PLURALISM IN SCIENCE

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ABSTRACT

PLURALISM IN SCIENCE

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This thesis examines the ineliminable status of pluralism in contemporary sciences, especially in biology. Pluralism in science is endorsed to avoid loss of knowledge, unproductive debates and explanatory inflexibility while the plurality indicates the disunited nature of knowledge in some areas. The pluralist stance approach, as an epistemological stance, argues that it is possible to reduce modest forms of pluralism to sophisticated forms of monism. However, the pluralist stance is vulnerable to the monist challenge that today's science is incomplete and brings a sort of epistemological disorder to scientific territory. This thesis tries to answer the following question: is it more beneficial if a modest form of pluralism is adopted for a better scientific practice? Integrative pluralism as a type of modest pluralism can be as pragmatic as the pluralist stance, without seeking theoretical unification but advocating explanatory resolution for a better scientific conduct.

Keywords: Scientific Pluralism, Compatible Pluralism, Integrative Pluralism.

ÖZ

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Bu çalışma, çağdaş bilimlerdeki, özellikle biyolojideki, elimine edilemeyen çoğulculuk durumunu inceler. Bilimde çoğulculuk bilgi kaybını, verimsiz tartışmaları ve açıklayıcı esneksizliği önlemek için desteklenirken, çoğulluk bazı bölgelerde bilginin ayrık olduğuna işaret eder. Epistemolojik bir duruş olan çoğulcu duruş yaklaşımı ılımlı çoğulculuğun bir çeşit sofistike tekçiliğe indirgenebileceğini ileri sürer. Oysaki, çoğulcu duruş, tekçilerin günümüz biliminin tamamlanmamış olduğu iddiasıyla bilimsel alana bir çeşit epistemolojik düzensizlik getirdiği iddiasına açıktır. Bu nedenle, ılımlı bir çoğulculuk formunun benimsenmesi daha iyi bir bilimsel uygulama için daha faydalı olur mu? Ilımlı bir çoğulculuk formu olan bütünleyici çoğulculuk, daha iyi bir bilimsel yürütme için teorik birleşmeyi aramadan açıklama düzeyinde çözümü savunarak çoğulcu duruş kadar pragmatik olabilir.

Anahtar Kelimeler: Bilimsel Çoğulculuk, Bağdaşabilir Çoğulculuk, Bütünleyici Çoğulculuk.

To My Parents

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CHAPTER 1

INTRODUCTION

With strong arguments, pluralism is a challenge against monism in philosophy of science today. The underlying goal in this thesis is to address the following question, is it possible to present the idea of pluralism into consideration adequately as a general philosophical explanation of complexity and diversity found in contemporary sciences? Developed by Stephen H. Kellert, Helen E. Longino and C. Kenneth Waters, the pluralist stance approach as a form of pluralism is one of the newest approaches in the philosophy of science literature, which brings a novel perspective to the problem of pluralism in science. Emphasizing that the initial question, whether a single, all-inclusive theory fully and consistently accounts for phenomena is an unsettled matter, the pluralist stance endorses the empirical investigation of the phenomena in question as the only way to decide whether a plurality of approaches is required to account for them or not.

Just like the other forms of pluralism, the pluralist stance too encounters an objection, known as the incompleteness of today's science. I argue that the pluralist stance is vulnerable to this objection by claiming that the results obtained from relevant empirical investigations of the phenomena

of interest carry the possibility to undergo a change over time. Therefore, the case of determination of investigative or explanatory methodology in order to capture the realities of scientific world fully by looking at the empirical results may be a case, which is not that robust due to the possibility of unforeseeable changes over time. In addition, it may not have a flourishing impact in the advancement of scientific knowledge as the pluralist stance articulates.

Moreover, I think that the pluralist stance brings some sort of epistemological disorder into the scientific territory. In order to avoid these challenges as well as to maintain the pluralist position, I defend that pluralists should adopt a form of modest pluralism rather than the pluralist stance or other forms of radical pluralism. Some forms of modest pluralism, such as the one Sandra Mitchell developed, can be as empirical and case-by-case pragmatic as the pluralist stance. Modest pluralisms seek a best explanation for essential aspects of the phenomena being investigated since there is only one true incorporated explanation for every phenomenon.

In order to fulfill this objective, this body of this work is comprised of four chapters. I begin with a chapter, focusing on the background and the motivation underlying pluralism in science. I briefly describe epistemological and metaphysical types of pluralism (i.e., horizontal vs. vertical, local vs. global, partial vs. local and isolationist vs. integrative) that are seen in the philosophy of science literature. Then, I examine three types of pluralism based on the interpretations of plurality: “modest”, “radical” and “empirically based” interpretations. Then, I elaborate the empirically motivated pluralist interpretation, which Kellert et al. call “the pluralist stance” approach and its possible implications regarding science and philosophy of science.

Throughout Chapter 3, I explain the vulnerability of the pluralist stance and the outlooks of the pluralist stance's consequences. The examination of the pluralist stance approach shows us that it is vulnerable to plausible challenges, such as the monist challenge that today's science is incomplete. I also argue that the pluralist stance induces a sort of epistemological disorder by being against to any sort of replacement or resolution between competitive or compatible explanations.

Afterwards, I will present my own critique of the monist assumption, namely incompleteness of today's science. Hinging on the fact that there will always be an ongoing change in natural world, I argue that scientific theories are never (and most probably will never be) complete. There is also the assumption that our cognitive capacities are limited; therefore, we are not competent to know that science will ultimately be complete or not complete one day. However, I will argue that the fact that there is (and will be) an ongoing change and that our cognitive capacities are limited do not and will not hinder scientists to perform their duties, namely the search for knowledge. I also argue that there are unanswered scientific questions that wait for being concluded. Therefore, the actual incomplete issues in the scientific domain still pose a challenge to pluralism, practically. Throughout this chapter, I recommend that it is more rational to adopt a modest form of pluralism for a better scientific conduct due to the vulnerability of the pluralist stance.

In Chapter 4, I present Mitchell's integrative pluralism as an example of modest pluralist interpretation in order to show why integrative pluralism provides a better scientific conduct. First, I explain the reasons why Mitchell thinks that reductionism should not be expected in the near future in contemporary biology. Then, I go on with the distinction between

competitive and compatible pluralisms. I also endeavor to comment on a possibility of compatible pluralism in physics.

As a type of compatible pluralism, I argue that integrative picture of the compatible pluralism contributes to a better scientific conduct than competitive or the isolationist picture of the compatible pluralism. There I appeal to Sherman's the "Levels of Analysis" argument and Mitchell's counter-argument - the "Case of Division of Labor" in social insects. According to the "Levels of Analysis" argument, biological research should be conducted from different levels of analyses. Mitchell's counter-argument shows us that due to the complexity and diversity of the biological phenomena, unification at the theoretical level is not forthcoming; however, it indicates that understanding of the characteristics of a biological phenomenon requires competing explanations from different level of the analysis and the integration of compatible explanations within the same levels. In other words, resolution is required at the concrete explanatory level for a better scientific conduct. Lastly, I conclude that we need a modest form of pluralism, for pragmatic concerns.

CHAPTER 2

PLURALISM IN SCIENCES

Particular issues within a science and common philosophical or methodological questions have attracted the interests' of scientists and philosophers to pluralism especially for the last 30 years. Several forms of pluralism about theories or methods of science have been developed since then. The underlying motivation of pluralism in science is the view that some natural phenomena of interest to be completely explained or investigated require more than one theory or approach because of the complexity in the concrete natural world; thereby, scientists construct multiple explanatory systems in order to meet this requirement. Thinkers understand and scrutinize pluralism in different ways. Hence, they draw different philosophical implications from it. In general, it is possible to understand pluralism in science as referring to "radical ontological or epistemological heterogeneity or merely the diversity of mechanisms in nature" (Kellert et al., p. vii). Due to the complexity in natural world and our representational limitations, contemporary scientific studies indicate that pluralism in science is unavoidable.

2.1 Pluralism in Natural Sciences

There are different understandings of pluralism in different scientific disciplines. In physics, for instance, pluralism does not have such a high value probably because physics has always been considered as “the paragon of unifying and unified science, in particular, the paragon of reducing and reduced by its own most fundamental theories” (Cat 2009). On the other hand, in chemistry, pluralist positions about chemical concepts are more common in comparison to physics. However, a pluralist stance is yet not widely appreciated in chemistry, too. In biology, scientists and philosophers of biology are more sympathetic to pluralism. The debates go back and forth between more pragmatic approaches (Sober 1993, Lange 1995, Mitchell 2003) and strong reductionist arguments (Wilson 1975, Dawkins 1979, etc.).

On the other hand, in the humanities and social sciences, it is possible to see pluralist stances more often than in natural sciences. In a way, every approach seems to be legitimate in the humanities and social sciences. However, I like to focus on pluralism in natural sciences within the context of this thesis. Pluralism in social sciences is a very different issue from pluralism in natural sciences, which I do not aim to elaborate in this work. Thus, it should be clear that I mean natural sciences by sciences.

The discussions concerning scientific pluralism in natural sciences can be gathered into two groups, namely earlier and more recent, more specific discussions. The first group comprises the debates, which focus on the development of the disunity of science thesis against the unity of science program. The second group holds more recent discussions, beginning with reasonable debates within particular sciences (e.g., physics, biology), and

extending to debates about metascientific concepts (e.g., theory, explanation, evidence) that have been about the relations between philosophical, historical and sociological accounts of science. To be more precise, pluralism discussions in the second group have been about the following sorts of philosophical problems: “the problem of species”, “the controversy about the level of selection”, “the relation between genetic and environmental explanations of differences” shaped the main discussions in philosophy of biology literature (Kellert et al., p. viii). The problems regarding “the interpretations of quantum mechanics”, “its relation to other branches of physics”, and “the status of laws” have been important issues in the literature of philosophy of physics (Kellert et al., p. viii). Today, philosophers of science keep the philosophical literature in the context of pluralism developing at the metaphilosophical level as well.

2.2. Types of Pluralism

Pluralities are one of the characteristics of the present status of science. Scientists adopt the pluralist attitude in their “representational or classificatory schemes”, “explanatory strategies”, “models and theories”, and “investigative questions” and “the strategies appropriate for answering them” (Kellert et al., p. ix). There are numerous approaches, models, theories about a phenomenon in the search for its knowledge. For example, biological scientists and philosophers of biology develop or rather discover new ways of thinking about the subjects, such as adaptation, development, units of selection, function, species, human nature, altruism, progress, and the human genome project.

