Pragmatism and transactional realism

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Abstract: Following the philosophy of John Dewey, language is a form of technology. In this essay I will illustrate this idea through what can be called "transactional realism": scientists do not perform the task of "copying" an existing reality, since they also transform it, and this, at least in some cases, brings about value issues into the language of science. I believe that transactional realism has significant consequences in the way public interests and values enter the subject-matter and procedures of scientific inquiry. Along with the rejection of the ideal of value-free science, transactional realism leads scientists to significantly change the perception of their work. Public interests and social values do not concern scientists only when the policy maker requests their assistance as experts, since they enter the very same ontology of science. This, as we will see, without foregoing realism.

Keywords: language as technology; realism; fact/value dualism; pragmatic maxim; biodiversity

1. *Introduction*

In this essay, I intend to illustrate two consequences of a well-known thesis which characterizes pragmatism, in particular the pragmatism of John Dewey. I refer to the thesis that language is a form of technology (cf. Hickman 1990). The first consequence of this thesis concerns the sense in which it is affirmed that theories and scientific language do not simply represent reality, since they also transform it. Hence a second consequence, typical of Deweyan pragmatism: the scientist, like any technologist, at least in some cases is involved in questions connected with social and moral values, in a way which turns out to be incompatible with the ideal of value-free science. The two consequences, which I intend not only to illustrate but also to defend, are closely intertwined and can therefore be summarized in a single statement: the scientist does not perform the task of "copying" an existing reality, but rather of transforming it, and this, at least in some cases, brings about value issues into the language of science.

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Although Dewey himself has had more than one uncertainty in this regard, the idea that language is a form of technology has nothing to do with the acceptance of instrumentalism or the reduction of all science to applied science (cf. Barrotta 2018: §§ 4.2 and 4.3). Rather it has to do with a specific form of realism, which I will call "transactional" following Sleeper (Sleeper 2001: 92).

I believe that transactional realism has significant consequences in the way public interests and values enter the subject-matter and procedures of scientific inquiry. Along with the rejection of the ideal of value-free science, transactional realism leads the scientist to significantly change the perception of their work. Public interests and social values do not concern scientists only when the policy maker requests their assistance as experts. Social interests and values enter the very same ontology of science. This, as we will see, without foregoing realism.

In the next section I will clarify in very general terms the characteristics of transactional realism. We will see in what sense, following this form of realism, language is not a mere representation of reality, in that it changes reality in the same way reality is changed by a technological tool. In the third section, this statement will be deepened and confirmed thanks to the analysis of the content of pragmatic maxim, both in Peirce's original version and in its extension operated by Dewey. In the fourth section, we will see how transactional realism leads to the thesis that, at least in some cases, scientists are involved in the value issues discussed in the public sphere. These issues concern them *qua* scientists not simply as experts hired by policy makers. We will do this thanks to the analysis of a scientific term: biodiversity. Some conclusions will summarize the guiding thread that has led us from transactional realism to pragmatic maxim and finally to the role of the scientist in relation to value choices. The guiding thread will be given precisely by the view of language as a particular form of technology.

2. *What transactional realism is*

Dewey has often focused on the relationship between knowledge and reality. It is certainly a subject of great importance within his philosophy. Unfortunately, it must be added that his claims on this issue are often obscure and difficult to understand. Admittedly, the following sentences have been specifically selected to illustrate the difficulties that the reader is faced with when dealing with Dewey's work. Dewey argues that "knowledge is reality making a particular and specific sort of change in itself" (Dewey 1908: 126). However, in an essay written around the same time, Dewey adds that he does not intend to deny the "undoubtedly axiomatic" truth according to which "the existence known does not change in being referred to by a proposition" (Dewey 1910:

140). Furthermore, in the same essay Dewey argues that this statement is compatible "with a change of meaning in the existence referred to, because it has become a subject of knowing. It is, moreover, consistent with alteration of the existence itself through knowing" (Dewey 1910: 140). A precise understanding of these statements will allow us to begin to outline the content and scope of transactional realism.

