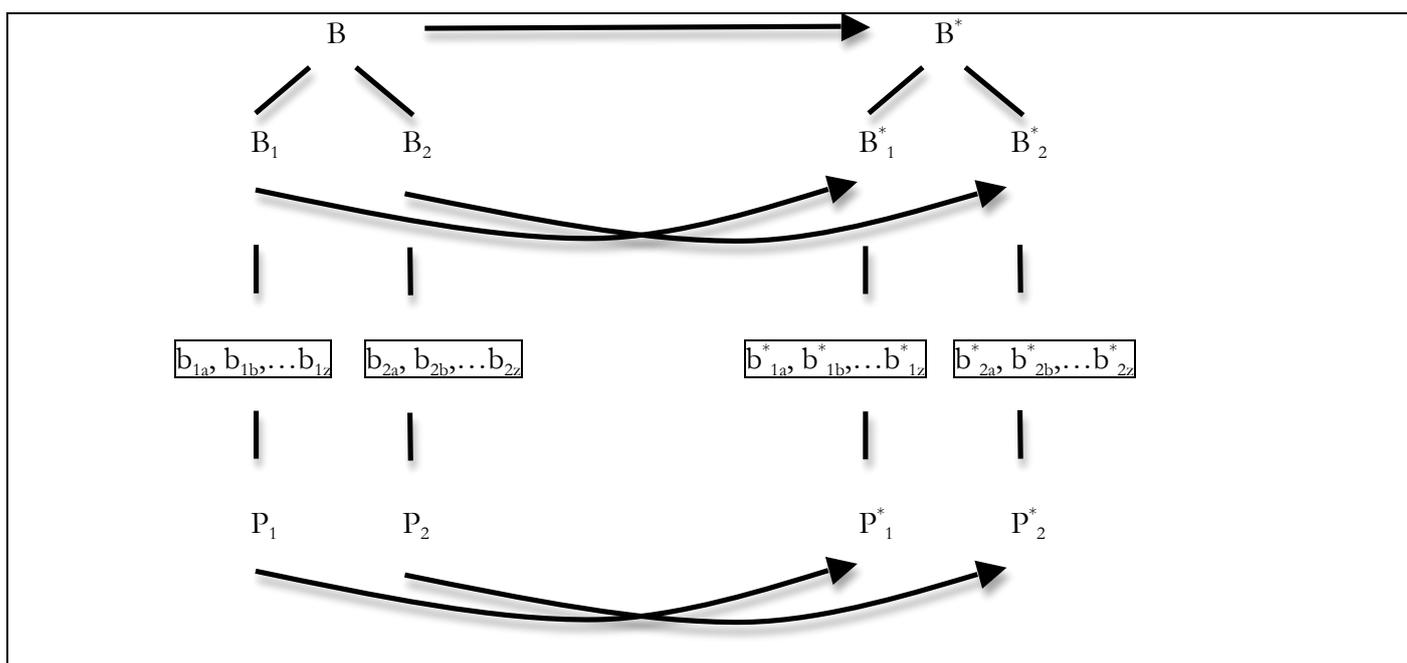
P_1 P_2 P_1^* P_2^*

Figure 2.4 *Conservative reduction*

On the basis of the fundamental physical laws, one can construct laws in terms of P_1, P_2, etc. that refer to the properties on which biology focuses. From those laws, one can deduce biological laws in terms of B_1, B_2, etc., given the nomological coextension of these concepts. These sub-types and any laws and explanations that are based on them are not, then, about epiphenomena (thus vindicating "*Cau*"). Nonetheless, they were replaceable by physics because of nomological coextension (no vindication of "¬*Rep*"). However, one reaches the laws and explanations in terms of B by bracketing the conceptualization of the functional side effects that are represented in B_1, B_2, etc. Since the specification of the function of B is contained in each of its sub-types, the original and abstract concept B cannot be eliminated. The abstract laws of biology couched in terms of B are non-physical and not replaceable by physics in the sense that there is no single physical law having the same extension as any of these laws, vindicating "¬*Rep*" for B. When talking about complex objects such as e.g. genes, cells, or whole organisms, the physical concepts focus on the composition of these objects. Due to

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[33] For more details, see: Michael Esfeld and Christian Sachse, *Conservative reductionism*, op. cit., ch. 5; Christian Sachse, "Conservative reduction of biology", op. cit.

selection there are salient causal similarities among the affects produced as a whole by such complex objects, even though they differ in composition. So, the abstract concepts of biology possess a scientific quality in the sense of satisfying "*Cau*" and "*¬Rep*", figuring in law-like generalizations that capture something that is objectively there in the world. Furthermore, these concepts and law-like generalizations do not conflict with the completeness of physics and ontological reductionism, since the reductive method used to express them is based on the fundamental physical concepts and laws.