> Pluralism is a view about this state of affairs: that plurality in science possibly represents an ineliminable character of scientific inquiry and knowledge (about at least some phenomena), that it represents a deficiency in knowledge only from a certain point of view, and that analysis of metascientific concepts (like theory, explanation, evidence) should reflect the possibility that the explanatory and investigative aims of science can be best achieved by sciences that are pluralistic, even in the long run. (Kellert et al. p. xi)

Pluralists in general have a consensus on pluralism: due to the complex structure of the biological systems, multiple approaches inevitably arise from the empirical investigations concerning the studied phenomena. Moreover, the fact that there are various, equally contributing theories indicates that neither the multiplicity in every situation arises from lack of knowledge nor all-inclusive, complete explanation is possible for every phenomenon when the deficient elements precluding the comprehensive understanding of that phenomenon are eliminated from knowledge.

There are four types of pluralism in epistemological and metaphysical sense. Jordi Cat distinguishes four types of pluralism:

> Pluralism applies widely: concepts, explanations, virtues, goals, methods, etc:
>
> - *Vertical vs. horizontal pluralism.* Vertical pluralism is inter-level pluralism, the view that there is more than one level of factual description or kind of fact and each is irreducible – equally fundamental, or ontologically/conceptually autonomous. Horizontal pluralism is intra-level pluralism, the view that there may be incompatible descriptions or facts on the same level of discourse.
> - *Global vs. local pluralism.* Global pluralism is pluralism about every type of fact or description. Global horizontal pluralism is the view that there may be incompatible descriptions of the same type of fact. Global vertical

pluralism is the view that no type of fact or description reduces to any other. Local horizontal and vertical pluralism are about one type of fact or description.

- *Local vs. partial pluralism.* Local in Lynch's sense above should be distinguished from another localization or selection-concept, partiality. Partiality refers to selection of areas of phenomena and models. We have seen it applies also to reduction and non-reductive unification.
- *Isolationist vs. integrative pluralism.* Isolationist pluralist is about underdetermination; about the choice from a disjunction of equivalent (types of) descriptions or of incompatible partial representations or models of phenomena in the same intended scope – the representational incompatibility may be traced to competing values or aims. It is the most common situation in the sciences. Integrative pluralism is the conjunctive or holistic requirement of different types of descriptions or facts. Each can be vertical or horizontal. (Cat, plato.stanford.edu)

In addition to the categorization of four types of epistemological and metaphysical pluralisms, it is also possible to categorize pluralisms according to pluralists' approaches to the defense of pluralism. To be more precise, it is possible to evaluate the types of pluralism according to "the strength of the pluralism" that philosophers of science adopt (Kellert et al, p. x). According to the strength of pluralism that philosophers of science adopt, Kellert et al. separate pluralist interpretations into three: "modest" (e.g., versions of Mitchell, Kitcher) and "radical pluralist interpretations" (Dupré's version), and "an empirically based interpretation", which they call "the pluralist stance" (p. xiff).

Regarding modest pluralisms, two interpretations catch our attention distinctively. Some modest pluralists "recognize the world as patchy" and claim, "one model or theory might explain phenomena in one patch while a different model or theory would be necessary to explain the similar

phenomena in a different patch" (Kellert et al., p. xi). The other modest pluralist interpretation is basically motivated by tolerating

> [a] plurality of theories, not because there is something importantly right about one that cannot be captured by another (and vice versa), but because it is difficult to predict which research program (or preliminary theory) will lead to a theory that provides a complete account of the phenomena. (Kellert et al, p. xii)

Since determination of *the* theory, which uncovers every facet of the phenomena, is perplexing in the case of complexity, we should tolerate multiple theories until we discover which approach will lead to *the* theory.

On the other side, Kellert et al. claim that Dupré's version of pluralism, which is known as promiscuous realism, can be categorized as a radical interpretation of pluralism. Basing on the anti-realist or nonrealist constructivist acceptance of "an indefinite number of theories, the only constraint being human ingenuity", Dupré claims that to distinguish and categorize the world into kinds can be well achieved by unlimited number of ways, which are equally correct and interest relative. Dupré poses a challenge against the essentialist and unificationist views about natural kinds, advocating ontological pluralism instead of the traditional views.

Kellert et al., criticize modest and radical pluralist interpretations because of two reasons. First, they adopt the pluralist stance, which I will explicate in the next paragraph. Second, they conceive modest pluralisms as "a sophisticated form of monism" whereas radical pluralisms are indistinguishable from radical relativism (p. xiif). Modest pluralisms are a sophisticated form of monism because they seem not in contradiction with the idea that pluralities in science ultimately will terminate and "for every

particular phenomenon, there is a single, best account" or "a single, all-encompassing single theory" (p. xii).

For instance, Kellert et al. state that Mitchell assumes that "nature varies in its strategies, using different strategies to achieve the same end, but for each situation in the natural world there is a single complete and comprehensive account that can be given" (p. xii). Therefore, according to Kellert et al., it is possible to "reduce this type of view to a nonfundamentalist or nonreductionist monism" (p. xii).

Moreover, toleration of multiple theories reduces to monism, as well, because the proponents of this form of pluralism acknowledge using "a division of cognitive labor" as a strategy to seek the answer to the question, of which "research program" or "preliminary theory" will lead to the theory about the complete account of the phenomena (Kellert et al., p. xii). In other words, using the strategy of division of cognitive labor is welcome to achieve *the* single true theory, which is "the putative long-term goal" (p. xii).

On the other side, they also think that it is difficult to separate promiscuous realism from "radical relativism", for promiscuous realism suggests the recognition of indefinite number of equivalently, hence, irreducibly referential and legitimate ways to distinguish and categorize the world into kinds (p. xiii).

2.3. The Pluralist Stance

Kellert et al. recommend adopting the pluralist stance instead of advocating a modest or radical form of pluralism. The pluralist stance is not a metaphysical or ideological stance but an epistemological one, whose

motivation is empirical investigation. Because it is empirically motivated, it avoids the a priori restriction about what can be known and how. In other words, it rejects any sort of "a priori commitments to either unity or multiplicity" because the question whether a single account can entirely capture all of the realities of the natural world is comprehended as an unsettled matter (p. xxiii). That is to say that the empirical "evidence and the practical success (or failure)" will determine whether unity or multiplicity of approaches is required in order to account for the phenomena (p. xxiii). In that context, the pluralist stance defends local pluralism, hinging on the inference that plurality is ineliminable in the particular cases, scrutinized especially in the case studies that appear in the scientific pluralism literature.

Before I look at the pluralist stance and its philosophical implications in detail, let me begin with taking the insights of scientific pluralism into consideration by invoking the description of scientific monism made by Kellert et al. I find their description important in the sense that it tackles scientific monism thoroughly. They identify the subject in five tenets as the following:

> We take *scientific monism* to be the view that
> 1. the ultimate aim of science is to establish a single, complete, and comprehensive account of the natural world (or the part of the world investigated by the science) based on a single set of fundamental principles;
> 2. the nature of the world is such that it can, at least in principle, be completely described or explained by such an account;
> 3. there exist, at least in principle, methods of inquiry that if correctly pursued will yield such an account;
> 4. methods of inquiry are to be accepted on the basis of whether they can yield such an account; and
> 5. individual theories and models in science are to be evaluated in large part on the basis of whether they provide (or come

> close to providing) a comprehensive and complete account based on fundamental principles. (p. x)

Many have envisioned scientific pluralism as the general view that a single theory or approach cannot completely explain or investigate some natural phenomena. Shedding light on this description of scientific monism I just quoted, I think that a further and more detailed understanding of scientific pluralism is now possible. I also believe that we need a further understanding of scientific pluralism in order to address our initial question: is it possible to propose, develop and further the idea of pluralism as a general philosophical interpretation of science or as a general philosophical explanation of complexity and diversity found in contemporary sciences? Kellert et al. consider that scientific pluralism should therefore stand up for the contrary state of scientific monism. They argue,

> *[s]cientific pluralism*, in contrast, holds that there are no definitive arguments for monism and that the multiplicity of approaches that presently characterizes many areas of scientific investigation does not necessarily constitute a deficiency (p. x).

In other words, pluralists indicate that it is possible for one single description to be unable to unfold the realities of the natural world adequately. Therefore, one should approach monism carefully because the nature of some parts of the world may just not fit in monist characterizations. Kellert et al. argue that "whether it [the natural world] can be so explained [by one single account] is an open, empirical question" (p. x). Therefore, there should be a detailed, systematic examination in order to determine whether monism or pluralism stands for that part of the world. Kellert et al. claim that this requirement

> [u]ndermines tenet 1 because if we don't know whether the world can be fully accounted for by a single, comprehensive account, then it seems unreasonable to assume that the ultimate aim of science is to achieve such an account. If the world cannot be fully accounted for by a single, comprehensive account, then there cannot be methods of inquiry that if correctly pursued would yield such an account. Hence, we should not assume the tenet 3 is true. And if we don't know whether the world can be fully accounted for by a single, comprehensive account, then it seems unreasonable to accept or reject scientific methods according to whether they can yield such an account (tenet 4) or to evaluate scientific theories in terms of how close they come to providing a complete and comprehensive account (tenet 5). (p. xf).

Since Kellert et al. have an understanding of scientific pluralism as above, the proponents of the pluralist stance invite philosophers of science to rethink the concepts of science and metascience.

The advocates of the pluralist stance have three basic reasons for embracing their view: to avoid loss of knowledge, to avoid the unproductive debates and to avoid the explanatory inflexibility. For instance, they argue that unification of diverse accounts regarding explanatory causes may lead to deprivation of detail and information, which might have equal explanatory value. They claim "monism on the part of researchers, especially when motivated by commitment to their chosen theory or approach, fuels sterile and unproductive debates", however, "adopting the pluralist attitude encourages scientists to pursue interesting research without having to settle the questions that cannot, in the end, be settled" (Kellert et al., p. xx).