A first impression that could be drawn from these claims is that Dewey's philosophy is incompatible with realism. For realism in fact, knowledge does not change reality, but approximates it with ever greater rigour thanks to scientific progress. The well-known fact that Dewey studied Hegel thoroughly and was also influenced by him, would confirm the idea that Dewey adopted some form of idealism.[1]

Of course, the labels "idealism" and "realism" represent very broad concepts, which also designate very different positions within them. I myself will later show the substantial differences between "transactional realism" and "metaphysical realism". However, my purpose is much narrower here: to understand the sense in which Dewey must be considered a realist, albeit of a particular kind.

It is important to note that in order to understand Dewey's seemingly obscure statements it is better to start not from Hegel's philosophy, but from a scientific theory: Darwin's theory of the evolution of species (cf. Dewey 1898, Dewey 1909). The same terminology adopted by Dewey suggests this shift. In this context, Dewey does not intend to reject the subject/object dichotomy, but that between organism and environment. Certainly, the overcoming of any dichotomy is a constant feature of Deweyan philosophy, a feature which shows its proximity to Hegel. However, it is thanks to Darwin's influence that we will be able to understand why Dewey comes to defend a peculiar form of realism: transactional realism.

Dewey gives a very current interpretation of the theory of evolution. It should not be believed that the evolutionary process consists of a simple passive adaptation of the organism to the environment. Rather, it must be thought that through the evolutionary process both the environment and the organism evolve through mutual influences. We should therefore speak more correctly of a co-evolution. In *Reconstruction in Philosophy*, Dewey offers a simple example of co-evolution, that of a clam with the environment in which it lives:

[1] Certainly many of his contemporaries thought that Dewey's philosophy was a form of idealism. On this, see Hildebrand 2003, Chapter 3.

Wherever there is life, there is behavior, activity. In order that life may persist, this activity has to be both continuous and adapted to the environment. This adaptive adjustment, moreover, is not wholly passive; is not a mere matter of the moulding of the organism by the environment. Even a clam acts upon the environment and modifies it to some extent. It selects materials for food and for the shell that protects it. It does something to the environment as well as has something done to itself (Dewey 1920: 128).

We find here a very elementary example of a transactional relationship. The "organism-environment" system must be understood as a whole, in which each element can be understood starting from the other.[2] Dewey also warns against confusing simple interactions with transactional relationships. In physics, an example of interaction is given by two bodies that attract each other. In an interaction, the elements that make up the whole do not change their nature, while, as we have seen, in the "organism-environment" transactional relationship each element changes in the light of the changes of the other.[3]

A certainly more complex transaction takes place between knowledge and reality. Along the evolutionary process, a being appears capable of expressing their knowledge in linguistic form. With this, reality has been enriched with a new element with respect to the previous whole organism-environment. Thanks to the new reality, this organism is now able to communicate their knowledge through language, whereas previously their knowledge was incorporated into the organism itself in the form of non-reflective thinking. Through language, humankind now has another tool to solve problematic situations through reflective changes in the world around. From an evolutionary and naturalistic perspective, language is an instrument, albeit of a particular type, such as a hammer or a lever. Dewey is clear on this point. As he writes in *Experience and Nature*: "[t]he character of the object [designated by a scientific concept] is like that of an instrument, say a lever; it is an order of determination sequential changes terminating in a foreseen consequence" (Dewey 1925: 121).

[2] The term "transactional" was introduced very late by Dewey. In his work with Bentley, Dewey gives the following definition of "transaction": "Trans-action: where systems of description and naming are employed to deal with aspects and phases of action, without final attribution to 'elements' or other presumptively detachable or independent 'entities', 'essences', or 'realities', and without isolation of presumptively detachable 'relations' from such detachable' elements'" (cf. Dewey and Bentley 1949: 108). However, the concept of transactional is already clearly anticipated in other works of his. In his *Logic*, for instance Dewey writes: "[i]t will […] be supposed that organism and environment are 'given' as independent things and interaction is a third independent thing which finally intervenes. In fact, the distinction is a practical and temporal one" (Dewey 1938: 40).

[3] All of this is connected with the relationship between language and experience in Dewey's philosophy. On this I refer to Gronda 2020, especially Chapters 1 and 2. The book by Gronda is one of very few detailed works devoted to the philosophy of John Dewey in the light of contemporary philosophy of science.

With language, reality has therefore been enriched with a new element capable of changing itself. One of Dewey's seemingly obscure statements from which we started should therefore now be clear: "knowledge is reality making a particular and specific sort of change in itself". When we examine the connections between transactional realism and pragmatic maxim, the link between language and technology will become even more evident.