III. Perspectives

Conservative reductionism constitutes a plausible framework for biological laws and kinds. As regards the question of special biological laws, it is consistent with the claim that these exist as things different in degree from physical laws within the reductionist framework. We can specify the different degrees of lawhood in terms of different degrees of abstraction and generality. That is to say, biological generalizations may be, within their domain of application, law-like. The argument for this is stronger within a conservative reductionism because, as we have shown, it avoids conflicts with an ontological reductionism and the thesis of the completeness of physics that are usually held to be antithetical to the biological law claim. Moreover, by showing that the concepts constituting abstract biological generalizations are theoretically connectable via sub-types with physical descriptions and laws, we may formulate sub-type-laws that get their law-like character from physics *deductively*, on account of nomological coextension. From this move, the original biological generalizations can also be understood as inheriting their law-likeness, since they only abstract from certain functional details. Against this background, we can connect the principle of natural selection to physics by means of its application to specific units of selection, and thus confer on it its law-like character. Still, because of its extreme generality, the principle of natural selection is not replaceable by physics. Keep in mind that the kind and degree of abstraction is entirely a matter of the given and changing environmental conditions, and not on some theoretical protocol.

Against this background, one may consider the debate on biological taxa being natural kinds. Conservative reductionism supports a realist attitude with respect to biological kinds in the following general way: since the sub-types are nomologically coextensive with physical descriptions, it is possible to apply any argument in favour of (composed) physical kinds being natural ones to the biological sub-types as well. Thus, the more abstract biological concepts inherit their naturalness and counterfactual robustness from their sub-types, or, to put it differently, the reductionist framework makes explicit the hierarchical structure of a system of natural biological kinds that is *theoretically* achievable. Additionally, depending on environmental conditions, the abstract biological concepts such as biological taxa may not only be descriptive but also figure in biological laws and explanations. In this way, neither inheritance nor the biological sphere's systematic hierarchical structure contains, in the ideal case, any conventionalist aspect. This seems at least plausible for any kind of biological property type at a certain time.

However, things become more complicated as regards biological species that are evolving while in time, when physical natural kinds are not. Physical natural kinds are *perfectly similar* and can thus be rigidly

designated, while biological kinds are at most *imperfect similar*. This difference suggests that we should deny any essence to the notion of the biological species. However, one may argue that imperfect similarities are sufficient for essence[34]. To show this, let us first consider the argument for the following claim: there is no principal difference whether we consider multiple realization of a type at one specific time or for a period of time. For instance, imagine an abstract concept B_{t1} such that it applies to any member of a species at t_1 and it can be conservatively reduced via its sub-types to physics. Look at that species at a later stage in evolution (at t_2) and imagine once again that an abstract concept B_{t2} applies to any member of a species and this concept can be conservatively reduced via its sub-types to physics as well. If we now compare both abstract concepts B_{t1} and B_{t2}, it is likely that they differ somehow and it is even more likely that their sub-types differ somehow since evolution has taken place. However, there is no principal objection to the view that both abstract concepts B_{t1} and B_{t2} may constitute themselves two sub-types for some more abstract concept that bring out salient characteristic similarities that figure in explanations. Call this a theoretical species concept that applies to B_{t1} and B_{t2}. Of course, common taxonomy may either satisfy these demands or not. But whenever it does, species concepts are natural ones and may theoretically figure in laws and explanations.

This then amounts to attributing essence to species. Say that the individuals of some species B differ physically and thus come under different physical descriptions P_1, P_2, etc. Applying the reductionist strategy, one may construct sub-types (B_1, B_2, etc.) of B that are nomologically coextensive with P_1, P_2, etc. Any attribution of essence to the constructed sub-types is justified since they are nomological coextensive with physical types (to which we generally attribute essences). Then, the species concept B can be understood as being nothing more than an abstraction from the essence *differences* of its sub-types. B spells out what all the individuals have essentially in common (similar to the functional similarity of biological types general). The same reasoning is, as shown before, applicable to larger time scales. We may thus share some essence with humans of previous generations. However, since evolution continues, any particular essence may disappear one day. This then raises the question about the essence changing, or a speciation event,

Within the reductionist framework, speciation may be understood as arising when at least two sub-types (B_1 and B_2,) no longer share "enough" to come under the previously common species concept B. No longer sharing enough here means that functional (essence) differences that are spelled out in the sub-types become more important than their functional (essence) similarities. This poses no theoretical threat of conventionalism, since whether or not such situations emerge depends on the environmental conditions. Within the framework of conservative reductionism, our argument suggests that differences in essence (in combination with the given environmental conditions) constitute the starting point for whether the speciation event occurs or not. In other terms, phylogenesis during evolution does not depend on us but on the world and the underlying physical structures and changes that can be, in theory, considered in terms of sub-types and more abstract concepts. On that theoretical basis, rather descriptive classifications that mostly focus on a historical dimension like common ancestry are not impediments to the ahistorical construction of biological kinds with genuine essences that figure in genuine explanations.

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[34] See also: Kevin Lynch, "A multiple realization thesis for natural kinds", in: *European Journal of Philosophy*, DOI: 10.1111/j.1468-0378.2010.00420.x, 2010, pp. 1-18.