Pluralists, who adopt the pluralist stance, have the presumption that many of the metaphysically fundamental problems about science will not be solved. Therefore, it would be more advantageous if scientists pursued their

research without attempting to terminate such questions that cannot ultimately be resolved. Since the pluralist stance sees commitment to monism without empirical investigation as a futile endeavor, they think that insisting on such an attitude in order to investigate every natural phenomenon would lead to a loss in scientific knowledge. Thus, the pluralist attitude is believed to be supportive in terms of the continuation of productive debates. In other words, if pragmatic reasons are crucial / determinative for scientists in deciding which approach(es) to follow in their research, the pluralist stance anticipates that such decisions would be enhancing productivity more. In addition to the benefit of avoiding loss of knowledge and unproductive debates, Kellert et al. specify explanatory flexibility as another utility that the sciences should enjoy. If separate explanatory contexts answer different interests, then all should be kept.

2.4. Possible Implications

Many would probably agree with the validity of the possibility that monistic scientific models make scientists hinder from seeing some aspects of complex phenomena while they are trying to elucidate others. While they are trying to elucidate certain aspects of phenomena, they aim to have a single, complete, and comprehensive explanation of phenomena of interest in the end. In addition to this, Kellert et al. note other effects of assuming the pluralist stance.

One effect is that assessment of scientific models (their approaches, theories, etc.) should not be made according to the monist ideal, whether they contribute to explaining the reality as a unified whole. Proponents of the

pluralist stance think that this monist ideal impairs argumentations in philosophy of science literature to a great degree. They also argue that scientists and philosophers should acknowledge that scientific models should be evaluated on the basis of how beneficial they are when explaining the aspects of the complex situations "because some descriptions offer better accounts of some aspects of a complex situation and other descriptions provide better accounts of other aspects. And this may be the way it will always be" (Kellert et al., p. xxiv). In other words, certain complex scientific phenomena may necessarily demand partial explanations provided by different accounts, which are and most probably will not be reducible or unifiable. A theory does not necessarily have to identify all the causal factors of a phenomenon in order to be beneficial. It implies that a theory should not be given up if it cannot capture all of the causal factors of a phenomenon.

A further effect of assuming the pluralist stance is that philosophers of science should seriously bear in mind the possibility that it may not be possible to draw metaphysical conclusions from science. Because "science has not and probably will not provide reliable answers to many of the big, interesting metaphysical questions" such as "the questions about determinism, *the* level of selection or whether the world is such that a unified comprehensive account of it is possible" (Kellert et al., p. xxiv-xxv). For example, "Copenhagen" and "Bohm" interpretations of quantum theory do not agree with each other on the metaphysical assumption that "the world is fully deterministic" (p. xxiv). However, the pluralist stance recognizes that both theories may be successful at capturing certain aspects of the phenomena well and both may contribute to the advancement of scientific inquiry. Given that "there are serious limits for drawing metaphysical conclusions from science", the pluralist stance entails a moderate realism (p.

xxiv). At the same time, it is "neutral with respect to realism in the sense that it does not require us [pluralists] to abandon realism" (p. xxiv).

Another effect that the pluralist stance draws is "for philosophers who draw on philosophy of science to form conclusions about other areas of inquiry" (p. xxv). Kellert et al. say,

> [f]or example, Bernard Williams, in *Ethics and the Limits of Philosophy*, writes, "In a scientific inquiry there should ideally be convergence on an answer" (1985, 136), and he takes this convergent monism in science as a sign of its objectivity, in sharp contrast to the community-bound nature of ethical discourse. (p. xxv)

Since pluralists do not consider unity in science as forthcoming, the conclusions hinging on the presumption of unity for other areas of inquiry should also be cautiously approached.

Next implication concerns the study of science and the practice of philosophy of science. Defenders of the pluralist stance argue that philosophers of science employ "the method of counterexample" in their analyses of scientific and metascientific concepts (p. xxv).

> … if a proposed analysis of fitness can't account for long-term, as opposed to the short-term, evolution of a trait, then it is rejected. The idea behind such an argument is that the counterexample proves that the proposed analysis must not capture "the" concept of fitness because the right interpretation of fitness will be useful for understanding all important aspects of a complex evolutionary process. (p. xxvi)

Pluralist stance is sympathetic to the idea that scientific concepts may have or be characterized by many meanings. On this account, there can be multiple

true interpretations of a term; all can successfully contribute to our understanding and investigation of it. One conceptual analysis can sufficiently account for an aspect of a complex process simultaneously with a different analysis of the same concept upgrading our comprehension for other aspects of the same complex process. Therefore, Kellert et al. claim that a revision of the counterexample method is required.

In addition to the analyses of scientific concepts, Kellert et al. make a comment on the analyses of metascientific concepts that are pursued in a similar manner, in which the assumption of the existence of one kind of abstract thing as a metascientific concept is ruling (p. xxvi). Specifying the active role of the counterexample method in the analyses of metascientific concepts, the pluralist stance sustains its view about the need of revision of the counterexample method for the analyses of metascientific concepts.

So far, I presented the plurality in the sciences and an empirically motivated interpretation of pluralism called the pluralist stance. In the next section of my thesis, I will present my critique of it and suggest adopting a modest form of pluralism.

CHAPTER 3

VULNERABILITY OF THE PLURALIST STANCE

In the previous section, I have presented the implications concerning science that the pluralist stance has. I think that some criticism can be raised against those implications. For instance, it is critical about the counterexample method; however, no alternative method that might well be replaced with the counterexample method has been proposed or promoted. Alternatively, no way has been shown to revise the counterexample method. It is not easy to drop the counterexample method from sciences: basically, almost every scientific research is conducted by this method. Therefore, it is important to be clear about how the counterexample method should be revised when such a revision offer is made. So, I think that this is an open point in the defense.

But here, I think that there is a more important issue that demands our consideration. I want to examine the central thesis of the pluralist stance, “the only way to determine whether a part of world will require a plurality of accounts is to examine the empirical results of scientific research of that part of the world” (p. xxiii).

3.1. Incompleteness of Today's Science

The philosophers of science who adopt the pluralist stance approach specify that

> [a]ccording to the pluralist stance, the plurality in contemporary science provides evidence that there are kinds of situations produced by the interaction of factors each of which may be representable in a model or theory, but not all of which are representable in the same model or theory. Each factor is necessary for the phenomenon to have the various characters it has, but a complete account is not possible in the same representational idiom and is not forthcoming from any single investigative approach (as far as we know). A more complete representation of some phenomena requires multiple accounts, which cannot be integrated with one another without loss of content. We do not hold that for every phenomenon there will inevitably be multiple irreducible models or explanations. We hold that the task of identifying which situations require multiple approaches requires empirical investigation. We believe that the pluralist stance has important implications concerning metascience and the public consumption of scientific knowledge. (Kellert et al., p. xiv)

The central thesis of the pluralist stance is vulnerable because it is possible to pose a challenge like the following: today's science, hence, the results of the empirical investigations regarding the relative part of the world, are not complete or are deficient to determine, fully, whether a multiplicity of approaches is required. Since today's science is incomplete, the identification of which situations require multiple approaches can be a temporary identification. In other words, the results of the empirical investigation tend to change in the light of new knowledge. Thus, the determination of whether multiple accounts are required or not can undergo a change as time goes by and it may not be possible to ascertain exactly which situations require

multiple approaches and which situations do not by looking at the empirical results of the scientific search as the pluralist stance articulates. Because of the possibility of this uncertainty, temporary determinations are able to promote inefficient debates about any given phenomenon because scientific research may achieve inconsistent or unhelpful empirical results on the phenomena over time.

For instance, let us assume that the empirical results display that the multiple approaches are required for explaining a complex phenomenon in a situation at time t_1. As scientific researches advance, I assume that they do, in a reasonable amount of time, say 10 years, let us also suppose that it turned out that a single approach does successfully account for the complexity at time t_2. On the other hand, let us also suppose that it goes back to a case such that multiple approaches are required to examine the matter under the light of novel evidence at time t_3 (say, after 10 years from t_2). Empirical results obtained at t_1, t_2 and t_3 indicate that we are confronted with a complex phenomenon that demands modification of the applied methodology, shifting back and forth between a single approach and multiple approaches. Methodology modification seems endless as long as scientists construct novel knowledge, find new evidence or make discoveries. Therefore, we have and will have methodological instability.

I think that inflexible methodology is beneficial to a certain extent. However, it should be kept in mind that the pluralist stance lines up with keeping all of the approaches at times t_1, t_2 and t_3 as long as they help account for the phenomena. The pluralist stance draws the portrait of a stance, which is against not only replacement of competing accounts but also integration of compatible approaches. In the light of novel data, adopted approaches can and should be modified if necessary; however, I think that having plurality in

sciences should be specialized for/directed towards a purpose. In other words, it should be strategical. This purpose should be a purpose beyond having infinitely many interesting arguments because scientific activity is not just a playground, where scientists entertain themselves. If you recall, the proponents of the pluralist stance have criticized monism for it stimulates unproductive, sterile debates on behalf of researchers because they are motivated by the commitment to their chosen theory or approach.

Those who defend monism may hit back at pluralism by claiming the same. That is, the pluralist attitude is detrimental for it may lead to losing sight of the larger context, the target, etc. Proponents of the pluralist stance also criticize monists and modest pluralists who think that there is a single, best explanation for every phenomenon (Kellert et al., p. xii). I argue that a modest pluralist may respond to the pluralist stance by claiming that there can be a single, best explanation for every phenomenon but this explanation does not have to be the same type of single, best explanation as monists seek. Here, I like to draw the attention to the adjective 'best', attributed to explanation. Rather than focusing on "the single, best explanation", focusing on best explanation seems to me more reasonable.

For example, it is better if we think of a biological phenomenon with its own history. Every phenomenon goes through different stages during its life, say, from being an embryo to an adult. The single stages in the phenomenon's past do not necessarily have to be in harmony with each other (because there is an ongoing change). Hence, a detailed account or description, which we mean by explanation, of various stages in a phenomenon's history may differ. Each stage has its own explanation, especially given the possibility of contingencies or other emergent elements there can even be multiple explanations within each stage. Since

phenomenon's unique story, which makes the phenomenon 'that' phenomenon, is the totality of different stages, and since each stage has its own explanation, the overall explanation of the phenomenon of interest will be comprised of different sub-explanations, each describes the stages through which the phenomenon has been. The phenomenon would then be best explained if all the sub-explanations were adequately given. Its "bestness" depends on how good the sub-explanations are, though.