For the moment, consider the reality of a geographical concept, such as "American continent". The assimilation of language to technology leads to the overcoming of the dichotomy between the discovery (of a pre-existing object) and the creation (of a new object). Of course, not every distinction is lost, although there is a sense in which "creation" and "discovery" coexist both in the case of "American continent" and in the case of technological artifacts, as happens for example with genetically modified organisms. The central point is that discoveries require conceptualization. We do not discover a continent because we simply run into it, and the same happens for GMOs. The coexistence of "discovery" and "creation" is well illustrated by Dewey precisely through the example of the discovery of America:

> Discovery of America involved the insertion of the newly touched land in a map of the globe. This insertion, moreover, was not merely additive, but transformative of a prior picture of the world as to its surfaces and their arrangements. It may be replied that it was not the world which was changed but only the map. To which there is the obvious retort that after all the map is part of the world, not something outside it, and that its meaning and bearings are so important that a change in the map involves other and still more important objective changes (Dewey 1925: 125).

Of course, there are many differences between the discovery of America and the creation of a genetically modified organism. However, there are also close similarities that should not be overlooked in philosophical analysis. There is no doubt that America existed long before Columbus. However, it cannot be said that it was discovered by the first men who, presumably in the ice age, crossed the Bering land bridge. These men did not discover America simply because they did not have the necessary linguistic and conceptual tools. We can say that the discovery of America occurred only when a conceptual change occurred, exemplified for example by the creation of new maps. With the introduction of new maps (as well as the introduction of theoretical terms of scientific language, such as "electron"), an enrichment of reality has also occurred thanks to the emergence of new relationships in the transaction between the particular organism represented by man and the surrounding environment. This explains the other equally obscure sentences we started from. Dewey reaffirms the "undoubtedly axiomatic" truth that "the existence known does not change

in being referred to by a proposition" but at the same time, stresses that there is "a change of meaning in the existence referred to, because it has become a subject of knowing". There is certainly a sense in which America existed before Columbus, just like the electron existed before J. J. Thomson, while GMOs did not exist before S. N. Cohen. However, we must also say that reality itself has changed with the discovery of America, the electron and GMOs, since it has been enriched with new meanings and new tools (for example, new maps in the case of the discovery of America). Finally, as Dewey points out, there is another way in which research involves an "alteration of existence itself through knowing". Indeed, with these discoveries, the road has undoubtedly been opened up to profound changes in existence, for example, through trade, in the case of America, or with the increase in agricultural productivity, in the case of GMOs.

Dewey was certainly a realist, albeit of a particular kind. Following Sleeper, we can define his realism as "transactional realism", since knowledge is a form of transaction that takes place between the organism and the environment (Sleeper 2001: 92).

Transactional realism leads us to a peculiar form of realism regarding the objects of science. What has been said so far gives us a fairly broad idea of transactional realism. To examine more precisely in which sense we can affirm the real existence, for example, of electrons or H_20, we must now clarify further what has been stated so far through the characteristics of pragmatic maxim, which will lead us again to consider the role of language as technology.

3. *Pragmatic maxim and transactional realism*

Pragmatic maxim is introduced by Peirce in his well-known essay "How to Make Our Ideas Clear". Also due to an unfortunate example, the formulation chosen by Pierce easily leads the reader to misunderstand its scope and reduce it to adherence to an excessively radical empiricism.[4] It is therefore more ap-

[4] The previous statement of the maxim is as follows: "[c]onsider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object" (Peirce 1878: 5.402, 258). The unfortunate example is that of a diamond never touched before its destruction. Peirce sets out to clarify the meaning of the concept of hardness and claims that it is meaningless to ask the question of whether a diamond burnt before it has ever been touched was soft or hard. This decidedly counterintuitive conclusion is induced precisely by the pragmatic maxim, which would have the implication that "[t]here is absolutely no difference between a hard thing and a soft thing so long as they have not brought to the test" (Peirce 1878: 5.403, 260). Note that in the formulation I have chosen the emphasis is shifted from observational effects to general habits of conduct. In other words, the maxim applies to research procedures, the purpose of which is the problem solving. Beliefs relieve us of doubt by providing rational habits. This certainly requires experimental investigation, but this statement is very different from asserting that our beliefs must be entirely reducible to observational effects.

propriate to refer to a second version of the maxim, which is the following: "[t]he entire intellectual purport of any symbol consists in the total of all general modes of rational conduct which, conditionally upon all the possible different circumstances and desires, would ensue upon the acceptance of the symbol" (Peirce 1905a: 5.438, 293). From the statement of the maxim, it immediately emerges that the problem that Peirce intends to address concerns the meaning of the symbols or concepts that occur in language, particularly in scientific language. After having clarified how pragmatic maxim intends to perform this task, we will see why and how it is also connected to Dewey's transactional realism.