When it is considered that there are different stages in the phenomenon's past, it is apparent that the explanations change with the stage shift. It seems unlikely to have a single explanation, which adequately capture all of the facets of the phenomenon all at once. At time t, the explanation *x* adequately provides account of the phenomenon for that moment. After a while, the explanation *y* does. The big picture, however, is composed of the sum of (different) explanations. It is an explanation with parts, which are probably not reducible, most of the time. Furthermore, given the fact of evolution, the big picture most probably undergoes a change through time. Therefore, I think that to be able to give the best explanations seems more important than to be able to give *the* single explanation in most cases for us to understand the nature of the phenomena.

3.2. Possibility of Epistemological Disorder

Now let us go back to the previous discussion, which was started earlier in the section 3.1. Consider the following question: what does having infinitely many arguments, competing and compatible – present all together without a purpose, gain us for the sake of science? The pluralist stance or a more

radical form of pluralism would naturally utter that it is beneficial for the advancement of knowledge. However, it is also possible that keeping compatible and competing arguments, accounts, models, etc. without replacement or integration will create a sort of epistemological disorder or confusion and interruption of focus. Therefore, both forms of radical attitude in monism and pluralism can have mutual effects.

Since phenomena with which we are concerned are complex, they comprise nested layers, which may have been interacting internally or externally. The fact that scientists work on the individual layers of the complex system implies that they are interested in different aspects of the complex situation. Therefore, which analysis is the best sometimes revolves around the interest of the scientist. Given various interests, there may be more than one single correct analysis about the aspects of the same phenomenon. Despite that, I also think that every phenomenon has a unique past and scientists cannot just go into laboratories and create facts as they like. The unique, causal story is a totality of causal relata for that phenomenon to occur as it is now. The phenomenon may have been through different stages. Different factors may have influenced the entire process. Nothing comes out of nothing; every natural phenomenon has a unique story. Consider biological phenomena, for instance. Contingencies, mutations that possibly may have occurred, genes, environmental factors, etc. are in part responsible for the biological phenomena throughout their lifetime.

Most of the contemporary biologists centre on the role of genes to explain complex biological phenomena (including its causal history, e.g. the causal factors). If a more comprehensive alternative addressing the complex phenomena from a different perspective than the genic perspective is developed, the former approach is usually dropped since the new approach

embraces the subject in a broader way, to wit, it provides more answers regarding causal factors. I think that both approaches should be kept *because* they may meet different intentions about the same inquiry. Perspectives are different: one is genic and the other one is nongenic. Having multiplicity of approaches can be useful to incorporate knowledge about different causal factors of the same phenomenon, which eventually brings its causal story to light.

The pluralism I defend here is a sort of modest pluralism in the sense that it acknowledges epistemological and methodological pluralism in order to flourish (novel) knowledge as much as possible. I do not think that being open to multiple approaches in investigating natural phenomena would be wrong to a certain extent; however I think that scientists should be open to multiple approaches or theories in investigating natural phenomena only on the condition of avoiding the loss of knowledge, not inviting some sort of disorder into scientific territory. The presence of competing and compatible accounts, theories, etc. without replacement or integration as the pluralist stance advocate may induce a sort of epistemological disorder and muddy the waters of useful activity in the search of story of the phenomenon.

Pluralist stance does not explicitly say that they are against any monist attitude, but it seems to me that it assumes it anyway; because it is not enthusiastic about any sort of resolution between different approaches as an outcome of the empirical investigation, resorted to determine which approach to follow. This is another reason why I think that the pluralist stance invites some sort of epistemological disorder into scientific territory. First, it encourages looking at empirical evidence to determine whether multiple approaches are required to explain the phenomena. Then, it stays distant (or unsympathetic) to any sort of resolution between different approaches. What

I mean by staying distant to any sort of resolution is that the pluralist stance does not seem to encourage any form of monist call as a conclusion that could possibly come out of the empirical investigation. It does not seem to favor any occurrence of a monist call; neither before the empirical investigation nor afterwards.

Then, what we have at hand is plenty of approaches, varying from compatible to contradictory territories. The pluralist stance says that all sorts of knowledge should be kept for the sake of their plausible explanatory value. However, unless it tells us something that makes sense for us to understand and explain the phenomena, unless it contributes to our comprehension of the phenomena in an adequate way, what is the point of having this amount of knowledge at hand, all at the same time? If it is true that there is one correct account of the causal history of every entity, the gained knowledge tells us something about entities regarding their single causal story either this or that way. Incorporation/integration of knowledge is or will be possible, then, when all the conditions are met. The pluralist stance, not welcoming or doubting the possibility of resolution anywhere is not different from a sort of epistemological disorder.

I have just mentioned the possibility of integration of knowledge. The integration does not have to be unificationist, reductionist or fundamentalist. If so, in order to avoid some kind of disorder or obfuscation in scientific territory, we must adopt a form of modest pluralism. By that, we profit by the pluralist attitude in flourishing novel and different knowledge and we can link them to a conclusion rationally. In order to support my point, I will introduce and discuss Mitchell's integrative pluralism as example of modest pluralism in the next section.

3.3. Critique of the Incompleteness of Science Argument

I have stated that monists, however, may pose a challenge against the pluralist stance by bringing forward the incompleteness of today's science. At first glance, this is a very appealing challenge. However, it can be ruled out for the following reason that scientific theories are never complete. In other words, they are never completely determined by what they achieved. One might try to repair the challenge, by claiming that the ideal of the ultimate aim of science will be met when our cognitive capacities are free of any constrains.

Nevertheless, I think that this repair is not working for two reasons. First, if our cognitive capacities are now limited and will be completely limitless one day, that means that we are not competent to say or know that today's science is incomplete or will someday be complete or it will not be complete, because this still is an open question until our capacities are entirely limitless. This is in favor of the pluralists' assumption. That is, whether a single account in principle can entirely explain the natural world or the part of the world being investigated should be an open empirical question.

Despite acknowledging limited cognitive capacities, to insist on adopting a radical agnostic stance about the incompleteness of science would be irrational. Even though we may not be competent to know whether science will be complete one day, this does not affect any scientific endeavor, hinder any scientists to perform their duties. Today in science there are many issues waiting for an elucidation. That is to say that there are incomplete cases. In the case of multiple approaches that are required to explain the phenomena, modest form of pluralism should be adopted for the reasons I discussed in the earlier paragraph.

Second, because there is a continuous change in natural world, completeness of cognitive capacities or science may not even be in question. In addition to continuous change, drastic or not, there is the possibility of evolutionary contingencies in future as there were contingencies in the past. It is hard to make a prediction already now about how the natural world will be in the future. For example, consider the possibility of extraterrestrial lives. Who knows, perhaps one day the mundane beings and extraterrestrial beings start to interact one another very intensely and change the natural laws drastically?

In other words, it is likely for some natural phenomena to be always nebulous. Therefore, we would better have suspicion about fixed views on the subject. Different but correct analyses can possibly be proposed. In addition, contrary to the proponents of unification, a unified theory to explain the causal story of phenomena may not be forthcoming. This is in favor of pluralists, too. However, for the same reason stated in the above paragraph, continuous change would not impede scientists from seeking answers. So long as there is a lack of compelling evidence, to seek best or the most comprehensive explanations for the phenomena is under consideration.

3.4. Possibility of the Best, Comprehensive Explanation

Despite the possibility that for instance some phenomena may always stay nebulous because of continuous change, it is possible to account for simpler phenomena, like, ice, stone comprehensively. In addition to this, I like to draw the attention to a possibly true case regarding biological phenomena. Perhaps, for some biological phenomena, a comprehensive explanation can

be possible largely. Today, science provides viable evidence for us to be certain about the fact of evolution, which makes most biologists accept that biological phenomena can be accounted for evolutionarily. However, we also know that there are some phenomena, which do not have an impact on solving adaptive problems such as survival or reproduction but still exists for a minor purpose.

To put it more precisely, let us consider the phenomenon of appendix, which is not an extinct phenomenon but its presence is not necessary for life. It is a very small rudiment and because of being small, it does not cost much for the organisms to maintain it in their systems. That is probably the reason why appendix is still present and probably a little selection is on to minify it. It seems to me that understanding causal stories of the aspects of the phenomena such as appendix is easier for scientists since drastic changes and contingencies in future are unlikely to occur for such phenomena as far as we know. That implies the possibility that the best, comprehensive explanation can be given for appendix by looking at its actual situation.

The phenomena such as appendix still provide valuable scientific knowledge about facts of the natural world because they are helpful for us to understand the world, obtain further scientific knowledge and use them in predictions or explanations for other cases of evolution. In other words, they contribute to the progress of science to a certain extent. This best explanation does not have to be fundamentalist, reductionist or unificationist. There can be cases in which the best explanation is unificationist but it does not necessarily have to be unificationist all the time. Therefore, to comprise both unified and nonunified explanations concurrently within a locale encourages us to adopt a form of modest pluralism instead of the pluralist stance.

For instance, Mitchell's integrative pluralism approves theoretical pluralism. However, it demands integrated explanations. The pluralist stance does not approve integration, positing its impossibility. Nevertheless, as I discussed the pluralist stance seems not different from a sort of epistemological anarchy and vulnerable to the claim of incompleteness of today's science, adopting a modest form of pluralism is more rational. Now, I will continue with presenting integrative pluralism.

CHAPTER 4

INTEGRATIVE PLURALISM

The reason why the pluralist stance is different from modest versions of scientific pluralism is that "it acknowledges that there may be no way to integrate the plurality of approaches or accounts in a science" (Kellert et al. 2006, p. xiv). However, there are some ways for integration of different accounts or approaches within a science. This section is about one of these ways, displaying how integration is possible, at least in biology. In addition, integration is defended in the absence of a grand unified theoretical framework.

In order to illustrate the possibility of integration, Mitchell's arguments regarding compatible pluralism will be examined. Mitchell thinks that compatible pluralism is more flourishing than competitive pluralism in science. Unlike the proponents of the pluralist stance, Mitchell acknowledges that it is possible to integrate the plurality of accounts in a science. She establishes her argument as the following: First, she criticizes "the Levels of Analysis" argument, by Sherman (1988) as an illustration of "a pluralistic account of biological explanations" (Mitchell 2003, p. 199) "to show that the levels-of-analysis model of compatible pluralism is mistaken" (p. 210).

Second, she argues for an alternative. That is, the explanations for division of labor in social insects display the possibility of integration of explanations from different levels, and even without unification. Before analyzing Mitchell's integrative pluralism, let me begin with an evaluation of how she defends pluralism as a fact in science.

4.1. Reductionism: Not Forthcoming

As scientists and philosophers, we all engage in a unique world in our endeavors to understand and explain it. The unique world of interest is the world in which we live. Those who look at the world from a reductionist point of view about its constituents in general look for contingency in representations of its features and explanations of the patterns of the phenomena being observed in this single world. Moreover, those who are reductionist about the constituents of the world demand "intertranslatibility" between scientific theories or "derivability" of them from one fundamental description in the end (p. 181).

Mitchell (2003) indicates that the ground for accepting reductionism is based on a "metaphysical assumption, namely, compositional materialism", which says that every composite entity is made up of physical matter (p. 181). Complex materials are made up of "simple components" and "composition functions" (p. 181).

> So if atoms make up molecules, and molecules constitute chemical elements, and elements make up different types of material objects, and material objects are the parts of the cells, and cells make up organisms, and organisms make up societies, then if we understand atoms (or quarks or whatever

> we take as fundamental) and how these combine to form less fundamental objects, that should suffice. Scientific truths of biology then could be restated as truths about chemistry, those in chemistry in terms of physics. So the reasoning goes. (p. 181)

Understanding the fundamentals via the most fundamental level is adequate to understand "the causal interactions responsible for all changes of state" according to compositional materialism (p. 182). However, Mitchell specifies,

> [i]f we endorse the doctrine of causal completeness, then while descriptions, explanations and predictions in a language of biology might be convenient (and true, if translatable or reducible to the fundamental level of representations), they are not necessary. (p. 182)

Compositional materialism implies that there is a logical composition relationship between entities in our scientific theories. In other words, the principle of causal closure runs. However, Mitchell rejects reductionism for all cases based on a more comprehensive analysis of the nature of scientific representations. While she acknowledges the basic assumption that compositional materialism holds (namely, all entities are made up of matter), Mitchell thinks that by resorting to views of Cartwright (1994) first and Bechtel and Richardson (1993) second, by causal completeness as a ground for reductionism can be weakened.

Even though there is a possibility for every event to be a part of a causal network, it still is possible that some constituents of the complete cause cannot be fully explained by a single theory in physics. Cartwright holds the view that "the local, contingent constituents of every causal

process" are always neglected "in the scope of physical theory" (Mitchell 2003, p. 185). Hence, Mitchell states,

> [t]here may well be causal closure at the level of physical entities, while there is always incompleteness, or causal openness, in the representation or theorizing about those processes, the representations that make up the physics entities. (p. 185)

I think that the idea of the possibility of incompleteness or causal openness legitimizes the contention that scientific theories are idealizations or abstractions at the same time. If the idea of incompleteness or causal openness is capable of developing with invulnerable evidence from science by philosophers of science (philosophers of physics especially), then I think multiple theories might be required in order to account for the same set of causal factors of physical phenomena and events, even in physics. If different accounts explain one or two aspects of the same causal factor (but not all of the aspects, all at once), those multiple explanations might be integrated while unification would not be required.

In addition to Cartwright's view, Bechtel and Richardson bring forward an idea, which enfeebles the connection between causal completeness and reduction. Their idea is constructed upon the view that "there are two aspects to composite, complex objects or events: the material and the manner in which the material is arranged, matter and form, or material and structure" (p. 185). Thus, Mitchell specifies that "in fact, as Bechtel and Richardson (1993) suggested, there may well be a continuum of contributions from matter and structure that actual causal processes occupy many different locations" (p. 185). By invoking this proposal, Mitchell claims that structure is either comprised at the physical level or is "a

continuum of contributions from matter and structure such that actual causal processes occupy many different locations" (p. 185). In both cases, structure is causally significant. Both of the possibilities contravene the metaphysical assumption that causal completeness requires reduction to purely physical level because

> [w]ell, if the physical level is construed only materially, then structure is a level up and causally significant. Hence, causal closure is false. If, however, structure is included in the physical level, then macro objects are physical and closure applies to a collection of micro and macro objects and events. Either way, reduction to a purely material physical level is thwarted. (p. 185).

Unlike reductionists, Mitchell thinks, "reductionism does not capture the realities of scientific inquiry" (p. 182). I think that splits between reductionist and anti-reductionist positions seem to emerge from the clash between theory and its practice in reality. The reason of the clash between theory and application is that "scientific representations are abstractions or idealizations" (p. 182).[1]

In other words, scientists theorize first. While they are theorizing, it is likely that they fail to notice or consider some empirical evidence because of two reasons. First, science is incomplete, as most of the monists would defend. Second, there are different scientific interests. In scientific activities, choices (between empirical evidence that are used for grounding certain scientific knowledge to account for some phenomena or so) are made within (or according to) particular scientific understandings, perspectives,

[1] Also see Cartwright (1980, 1982, 1989, 1994); Dupré (1983, 1993, 1996); Wimsatt (1987).

worldviews, traditions, so on. No knowledge is groundless (either there is a history behind it or some may say that there is an intuition).

Either way, scientists construct their scientific inquiries upon a certain form of scientific comprehension (no matter how it is incommensurable with other forms of comprehensions) that belongs to a scientific community or tradition even though each member might act out of dissimilar understandings of the world at the individual level. Given the incompleteness of science and various scientific interests, some evidence that could be empirically crucial is overlooked while theorizing. If so, I think that theories (especially those are hinged on a single theoretical framework) may then be inadequate to capture the reality entirely.

Secondly, when they theorize, scientists apply their theories that they develop to identify the features of the phenomena they observe. However, the possibility that the actual structure of the world might be dissimilar from how they theorize it engenders polarizations between standpoints because theory and reality are probably different from each other because of not only the incompleteness of today's science but also the complexity of the phenomena being investigated. Perhaps, some complex phenomena (especially those in biology) require the elucidation of multiple causal factors in order to be adequately captured. This implies that theories should be understood as representing partial features of phenomena of interest. In Mitchell's words,

> [a]ctual, complex events or concrete individuals – the constituents of the one-world ontology – are, at the same time, instances of objects of multiple abstract theories concerned with different compositional levels. Reductionism requires replacing the higher-level abstractions by lower-level ones. Yet the abstractions, which constitute theoretical objects at the different levels, do not constitute identical representations across levels. That is, even if the descriptions

> at the various levels are all accurate, by being partial they may not be representing the same features of nature and hence would not stand in any straightforward derivability or intertranslatibility relation, nor form a neat, nested hierarchy. (p. 182f)

Therefore, I think that different explanations at theoretical and practical levels might be inescapable, moreover required in terms of pragmatic concerns. Science seems to draw an anti-reductionist picture because of multiple theories, models and explanations about the similar set of phenomena. Moreover, contemporary biological sciences come up with some robust evidence, implying that anti-reductionist stance is very appealing at least at the explanatory level. The question now should be to what extent pluralism in science should be endorsed.

4.2. Pluralism in Contemporary Biology

For Mitchell (2003), “the fact of pluralism in science is no surprise” and the question is what kind of pluralism should be adopted (p. 208). Her proposal is a form of pluralism that recognizes integration of compatible explanations without unification. After asking “yet, if science is representing and explaining the structure of the *one* world, why is there such a diversity of representations and explanations in some domains?”, Mitchell emphasizes that the complexity of the biological phenomena generates the explanatory and representational diversity (p. 208). Biological phenomena are complex for they are evolved systems, having many characteristics made up of several components and levels. Due to the complexity of biological phenomena and explanatory diversity, some philosophers of biology seem to develop an anti-

reductionist consensus today. The consensus is described in Mitchell (2003) as,

> [a] simple derivability relationship between accounts of macroscopic phenomena (organisms, minds, societies) and accounts of microscopic phenomena (cells, molecules, atoms) of the kind long advocated by many philosophers of science is inadequate to capture the rich variety of relations among the results of scientific inquiry. (p. 180)

Therefore, the complexity of biological objects ends up with giving rise to a plurality of theories, models, and explanations in today's science. Before defending integrative pluralism as the right type of pluralism, Mitchell shows why the pluralisms defended by Dupré (1983, 1993, 1996) and Paul Sherman (1988) fail even though they both aim to defend anti-reductionism.

The reductionism discussed above was understood as a requirement of compositional materialism. Defending a "weak, compositional materialism", which approves of anti-reductionism, Dupré argues against the idea that "causal closure is a doctrine about sufficient cause" (Mitchell 2003, p. 183). Dupré's thought-experiment for reconstructing the reductionist assumption goes as follows:

> Consider an electron in my index finger. As I move my finger to type the letter b on my keyboard, the electron must move. Causal completeness at the level of elementary particles implies that there is some condition of events at that level sufficient to explain the movement of the electron. Suppose, then, that I offer some causal story at the macroscopic level about the movement of my hand. For example, suppose my hand moved because I intended to type the letter b, or, for those who deny that this is a causal explanation, suppose that my finger was dragged down by my typing instructor. Either story, if it explains the movement of my finger, also entails the movement of the

> electron. At the microlevel, meanwhile, there are presumably sufficient causes operating on every elementary particle in my finger. The causal efficacy of events at the macrolevel had better at least be consistent with all these billions of microlevel causal facts. (p. 100)

His thought-experiment illustrates "a powerful argument, and one that sits behind many contemporary defenses of some form of reduction. In the face of it, many have promoted what Dupré correctly identifies as a weak form of reductionism, namely supervenience" (p. 184). However, Dupré (1993) aims to defend that causal completeness at one particular level is simply mistaken. Therefore, reductionism is mistaken (for it hinges on causal completeness in terms of compositional materialism). Causal completeness at one particular level is mistaken because "a central purpose of the ontological pluralism [he has] been defending is to imply that there are genuinely causal entities at many different levels of organization" (p. 101). He argues that reductionism is implausible in certain cases in biology and psychology because of ontological plurality. However, Mitchell states that Dupré's arguments are only case-based. More importantly, the cases that have been selected from biology and psychology in order to show the failure of reductionism are cases in which reductionism is unavailable indeed (p. 184). "It does not show that it [reductionism] is *in principle*" (p. 184). Consequently, Mitchell argues that the pluralism Dupré defends fails.