Peirce intended to introduce the typical rigour of the experimental scientist into philosophy. As he wrote, the experimental scientist will always try to clarify the practical consequences that follow from an operation performed in the laboratory: "when you have found […] the typical experimentalist" – Pierce notes – "you will find that whatever assertion you make to him, he will either understand as meaning that if a given prescription for an experiment ever can be and ever is carried out in act, an experience of a given description will result, or else he will see no sense at all in what you say" (Peirce 1905b: 5.411, 272-273). Peirce hoped that the experimentalist's approach in philosophy would put an end to unnecessary metaphysical disputes, a hope which is certainly not new in the history of philosophy.

It is not immediately clear how the maxim is able to introduce the rigour of the experimentalist in fixing the meaning of concepts. For example, how does the maxim help us fix the meaning of "water" or "H_2O"? If we even very carefully read the formulation of the pragmatic maxim offered by Peirce, we do not find precise explanations in this regard. However, it is not difficult to find precise indications in Peirce's works. In the first of his "Harvard Lectures on Pragmatisms", Peirce expresses himself in this way:

> Pragmatism is the principle that every theoretical judgment expressible in a sentence in the indicative mood is a confused form of thought whose only meaning, if it has any, lies in its tendency to enforce a corresponding practical maxim expressible as a conditional sentence having its apodosis in the imperative mood. (Pierce 1903a: 5.18, 15).

Following Peirce's indications, the meaning of the concept of water should therefore be clarified through a series of conditional statements such as: "if you put water in the refrigerator (protasis) then you must expect that it will freeze when it reaches the temperature of 0 degrees Celsius (apodosis) "; or "if you put water in a container placed over the fire (protasis) then you must expect it to boil when it reaches the temperature of 100 degrees Celsius (apodosis)"; or again "if you drop droplets of water on a red-hot iron (protasis)

then you must expect that hydrogen gas will be released (apodosis)", and so on. In summary, the pragmatic maxim clarifies the meaning of the concepts thanks to conditionals with the following form: if you perform an action of a certain type *x* on an object *y* then you will have to expect a certain type *z* of observable consequences. Furthermore (and this is something that has a certain importance to fully understand pragmatism), it should be noted that all this could easily translate into rules for action, when we aim to achieve certain objectives. For example, to continue with the concept of "water", a rule for the action would be the following: "if you want to produce hydrogen from water, then drop droplets of water on an incandescent iron". *The rules of action, in view of specific objectives, and the meaning of the concepts represent the two sides of the same coin.*

Thus, this is the connection we were looking for. When we want to clarify the meaning of a concept (for example, water), we have to translate the statement in the indicative (water is…) into statements in their conditional form, where the antecedent (protasis) is given by an action on the object and the consequent (apodosis) is given by the observational effects that are the consequences of that action on the object. If the same action brings about the same consequences then we face the same concept and any further consideration becomes meaningless jargon, as happens, according to Peirce, in the case of theological controversies on the concepts of wine and bread connected to the dogma of transubstantiation (cf. Peirce 1878: 5.401, 257-258). Therefore, for Peirce, the practical consequences that pragmatists often debate are observational consequences, which follow from an experimental operation. It is in this sense that for Peirce pragmatism represents the philosophical attitude that characterizes laboratory activities.

Although it may initially appear to be a digression from the way the meaning of concepts is fixed, it is worth investigating a point already mentioned previously: Peirce's experimentalist philosophy is far from the radical empiricism subsequently supported by neopositivists.