4.3. Necessity of Rational Metaphysics in Science

Apart from Mitchell, I hold the view that physical ontology (i.e., matter, substance, whatever it is called) is one. However, some may pose a challenge

to metaphysical monism by claiming that it is very hard to define metaphysics, first of all. Therefore, the comprehension of metaphysical ontology may not be clear if there is a descriptive vagueness of metaphysics. Here, for example, I must specify that we should not understand metaphysics as about things that do not change, as Aristotle understood. Furthermore, metaphysics is understood as the study of matters that transcends mundane concerns by contemporary scientific position from which natural phenomena are considered or judged. Neither physics nor biology is interested in studies going beyond the physical, phenomenal world because science endeavors to elucidate physical ontology. Nonetheless, in philosophy it seems that among thinkers today there is no consensus about the current conception of metaphysics.

Some pluralists like Suppes, Dupré, etc. consider that science depends on metaphysical assumptions. As philosophers of science, we should technically understand metaphysical assumptions as theoretical abstractions about all the reality, which are idealizations of theoreticians. Science has mundane concerns and its interest is in physical beings (including chemical and biological entities). Epistemically warranted beliefs constitute the target of the scientific practice.

Kellert et al. defend that “science has not and will not provide reliable answers to many of the big, interesting metaphysical questions” (p. xxiv). I think that some may pose a challenge to their defense with the claim of impossibility of metaphysics. Impossibility of metaphysics has been argued in weak and strong forms in philosophy since Hume. Metaphysical statements are considered as either meaningless or meaningful but their truth or falsity (probability or improbability) cannot be discovered by human

mind.[2] If metaphysics is impossible, then seeking answers for the truth or falsity of metaphysical statements is no longer a subject matter.

However, I think that rational metaphysics –metaphysics about the world that we perceive, which is regularly supported by empirical evidence- regarding 'what is reality', is required in order to avoid poor research in science. If there is a failure of science in providing reliable answers to some big metaphysical questions as the proponents of the pluralist stance claim, I think that the failure does not belong to science but to theoreticians because our models are "idealizations and as such map onto an ideal world rather than the real world" (Longino 2002, p. 180). If we can understand and analyze the real world correctly by looking at the empirical results, we can understand the nature of reality and the rules that govern the reality. Rational metaphysics helps us construct better theories about the phenomena we observe, the real world. When theories are tested with the appropriate science, we would be testing our theories about the reality at the same time.

Although acknowledging that the physical ontology is one, I also acknowledge that the episteme of some complex phenomena can be made up of multiple compatible explanations, which are not reducible or unifiable. In order to understand scientific pluralism better, now let us look at the distinction between competitive and compatible pluralism.

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[2] For example, A. J. Ayer in *Language, Truth and Logic* concluded that metaphysical statements are meaningless, invoking the verifiability theory of meaning. Alternatively, logical positivists argued that metaphysical statements could not be either true or false; hence, this made them meaningless so they should be ignored. In addition, I. Kant in *Critique of Pure Reason* distinguished noumena from phenomena. "… our own faculties of representation … determines how objects must be – at least when considered just as phenomena, i.e., as objects of experience rather than as noumena, i.e., things-in-themselves specified negatively as unknown and beyond our experience, or positively as knowable in some absolute non-sensible way - which Kant insists is theoretically impossible for sensible beings like us." (Audi 1999, p. 462f).

4.4. Competitive vs. Compatible Pluralism

Mitchell (1992, 2002) and Mitchell et al. (1997) indicate that the distinction between competitive and compatible pluralism draws a comprehensive framework of scientific pluralism. Competitive pluralism can be understood from two perspectives. From one perspective, competitive pluralism is the view that understands competing hypotheses as the representatives and focal points of pluralism (Mitchell 2002). Many of the recent philosophers of science take pluralism into consideration in this sense, (except Cartwright 1994, Dupré 1993, 1996, and Hacking 1996). Pluralists prefer the presence and persistence of competition in various scientific domains because competing theories or approaches are believed to contribute to the scientific progress (Feyerabend 1981, Lakatos 1978) so that each individual account can be tested against falsity or impotence of empirical evidence, which is used to account for the same set of phenomena. From this perspective, the more the falsity or impotence of empirical evidence is exposed within and among competing accounts, the more science is believed to progress.

From another perspective, Mitchell (2002) specifies that competitive pluralism is understood as a strategy, which is used against falling into the ambush, called empirical uncertainty since it is uncertain that current epistemological accomplishments will always be retained, as they are (Beatty 1987, Kitcher 1991).

Both forms of competitive pluralism seem to follow one strategy. Mitchell (2002, 2003) points out that the proponents of competitive pluralism seem to assume that there is an ultimate aim of science. The war of oppositions between ideas will be over with the winning theory in the end. Mitchell (2002) argues that this account of the competitive pluralists is

unsuccessful at accurately characterizing every different, current model and explanation in contemporary science. For instance, some diversity in biology can only be captured by compatible alternatives. Accordingly, she advocates compatible pluralism.

4.5. 'The Levels of Analysis' Argument

Excluding the competitive pluralism, Mitchell considers what sort of compatible pluralism should be adopted. Regarding this, several arguments have been developed based on a "level of analysis" account of the plurality of theories and explanations. The level of analysis account went through the following steps. First, Mayr (1961, 1982) made a distinction between "ultimate (why)" and "proximate (how)" questions "in the face of the possible encroachments of genetics into whole organism biology" (Mitchell 2003, p. 186). This distinction aimed to "protect the autonomy of separate biological traditions from a perceived threat of reduction and elimination (Beatty 1994)" (Mitchell 2002, p. 57). After Mayr, Tinbergen (1963) articulated four different questions in order to comprehend the nature of biological phenomena (Mitchell 2002).

Next, Mitchell (2003) expresses that Sherman and more recently Reeve and Sherman (1993) restored the effectiveness of Tinbergen's model by subdividing "the four 'levels' of questions that partition biological research" (p. 186). According to this restoration, levels such as "evolutionary origins, functional consequences (the two "why" questions), ontogenetic processes and mechanisms (the two "how" questions) constitute the categories of the analysis (p. 186). Regarding Sherman's subdivision of

questions, Mitchell and Dietrich (2006) add, “naturally, questions at different levels require different answers. In some sense, the questions are not addressing the same problem, and hence, the answers cannot be taken as competing” (p. 77). Thus, competitions are bordered within each individual level. Furthermore, each different answer to questions posed at the different levels is understood as standing for “compatible components of a multidimensional body of biological knowledge” (Mitchell 2003, p. 200). Theories seem isolated level-to-level; hence to bringing explanations forth for inter-theoretical relations among the levels is not a requirement (Sherman 1988, Mitchell 2003).

Before moving on to introduce Mitchell’s reasons to prefer integration to isolation, I want to refer to a point that compatible pluralism in science can be feasible more than we think. To say it clearly, some sort of compatible pluralism can be valid in the sciences, which are thought less diversified like physics in addition to the sciences, which harbor much diversity like biology or ecology.

4.6. Possibility of Compatible Pluralism in Physics

In the first half of twentieth-century, Heisenberg and Schrödinger both employed different ways of describing quantum mechanics resorting to mathematics. Heisenberg used matrices when writing down the sets of properties whereas Schrödinger used the mathematics of waves. They applied different methods (i.e. formulations) and both interpretations competed for a while. Matrix mechanics and wave mechanics were then combined into the quantum theory, which is known as quantum mechanics. The introduction of

the quantum mechanics into the scientific field led us suspicions about traditional Newtonian physics of that time.

Today, studies for Grand Unification (viz., the quest for incorporating the fundamental forces (i.e., electromagnetism, gravitation, strong and weak interactions) via quantum mechanics) are profound; however, presently the best theory explaining the gravitational force, which is known as the general relativity theory, has not been integrated into quantum theory. Perhaps the gravitational force accomplishes the interaction in one way and the other three forces accomplish the interaction in other ways. It is a possibility that the hypothetical elementary particles known as gravitons that mediate the gravitational force in the framework of quantum field theory are never going to be observed at all (for instance, because of the possibility that gravitons do not exist) and the general relativity theory will not be unified with the quantum theory. Therefore, we may now have one correct account of the gravitational interaction and one correct account of other interactions. Perhaps this will always be the case.

The current situation in physics may entail the following: Different levels of analysis also for physical entities are required. Both accounts of interaction can be complementary or compatible at different levels of analysis and both can adequately account for at least some physical entities while unification is not required. There can be rival theories of gravitational interaction while different theories to explain electromagnetic interaction compete with one another. However, there is one correct account of gravitational interaction and of electromagnetic, weak and strong interactions. One the other hand, the best theory that explains the gravitational interaction at one level and the best theories that explains the electromagnetic, weak and strong interactions at another level all together

may capture the realities of the physical phenomena and the natural world adequately. That is to say that, the case whether a compatible pluralism without unification is possible or rather required also in physics should be open to considerations.

Nevertheless, we should admit that the case of complexity and diversity in physics is not as perplexing as it is in very complex systems such as biological or ecological systems. However, since our models about gravitational interaction are products of our abstractions, when we are applying them into the actual world, we may end up with partial accounts about the ways in which elementary particles and bodies can influence each other. Therefore, we should bear in mind that it is important if we discover or develop new ways of thinking about scientific facts, as philosophers.

4.7. Critique of Isolationist Stance

Based on the assumption that competitions are only intra-level, Mitchell states that an isolationist stance of levels of analysis can be fostered with respect to the separate analyses in extreme cases. Isolationist pluralism implies separateness of theories and no interaction between them. However, the isolationist picture of compatible pluralism is vulnerable for two reasons. First, its presumption "explanatory closure *within each 'level of analysis'*" can be attacked (p. 187). Different levels may involve causally dependent and interacted processes. However,

> [r]emaining within a single level will fail to provide understanding for the questions addressed *even at that level* (Bechtel and Richardson 1993). Thus, the division of levels of analyses, different questions with different answers, could

> be mistakenly interpreted as a justification for unproductive heuristics for scientific investigation. (p. 187)

Accordingly, also secondly, since to account for intertheoretical relations is not required, isolationist compatibilism can be challenged by an assertion that it gives rise to unproductive debates because it presupposes

> [a] narrowness in scope of scientific investigation that precludes the type of fruitful interactions between disciplines and subdisciplines that has characterized much of the history of science (see Darden and Maull 1977). (p. 187)

The case that is narrowing the scope of scientific investigations down to a level only as isolationist picture of compatible pluralism requires is an avoidable case, according to Mitchell. Theoretical models and their applications should be evaluated distinctively. Theoretical models are idealized models; in addition, they are supposed to explain real cases. However, they might be applied to concrete, nonideal cases to explain real cases. Ideally, noncompetitive answers among different levels might be expected; however, in reality it is seen that answers given to questions at different levels are related because of possible interactions between the components of the complex systems.

4.8. Critique of the "Levels of Analysis" Argument

Mitchell (2002) finds Sherman's level of analysis inadequate to describe the relations between alternative explanations because she thinks that Sherman's analysis misidentifies the location of conflict. She says,

> [t]he mistake of the levels of analysis approach lies … in the assumptions made about the epistemological structure of the answers. That is, scientific explanations often are causal explanations, identifying the set of conditions that give rise to the phenomenon of interest. At the same time, complex phenomenon harbors multiple interacting causal processes and multiple levels of organization, which all may be involved in the generation of the feature to be explained. By disambiguating the question to be answered by an explanation – i.e., what is the evolutionary origin of a trait or behavior we observe now – one is still left with a plurality of potential causes acting at a number of levels of organization, which may well constitute compatible answers to that single question. (p. 57)

For instance, several component causes may play a complete or partial role in the evolution of the complex trait *t*.[3] Mitchell (2003) expresses two possibilities for a complex trait *t* in population p to occur. First, *t* may have been fully determined by any single causal process. Second, any single causal process may have been responsible for *t* only to a degree. In other words, several causal processes may work on *t* interactively.

In general, natural selection plays the leading part in the construction of theories about causal processes. However, Mitchell (2003) specifies that Stuart Kauffman (1987, 1993) displayed the possibility of other alternatives. Kauffman's random *NK* Boolean networks model for complex systems was developed to "show what kinds of orders emerge 'spontaneously' in complex systems" (p. 204). Kauffman's model is based on the assumption that

[3] See Mitchell (2003), for details of component causes: "direct selection for the adaptedness of the trait", "indirect selection of part of adaptive complex", "nonselective explanations", e.g., Chance, migration, mutation, direct environment modulation and developmental laws of form, p. 203f.

"developmental causes may be responsible for the presence of traits *despite* the operation of selection" (p. 204).

For instance, Page and Mitchell (1991) show that some traits may be results of spontaneously arisen properties in case of complexity (despite that they are thought as products of direct or indirect selection) by employing Kauffman's model to "colony-level phenotypic traits of honeybees" (i. e., division of labor and task specialization) in order to boost Kauffman's alternative (p. 204).

4.9. Mitchell's Counter-Argument: Social Insects

There are several explanations of division of labor in social insects. Mitchell (2002) states that "division of labor in social insects refers to patterns of variation among workers within a colony in the task they perform (Oster and Wilson 1978)" (p. 58). Mitchell (2003) argues against Sherman's 'Levels of Analysis' argument in the following way: Consider a social insect colony such as bees, which exhibit such behavior as "cell cleaning and capping, brood and queen tending, comb building, cleaning, food handling, guarding to foraging."[4] (p. 210). The division of labor in the colony is not accidental. To put it differently, "a pattern of distribution of behaviors called 'age polyethism'" takes place.[5] This pattern shows that young and old individuals differ from one another in terms of work location. It is apparent that the

[4] Mitchell's note: See Winston (1987).

[5] Polyethism: Functional specialization in different members of a colony of social insects, which leads to a division of labour within the colony. The various functions may be carried out by individuals of different morphology (caste polyethism) or of different ages (age polyethism), cited from Michael Allaby. "polyethism." A Dictionary of Zoology. 2004. *Encyclopedia.com.* 5 Jul. 2009 <http://www.encyclopedia.com>.

pattern of the age polyethism is one of the most common explanations of division of labor in such social insects as bees. However, in ant colonies the situation is a bit different:

> Honeybee colonies harbor sufficient genetic variability among the workers to generate variant responses to stimuli (Calderone and Page 1992; Page and Metcalf 1982). Ant colonies, on the other hand, are generally not genetically diverse (but see Boomsma et al. 1999 for the exception in ants) and thus may accomplish the same sort of response flexibility by means of nest architecture (Tofts and Franks 1992) or some other mechanism. (p. 211)

In short, in different social insects, there is diversity with regard to solutions of the same problem.

The explanation concerning the division of labor in social insects that can be considered salient is the adaptationist explanation (Wilson 1971). The adaptationist explanation is "the patterning of work within a colony is analyzed to determine what would be optimal in terms of ergonomic efficiency" (Mitchell 2003, p. 211). Natural selection operated on the heritable variation paved the way for the present pattern, viz., the optimal, age-related one with specialization.[6] However, Mitchell (2003) argues that this adaptationist explanation of division of labor neglects "the mechanisms by which the pattern is generated" (p. 211). Such adaptationist explanation "implicitly assumes that however a phenotypic trait make come to be expressed, as long as it is heritable, natural selection would be able to optimize on variations of that trait" (p. 211). However, natural selection is perhaps not the sole contributing factor: "in particular, self-organization models of aggregate or emergent traits provide for the possibility that natural

[6] See Mitchell 2003, p. 210f.

selection alone is not the appropriate agent to explain some complex traits" (p. 211).

Since such monist explanation as adaptation is inadequate to capture the case of division of labor in social insects, fully, Mitchell proposes an alternative way to explain away the inadequateness and monism of that rather common sensical explanation. In order to be able to achieve her goal, Mitchell presents an argument from development, so-called "self-organization models [that] have been used to describe how microscopic physical and chemical processes give rise to macroscopic structures" (Mitchell 2002, p. 59). The aim of constructing self-organization models is to be able to account for the complexity of various traits, arising from "the interactions of individuals exhibiting only simple behaviours" (p. 59).

According to self-organization models, explanations of division of labor can be listed as "[1] individual genetic diversity, [2] hive or nest architectural structure, and [3] individual learning" (p. 60). Self-organization models undermine adaptation in the way that,

> [i]f individuals interacting generate some features of division of labor necessarily, … , then there would be no variation on the presence or absence of these features for selection to have operated on in the adaptation history of the populations (Mitchell 2002, p. 60)

Nevertheless, according to the self-organization model based on genetic diversity, "some aspects of division of labor can arise, indeed must arise, among groups of cohabiting and mutually tolerant individuals who harbor genetic variation" (p. 60). On the other hand, the self-organization model appealing to architectural structure, which is also known as Tofts and Franks' (1992) "'foraging for work' algorithm" (p. 61), basically states that due to the identical work algorithm of each individual and due to the

systematic structure of the nest architecture, “[a] pattern of division of labor coordinated to colony needs and age polyethism emerges” (p. 61). When it comes to such self-organization model as individual learning algorithm, it is apparent that each individual has identical learning algorithm and the birth of potential new workers is not simultaneous so that “[a] pattern of division of labor with age-polyethism emerges” (p. 62).

It is clear that these explanations are not the only possible explanations, and this brings us to the main concern of the critique of pluralism in science, in particular, the pluralist stance within the context of this thesis. For instance, how these explanations at different levels are related? Are they mutually exclusive or partially eliminable explanations? Is any sort of unification possible or is it rather required? What would these explanations stand for depending on which type of pluralism is adopted? Is the pluralism captured by these explanations vulnerable in terms of the incompleteness of today’s sciences and the challenge of epistemological disorder?

At this point, as it is clear that Mitchell argues that the possibility of competition between levels is plausible and that the possibility of competition within the same level is not plausible, contrary to Sherman. Regarding the relationship between these explanations at different and within the same levels, we can say that the explanations from different levels are not agreeable and the explanations within the same level should be agreeable. I think that this inference endorses the possibility that understanding of traits might require compatible explanations within each level for the sake of producing more realistic explanations regarding nonideal cases.

4.10. Integrative Pluralism

Explanatory simplicity is a desired notion in sciences, in general; however, "the pragmatic virtue of simplicity is most frequently bought at the cost of realism in explanations (Levins 1968)" (Mitchell 2003, p.188). The argument goes as follows: Given the complexity and diversity of phenomena and the assumption that scientific models are idealizations or abstractions, simple accounts may capture the reality only to some extent. The simpler the model, the less complete it is due to partiality of representation or capture. In order to come up with further realistic explanations, advancement of less simple models should be encouraged. This argument lays the groundwork for "a pluralism of models of causal processes that may describe contributing factors in a given explanatory situations" (Mitchell 2003, p. 189). Now the question is how to integrate the idealized models into explaining concrete, nonideal cases.

It has been specified that scientific theories are idealizations and abstractions. Cartwright (1980) also indicates that *ceteris paribus* clauses give form to fundamental scientific laws. *Ceteris paribus* clauses "describe what is to be expected in idealized situations, when only one of a set of potential causal factors is operating, that is, when nothing else is interfering" (Mitchell 2003, p. 188). Ceteris paribus is a motto for unrealism in a sense. There is an ideal world that scientists construct on the one hand; on the other hand, there are nonideal, real cases. As Mitchell states, "[i]f we accept that multiple causal factors can, and often do, interact in the production and the maintenance of human cultural practices, that the real cases are complex without the ceteris paribus proviso, the laws would be literally false" (p. 188). Or else, our explanatory models are partial. Moreover, some scientific

models fail to represent some components that are essential to elucidate some concrete events. Pluralism in science that Cartwright advocates hinges on a patchwork relationship among idealized theories and models. She says, "nature is governed in different domains by different systems of laws not necessarily related to each other in any systematic or uniform way" (Cartwright 2000, p. 289).

Acknowledging Cartwright's approach to compatible pluralism, Mitchell indicates that more conclusions can be drawn than what Cartwright has depicted, regarding the patchwork relationship of compatible pluralism. Moreover, Wimsatt (1987) adopts the view that idealized models are simply wrong. However, he thinks that it is possible to convert false models into true theories by adding assumptions that are getting closer to reality.

> Thus, while one might start by seeing what pattern of worker behavior would be generated by genetic diversity alone, one could subsequently combine that model with one that also included the results of learning. This second-generation model would still be ideal, but suggest a strategy of asymptotic approach to a non-idealized representation of the system. (Mitchell 2002, p. 65)

Mitchell thinks Wimsatt's model enables integration of explanatory components; nevertheless, there are other ways for integration.