The way pragmatic maxim fixes the meaning of the concepts is certainly connected with the experimental attitude, but this statement is very different from asserting that our beliefs must be entirely reducible to observable effects. On closer inspection, Peirce's break with empiricism is much more radical than it appears at first glance. The differences between pragmatists and empiricists are numerous, starting with the different conception they have of experience and observational statements.[5] Here, it is useful to examine a specific differ-

[5] Unlike empiricists, Peirce stresses that even the simplest observational statements are not immediately given, since they themselves are the conclusion of inferences. See, for example, Peirce 1903b.

ence between Peirce and the empiricists: the different way in which the laws of nature are conceived. Thanks to this difference, we will in fact be able to return to the role of conditionals in clarifying the content of pragmatic maxim.

Consider the following two statements, which usually exemplify the difference between genuine laws of nature and accidental regularities: 1) "All heated metals expand" and 2) "All the coins in my wallet are 20 cents". Evidently only the first is a law of nature, although both have the same logical form. One way to conceptually clarify the difference consists in reformulating them into conditional statements. As will be remembered, Peirce himself suggests clarifying the functioning of the pragmatic maxim by translating the sentences from the indicative mood to conditionals with the apodosis in the imperative mood. In the first case, there are no problems. The translation would give a result of this type: "If this metal is heated then you must expect its expansion". The "must" we find in the apodosis is justified by the fact that we find here a connection between an experimental possibility and the necessity for a certain result. The laws of nature therefore represent *possible necessities* in that from the possibility of the antecedent of the conditional happening the occurrence of the consequent of the conditional necessarily follows. In the second case, however, I certainly cannot say that if a coin were put in my wallet then it would necessarily be a 20 cents coin. Once put into my wallet, a 50cent coin would not turn into a 20cent coin. The difference consists in the fact that both propositions express an empirical regularity, but only the first is a law stating a necessity of nature, while the second represents, in fact, only an accidental regularity. With their attempt to reduce all laws to empirical regularities, empiricists have always had some difficulty in distinguishing genuine laws of nature from accidental regularities. Here there is no need to see if and how empiricists are able to solve the difficulty. Rather, it is important to understand that Peirce, unlike empiricists, does not defend at all a regularistic conception of the laws of nature. This would in fact be incompatible with important aspects of his philosophy. Another passage from Peirce should be mentioned, then we will comment on it briefly:

> Pragmaticism makes the ultimate intellectual purport of what you please to consist in conceived conditional resolutions, or their substance; and therefore, the conditional propositions, with their hypothetical antecedents, in which such resolutions consist, being of the ultimate nature of meaning, must be capable of being true, that is, of expressing whatever there be which is such as the proposition expresses, independently of being thought to be so in any judgment, or being represented to be so in any other symbol of any man or men. But that amount to saying that possibility is sometimes of a real kind. (Peirce 1905a: 5.453, 306-307).

In this passage, Peirce affirms something important. He argues that laws are possible necessities that belong to nature and upholding the reality of laws is tantamount to stating that laws are not simply synthetic ways of expressing regularities between the occurrence of the antecedent and the occurrence of the consequent of the conditional. In other words, with regard to the laws of nature, Peirce adopts a realism that is incompatible with empiricism.

We therefore confront the problem of realism again. As is well known, there are many and important differences between Peirce and Dewey, from their conception of truth as an end of inquiry to the type of realism defended by them. However, here I would rather emphasize some elements of continuity, which are once again given by the pragmatic maxim.

In his essay, "What Pragmatism Means by 'Practical'", what Dewey adds to Peirce's analysis of the pragmatic maxim is a relevant distinction for our purposes. In addition to clarifying the potential confusions of James' pragmatism, Dewey distinguishes between the meaning of an object and the meaning of an idea. As for the former, Dewey writes that "[w]hen […] it is a question of an object, 'meaning' means its conceptual content or connotation, and 'practical' means the future responses which an object requires of us or commits us to" (Dewey 1916: 379). If we keep in mind the previous reconstruction of the pragmatic maxim it should be clear what Dewey means. Retrospectively, "If … then" statements explain the properties of a given object (the connotation). If someone asked us what the term "water" means, we could explain its conceptual content by saying, for example, that if it is drunk then it quenches thirst; if it is put on a fire then it boils at one hundred degrees at sea level; and so on. Furthermore, from the point of view of future answers, pragmatic maxim tells us what to expect when we act on an object. Following our example, what we should expect if we drink water or put it on the fire.