So far, it has been seen that Mitchell argues that Sherman's construction of level of analysis model of compatible pluralism is mistaken on identification of where to locate the conflicts. She develops an alternative view, *integrative pluralism*, which is opposed to both reduction and isolation. Integrative pluralism represents the relations in science in a better way. Pluralism in science at the theoretical level is more promising than monism. However, when it comes to the concrete explanatory level, integration of

multiple explanations within the same level is not only more promising but also is required for the sake of better scientific conduct. Mitchell and Dietrich (2006) contend “the explanations of complex phenomena in biology regularly integrate phenomena across levels” (p. 78). Therefore, one needs integration of a number of accounts to explain a concrete biological particular; however, a comprehensive unification at the theoretical level seems not capable of being accomplished due to historical contingencies. Contingencies pave the way for the diversity, which results as evolved complexity.

4.11. Integrative Pluralism without Unification

The intensive search for certainty and completeness, arousing the interest of scientists and philosophers has led them to debate the question “Is science unified or disunified?” over the last century. Concerning the unity of science, philosophers of science have asked questions like the following: within a particular science, is it possible to unify theories? Is it possible to unify different scientific disciplines into a single overarching theory/discipline? What is unification about? Is it about, e.g., concepts, terms, methods, rules and uses of languages, theories? Does unity always imply some sort of objectivity? When we talk about what is out there, do we talk about one single thing or different sorts of things? If what is out there is composed of different sorts of things, how are those related? And so on. The positions in favor of unity of science have privileged foci on scientific studies in natural sciences (especially physics). The positions in favor of unity extend to social sciences, especially to psychology, as well.

Interest in the unity of science goes back to ancient atomism and the works of the French Encyclopedists. This interest revealed itself as logical empiricism in the twentieth century. For logical empiricists, unified science was associated with a unified language of science, in particular, a universal observation language in the first place. According to this understanding, "all laws and theoretical statements were to be translatable into such an observation language, or else be appropriately related to sentences of this language" (Audi 1999, p. 939). Another understanding of unity of science regards the view that intertheoretic reduction of the theories of all non-basic branches to one basic theory merges all branches of science.

> These reductions may proceed stepwise; an oversimplified example would be reduction of psychology to biology, together with reductions of biology to chemistry and chemistry to physics. The conditions for reducing theory T_2 to theory T_1 are complex, but include identification of the ontology of T_2 with that of T_1, along with explanation of the laws of T_2 by laws of T_1 together with appropriate connecting sentences. These conditions for reduction can be supplemented with conditions for the unity of the basic theory, to produce a general research program for the unification of science. (Audi, p. 940)

With his works, the Vienna Circle's co-founder Otto Neurath has driven the unity of science movement in 1920s. Rejecting metaphysics, Neurath tried to draw a path for unified science, whose aim was to situate social sciences with a causal base similar to that of physics and chemistry in two-volume work, *International Encyclopedia of Unified Science*. However, the views that Cartwright and her collaborators (1996) offered in *Otto Neurath: Philosophy between Science and Politics* posed an alternative approach against the general comprehension of Neurath's the Unity of Science movement. They

claim that Neurath's views on the unity of science underwent a change and Neurath became uninterested in considering the traditional unified picture of the world, i.e., a unity of sciences at the theoretical level. Because, they say, Neurath was indeed anti-realist about scientific concepts and laws, displaying an implicit agreement with Weber's views on reality. Quoted in Stephen Turner and Regis Factor (1984), Cartwright, et al., specify Weber's views,

> … [r]eality consists of an infinitely manifold stream of event where analysis of infinite reality, which the human mind can conduct, rests on the tacit assumption that only a finite portion of this reality constitutes the object of scientific investigation. (p. 168)

Making an analogy between Weber's view on reality and how they depict scientific working, Cartwright et al. claim that Neurath acknowledged that "a unified picture is impossible" in terms of theoretical ends; however, "unification at the point of action is necessary" in terms of practical ends (p. 171).[7] In short, Cartwright et al. specify that Neurath's interest in unity had a purpose, which was to change the world. Lastly, Cartwright et al. quote Neurath (1946, [1983], p. 242):

> The unity we have before us, as a goal for the encyclopedism of logical empiricism, is based on the actual store of expressions which people have in common all over the world. Its evolution would be based on conventions, which

[7] Cartwright's and her collaborators' depiction of scientific working: "Science does not work by zeroing in on properties that are really there in the stream of events and that are causally (or nomologically) responsible for what happens. Rather science works by constructing concepts that we can deploy more or less well to grapple with reality in the ways we need. Different sciences have different concerns and different concepts are already historically given. Trying to fit these concepts into a single theory is a false ideal deriving from the mistaken assumption that they are all small pieces of a single picture. In fact they are not pieces of a picture at all" (p. 171).

> could never be definite or authoritative as far as the aspirations of conscientious logical empiricists are concerned. Pluralism is the aura of this scientific world community of the common man. The encyclopedism of logical empiricism … competes with no philosophy, and is anti-totalitarian through and through. (Cartwright et al., p. 255)

In addition to Cartwright et al.'s interpretation of Neurath's philosophy, the arguments for the disunity of scientific context developed especially by the Stanford School of philosophy of science with an appeal to empiricism seem positing a challenge against the arguments for the project, seeing science unified.[8] As specified earlier, Cartwright (1983, 1999) proposes a limited realism on nature and its laws. Rejecting the metaphysical assumption that there is a universal order, she also argues against that the universality of the laws of nature controlling or determining events. Instead, patchworks of laws and local cooperation govern them. The patchworks of laws and local cooperation stand for the idea of *a dappled world* in Cartwright's philosophy. Theories regarding the phenomena studied of this dappled world are theories that hold ceteris paribus laws, applying so long as their explanatory models agree with/fulfill/match the phenomena. Because of seeing the world patchy, a unified theory (in physics, hence in science) is unlikely to be developed.

If we turn back to the current situation in biology, it is apparent that there is a tension between unificationists and nonunifications regarding evolutionary synthesis in the neo-Darwinian sense today. While natural selection historically was holding the prominent status in evolutionary synthesis,

[8] The Stanford School of philosophy of science: P. Suppes, J. Dupré, I. Hacking, N. Cartwright and P. Galison.

> [a]s molecular biology rose in prominence in the 1960s, … , as biologists began to compare biochemical similarities and differences in order to make evolutionary inferences, they began to entertain the idea that not all molecular changes had been subject to natural selection. (Mitchell and Dietrich 2006, p. 74)

Mitchell and Dietrich emphasize that biologists began to attract the attention to possible alternative processes at the molecular level in the early controversies (p. 74).[9] Today most of the molecular biologists agree that neither neutrality theory nor selectionism theory cancels out one another. In other words, the rise of molecular biology partitioned "the domain of evolutionary biology into molecular and morphological levels" (p. 74). While it is considered that the neutrality theory accounts for the evolution at the molecular level better than natural selection, it is also considered that characters of organism's phenotype are explained with natural selection better at the morphological level. Levels of analysis are different; however, both of the theories are accepted compatible in evolutionary synthesis.

Contemporary biologists tend to endorse the recognition of multiple causal processes in the evolution of phenomena. They seem to encourage different types of explanations to be proposed for evolutionary phenomena at the molecular and morphological levels instead of looking for a unified evolutionary theory. The complexity and diversity of biological phenomena lead biologists to be pluralists in explanatory and methodological senses. "Unificationist approaches" do not provide :the explanations that biologists seek" (p. 76). Explanatory pluralism regarding some features of biological phenomena may refer to competing or (independently or collectively)

[9] See Kimura (1968), King and Jukes (1969).

contributing hypotheses in different contexts or at different times. Mitchell and Dietrich specify that even though analyses of competing hypotheses provide justification for some of the pluralism characterizing biological explanations, "not all explanations compete" in biology (p. 76).

To illustrate their point, they compare alternative hypotheses put forward about the origin of infectious diseases having a role in the recent amphibian decline. One hypothesis says that the pathogen is endemic while the alternative says it is novel. Although these two hypotheses compete, due to the complexity of the ecosystem, it is possible that quite a few factors such as "habitat destruction, climate change, increasing levels of ultraviolet radiation, environmental contamination, disease and the introduction of nonnative species" (p. 76f) are causative in the amphibian decline.[10] Each causal factor brings a new perspective into the debate to understand the emergence of the amphibian decline and even none of them would be superior to the other in terms of being the most important cause in explaining the decline. Thus, we have a plurality of pluralisms at hand: competing and compatible pluralism (e.g., individual or collective causal factors in the case of amphibian decline).

> This situation is typical of evolved, dynamically robust biological systems. The different hypotheses that scientists propose to identify causes of an effect of interest are more probably not solely determinant but rather contribute in context-dependent ways to bring about the effect. (Mitchell and Dietrich 2006, p. 77)

Generally, complex effects are composed of multiple causal factors. "Modeling each individual causal factor" is helpful to trace its possible

[10] See Blaustein and Kiesecker (2002)

contribution to a complex effect; however, integration of causal factors in multiple forms is required in order to “begin to detect the actual story” (p. 78).

CHAPTER 5

CONCLUSION

In this work, I scrutinized pluralism in science over the empirically based and modest pluralist interpretations. I benefited from Kellert et al.'s pluralist stance approach and Mitchell's integrative pluralism. The debate between monism and pluralism in science goes on. Pluralist attitude is considered as more beneficial for the advancement of knowledge in general. Kellert et al. advocate that we should adopt the pluralist stance in order to avoid the loss of knowledge, the explanatory inflexibility and unproductive debates. They also claim that integration of multiple accounts with each other brings about loss of content. I do not think that integrative pluralism would contradict with the goals of the pluralist stance. It fuels explanatory flexibility on robust grounds. I hope that I have shown that integrative pluralism draws a path for a better scientific conduct. Unlike the pluralist stance, it affirms the possibility of resolution at the concrete explanatory level even though theoretical unification seems not possible between the explanations for some complex phenomena.

I hold the view that plurality in the sciences displays the disunited nature of knowledge in some areas. We should adopt pluralism in science; nevertheless, we should exhibit a cautious behavior about the degree of pluralism that should be allowed in science. So long as pluralism in science is local and sanctioned for pragmatic concerns, we can get the best of it in our

explanations. Our purpose should be to have the correct epistemology. Yet we can understand the reality better.

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