As for the meaning of ideas, Dewey expresses himself in this way: "what an idea as idea means, is precisely that an object is *not* given. […] an idea is a draft drawn upon existing things, an intention to act so as to arrange them in a certain way. From which it follows that if the draft is honored, if existences, following upon the actions, rearrange or readjust themselves in the way the idea intends, the idea is true" (Dewey 1916: 379). Consider the term H_2O. In the eighteenth century, the term was not believed to have a meaning, since water was thought to be an element, not a compound of two gases or "airs" (as was said at the time). H_2O was introduced as a concept for solving some problems. Indeed, through operations on H_2O it was possible to correctly predict a series of consequences. For example, Lavoisier made a series of experiments in which he succeeded in producing hydrogen by dropping small drops of water on a red-hot iron bar; a result incompatible with the idea that water was

a simple element. Furthermore, this has made it possible to obtain hydrogen on a large scale through a new system of production rules. The main point is that we are authorized to say that H_2O exists (that is, it has an authentic denotation) because we can act on it through a series of operations that have the expected result. In this case, following Dewey, pragmatic maxim clarifies how the meaning of an idea is established thanks to the inquiry that successfully "reorganizes" the experience.

The relationships between the meaning of an object and the meaning of an idea should be clear. When the existence of an object is taken for granted, at the end of a successful inquiry, pragmatic maxim explains the properties of the object (its connotation). When new areas of research are explored, however, an idea has the task of reorganizing the experience. If it is successful, the idea corresponds to a genuine referent (its denotation). The same analysis could be applied to understand the relevance of the pragmatic maxim regarding far more complex entities than "water", such as atoms and electrons. Here I would like to emphasize that following pragmatism a conceptual content can never be separated from the practical activity that derives from it. In some contexts, assertion such as "Water boils at 100 degrees" or "Water is a compound of oxygen and hydrogen" are a way to retrospectively analyze the properties of water after inquiry has been successful in organizing the experience; in other contexts, the same statement serves to guide us in anticipating the future when we perform operations on an object that we recognize as water; in still others, there are ideas or conjectures "chasing a denotation", in the sense that we try to understand if they have a correspondence with reality, for example when the composed nature of water was not known. In all cases, the concepts are tools that are used or have been used to organize the experience, in the same way in which when a light placed on a gas detector turns on means that there is gas leak and helps us avoid lighting a match. As Dewey writes in *Experience and Nature*, language "is no different in kind from the use of natural materials and energies, say fire and tools, to refine, reorder, and shape other natural materials, say ore. In both cases, there are matters which as they stand are unsatisfactory and there are also adequate agencies for dealing with them and connecting them" (Dewey 1925: 61).

To sum up, Dewey's realism opposes the idea that the objectivity of scientific language is guaranteed by the fact that it faithfully represents or "copies" reality. Instead, for Dewey's realism we should consider language as a form of technology, since language and knowledge allow us to act on reality and are themselves part of reality. As has been seen previously, this is the fundamental idea of transactional realism.

4. *Value-laden concepts in the light of transactional realism*

Today, the thesis that in the meaning of some concepts, including scientific concepts, values and facts are closely intertwined, has increasingly become plausible. The entanglement between facts and values involves many epistemological and ethical problems, starting with the rejection of the ideal of value-free science; an ideal still widely accepted today by the vast majority of philosophers of science and scientists.[6]

Pragmatism wholeheartedly accepts the fact/value entanglement. In particular, transactional realism shows the way the moral sphere is in some contexts able to enter scientific language as its constitutive component. If we follow the idea of knowledge as a copy of reality, morality has the sole purpose of examining the possible uses of knowledge. Transactional realism opens up a different perspective, which is able to solve some philosophical problems regarding the nature of scientific language and is also able to make us better understand the role of scientists when they offer their advice as experts in view of the resolution of socially relevant problems.

Here I will confine myself to offering a specific example, which in addition to further illustrating what has been said so far, will also show us how transactional realism is able to clarify the entanglement between facts and values. I believe that this is a considerable advantage of the kind of realism proposed by pragmatism, since transactional realism also proves to be insightful in understanding some areas of scientific research. The example we will focus on is given by the term "biodiversity".

The term "biodiversity" has a relatively recent origin. It was coined in 1986, when the conference "The National Forum of BioDiversity" was held in Washington, the proceedings of which were edited by Edward O. Wilson. One of the aims of the conference was to precisely define the meaning of "biodiversity" which, once operationalized, should have been able to offer objective and real measurements of actual biological diversity.

The references to the 1986 conference and to Wilson, surely one of the pioneers of conservation biology, immediately introduce us to the problem the first researchers who dealt with biodiversity had to face; a problem that is not only scientific, but also epistemological: how should we measure biological diversity? Without its objective measurement, satisfactory answers could not be given to the needs of environmental conservation. For example, the greater or lesser biological diversity of one area compared to another could not be objectively displayed. More importantly, one could not objectively answer the

[6] See Marchetti and Marchetti 2016 for an overview.

question of whether a certain policy increases or decreases biological diversity. In his book on biological diversity, Wilson poses the problem in very precise terms: "[s]ince antiquity biologists have felt a compelling need to posit an atomic unit by which diversity can be broken apart, then described, measured, and reassembled. […] Not to have a natural unit would be to abandon a large part of biology into free fall" (Wilson 2001: 35-36).

Despite Wilson's concerns, conservation biologists quickly realized that they did *not* have the atomic unit that would have been needed to measure biodiversity. Today, this is a fact that is difficult to contest. Gaston and Spicer expressed it from the first pages of their introduction to conservation biology: "[a]s a result of the variety of elements of biodiversity, and of differences between them, there is no single all-embracing measure of biodiversity – nor will there ever be one! This means that it is impossible to state categorically what the biodiversity of an area is or of a group of organisms. Instead, only measures of certain components can be obtained, and even then, such measures are only appropriate for restricted purposes" (Galton and Spicer 2004: 9).

Gaston and Spicer's scepticism is justified by a simple consideration, which was obviously also known to Wilson when he wrote the above-mentioned book. There are at least three basic biological concepts that can be used to measure biodiversity: species, genetic characteristics and ecosystems (cf. Sarkar 2005). If they do not have good and objective reasons for choosing one, we will have contradictory measurements. For example, we can say that environment *A* has a greater biodiversity than environment *B* because it has a greater number of species. Or we could say that it is *B* that has a greater biodiversity than *A* because the latter is populated by groups of species that are mutually similar from a genetic point of view.

This well-known situation has not discouraged biologists. Many, starting with Wilson in his book above, believe that choosing the number of species appears to be the most natural metric for gauging biodiversity. In practice, there are many biologists who adopt this vision, although they are obviously well aware of the potential semantic plurality of the concept. However, the situation becomes even more complicated if we consider that in biology there are also different concepts of "species" that offer different and incompatible metrics. For example, we have a biological definition and a phylogenetic definition of species. Both have operational significance but lead to very different measurements. In fact, it has been ascertained that the definition of species based on phylogenetic history greatly overestimates the degree of biodiversity compared to the biological definition of species (cf. Agapow el al. 2004).

The situation has brought about some embarrassment among biologists. As we said earlier, it is quite common to find essays in conservation biology that

begin with warning that there is no single metric to measure biodiversity, but then they continue as if there was only one, usually that offered by the species in its biological meaning (cf. Gaston 1996). The moral we have to draw from the situation in conservation biology is that, despite the evolution of the discipline pushing towards a pluralistic conception of the meaning of "biodiversity", conservation biologists find it difficult to accept it coherently, in all probability because they lack an epistemology that is adequate for the problems posed by pluralism.

Transactional realism and pragmatic maxim offer a solution to the embarrassment caused by the plurality of biodiversity measurements. The solution consists in considering the concept of biodiversity as a technological tool in view of the solution of the environmental problems we are experiencing (cf. Barrotta and Gronda 2020).

Through the pragmatic maxim, we have previously seen that the denotation of a concept is fixed at the end of scientific inquiry. Faced with problems, which are sometimes exclusively theoretical and sometimes of a social or practical nature, scientific investigation constitutes the most suitable concepts for solving them. This means that the object which we refer to is not something that is given to us regardless of the language and conceptual structures of the inquiry. The object is not simply discovered by the inquiry. Rather it is linguistically constituted through the inquiry in order to solve purely theoretical or social problems. As has been repeatedly stressed, language is a tool, like a hammer or a lever, which serves to solve the doubtful situations the scientific community has to face. This, let us recall, is the basic idea of transactional realism. Scientific concepts do not "copy" or represent a predetermined reality, but they constitute and transform it in the light of the problems and objectives we set ourselves.

Once more, this does not mean abandoning the objectivity of scientific inquiry. As common sense suggests, we can continue to affirm that an object really exists only when research is empirically successful. Rather, transactional realism leads us to conceive objectivity in such a way that it is more connected with scientific inquiry. What is rejected is not the realism of common sense, which is strongly entrenched in the scientific mentality, but metaphysical realism, which affirms the existence of a reality that scientific language should simply "copy".

The concept of biodiversity exemplifies, I believe very accurately, this philosophical view, which is in itself rather abstract. I also believe that transactional realism allows conservation biologists to overcome the embarrassment caused to them by pluralism. The plurality of biological diversity concepts is in fact what we should expect if transactional realism is followed.

Biological reality is extremely rich. As Ernst Mayr observed, "[t]he most impressive aspect of the living world is its diversity. No two individuals in sexually reproducing populations are the same, nor are any two populations, species, or higher taxa. Wherever one looks in nature, one finds uniqueness" (Mayr 1997: 124). Consequently, conservation biologists have the task of *choosing* which aspect of reality is appropriate to select with respect to the problems we have to face and the objectives we aim to achieve. It is in this context that social values come into play and, with them, the inevitable plurality of biodiversity concepts. Only after we have chosen which aspect of biological reality we wish to preserve or increase in the light of our values can we adequately establish the meaning of "biodiversity". From the perspective of transactional realism, the meaning of the concept appears to be a technological tool in the sense that it tells us what results we will be able to achieve when we perform a set of operations.

Thus, there is no biological "atomic unity" (as Wilson wanted). Nor do we need this unity to prevent scientific measurements from becoming arbitrary or conventional to such an extent that we risk "abandon[ing] a large part of biology into free fall". When conservation biologists claim that biological diversity is increasing or decreasing, they are not only representing facts, but also evaluating them. The two activities (description and evaluation) are closely intertwined given the plurality of biodiversity concepts in principle usable by conservation biologists.

Research in conservation biology must certainly face complex problems. It is in fact biological reality itself that is complex, as we have previously observed following Mayr. Furthermore, not all biodiversity concepts can easily be operationalized. What I would like to point out here is that many of the epistemological puzzles would be solved if conservation biologists saw themselves as technologists. Not only when their expert advice is requested in solving conservation biology problems in certain areas of public concern, but also in the way they should conceive their scientific inquiry, that is when they have to develop adequate concepts and metrics to gauge biological diversity.

5. *Conclusions*

The realism defended by pragmatism, and in particular by Dewey's pragmatism, is certainly a peculiar kind of realism. Scientific inquiry does not have the task of representing or "copying" reality, but that of orienting ourselves successfully by examining the consequences of our actions. In a sense that I hope I have clarified, scientific language should be considered as a technological tool. Furthermore, I am confident that I have made it clear that

this does not in any way mean abandoning the realism of common sense. Rather, it means abandoning metaphysical realism and adhering to a kind of realism that we can define as "transactional" in order to emphasize how scientific language and reality mutually change themselves along the inquiry process. There is a sense in which the objects to which science refers are not pre-existing to scientific inquiry, since they are constituted by research that is successful in solving the problems that the scientist must solve. Sometimes these problems are practical and social in nature; and therefore, it is not surprising that value issues also concern scientists *qua* scientists, not simply when scientists are asked for their advice as experts. Transactional realism has undoubtedly the advantage of making us understand the reason why, in some research contexts we find the entanglement between facts and values in the concepts used by science. We made this point clear through a case of no less importance: the notion of "biodiversity".

For many, the inevitability in some contexts of the entanglement of facts and values in scientific language appears to be mysterious or even outrageous, because it means giving up the ideal of value-free science. On the contrary, the entanglement of facts and values is within pragmatism something that we should expect for the simple reason that the consequences of our actions sometimes have moral and social consequences. Language is a technology, albeit of a particular type, and, like all technologies, sometimes has morally relevant implications. From a metaphysical point of view, transactional realism is certainly less ambitious than realism which affirms the existence of entities that in principle could be correctly represented by language, independently of our actions. However, transactional realism appears to be a form of realism epistemologically better founded, in the specific sense that makes us better understand the very complex and radically different processes of scientific inquiry.

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