Joanna Gęgotek

On partial truths in science : some remarks on Susan Haack's "The whole truth and nothing but the truth"

Filozofia Nauki 19/4, 55-66

2011

Filozofia Nauki
Rok XIX, 2011, Nr 4(76)

Joanna Gęgotek

On Partial Truths in Science
Some remarks on Susan Haack's *The Whole Truth and Nothing but the Truth*

As Professor Susan Haack emphasizes in the article *Professor Twardowski and the Relativist Menace*, the main topic of her *The Whole Truth and Nothing but the Truth* is the matter of partial truth [Haack 2011b, p. 25]. In the comments below I thus focus on this theme in relation to natural sciences. The article consists of two parts. In the first one I formulate some doubts about Haack's conception of partiality of truth. However, as one of the assumptions I take Haack's concept of truth, not bringing it up for discussion. Despite the objections, I find Haack's observations on the partiality of truth stimulating and in the second part of the article I propose some development of her idea of partial truth in application to problems of philosophy of science. I present there a simple typology of possible sources of truth's partiality in science.

1. TWO KINDS OF PARTIAL TRUTHS?

Analyzing the words of the oath "the whole truth and nothing but the truth", Prof. Haack distinguishes two kinds of partial truths:

> To describe a statement as partially true may mean either of two significantly different things: (i) that it is true in part but also false in part; or (ii) that it is true but incomplete [2011a, p. 15].

Relations between the two classes of statements Haack describes as follows:

> A statement that is partially true in sense (i) (…) will also be partially true in sense (ii) (…); but the converse implication does not hold [Haack 2011a, p. 15].

The examples of the partial truths in the first sense, i.e. of the statements true only in part, given in the article, are examples of conjunctions of at least one false and at least one true statement. According to the classical logic, these conjunctions are false, and, I suppose, the classical logic is in that point compatible with our natural attitude. If somebody says that "she was poor but (and) she was honest" describing e.g. a poor swindler, most of the hearers judge that he is not right. Insisting on classifying these statements as "true, but partially" evokes some not quite serious air, in a "Radio Yerevan" style, where the questions: "Is it true, that *p*?" were answered always, no matter how absurd or patently false *p* actually was: "Yes, it's true, but…" Easiness of giving absurd examples of partial truths in the first sense shows that the mere notion of the partial truth in the sense is not intuitive or even somewhat paradoxical.

Haack does not expand the theme of partial truths in the first sense in detail, but it may be interesting to consider some other types of compound sentences (below I focus only on the classical logic, however other manners of logical analysis of natural language would be probably more suitable and fruitful).[1] For disjunctions a problem of partiality of truth does not arise: a disjunction with one false disjunct is a "whole truth", not a partial truth. More interesting is the problem of implication — do we want to recognize an implication with true antecedent and false consequent as a partial true? In common usage it will be a situation of drawing false conclusions of true premises, e.g. when somebody says: "She was poor, so she was honest". Situation of equivalences seems similar. Interesting may be also statements with general quantifier — in everyday life it is used for formulating stereotypes, e.g. "All poor people are honest". If these stereotypes are based on recurring observations (even though in the above example the instances are from XIX-century literature rather than from real life), we can probably say that it is "partial truth" in the first sense; whereas "nothing but the truth" there would be a statement with existential quantifier (or some partial one, like "a proportion of").

Haack agrees that the partial truths in the first sense are "strictly speaking, just plain false" Haack 2011a, p. 17]. However, status of statements partially true in the second sense seems different, at least from the formal point of view. The statements in the light of classical definition of truth (which Haack accepts) might be without great scruples classified as true. Compare e.g.: (i) "She was poor and honest" and (ii) "She was poor" as descriptions of the poor swindler. And Haack admits that "a partial truth in the second sense (…) is, strictly speaking, just plain true", emphasizing however that "unless it is also partially true in the first sense, only true in part" [Haack 2011a, p. 17]. If so, it is unclear, what relations are between statements of the two groups. Particularly, Haack's opinion that "a statement that is partially true in sense (i) (…) will also be partially true in sense (ii)" seems incorrect.

[1] Prof. Haack suggests using Emil Post's many-valued logic for the purpose. However, it is doubtful whether attributing specific values to partial truths would be possible. Furthermore, reconciliation of this system of logic with Tarski's conception of truth seems problematic.

Distance between the two classes of “partial truths” (first of which being, in fact, a class of falsehoods) seems however decrease when we consider casual mode of communicating and more complicated examples from everyday life instead of simple illustrations of the logical principles. When we e.g. considering a long essay with some unimportant errors or omissions, we may be inclined to judge it as true despite of the errors (omissions). Nevertheless we do not use in the situation with errors (and probably in the situation with omissions too) the attribution “partially true” — rather “generally true, but with some errors/omissions”. Anyway, our reaction would rather not distinguish the two types of partial truth.

In science, when we consider more complicated systems of sentences than simple examples, positions of the two classes of sentences get closer even more. Firstly, it would be the case of some type of statistical laws. There are, namely, two groups of statistical laws: one of them contains laws in which probability or probability distribution is explicitly mentioned (for example Mendel’s laws) and the other contains laws which do not mention probability in their contents, but which are fulfilled only with some (high) probability (as the Pascal’s law of transmission of fluid pressure or Boyle–Mariotte law). Most of modern scientific laws represent the second group [Krajewski 1998, p. 157-160].

Secondly, there are always omissions in theories, so there are always true only partially in the second sense.[2] They often contain as well some false elements, so describing them as partially true in first sense is justified as well. Galileo’s law or Newton’s theory may be considered as false but with elements of truth. It is an attitude of e.g. Karl Popper — according to his idea of verisimilitude, each theory is strictly speaking false, even though it has some content of truth. Rank of verisimilitude = 1 may be granted only to the “theory of everything”, whole truth and nothing but the truth [e.g. Popper 2002, p. 317-318].

A problem of conditions of acceptability of partial truths (in both senses) in science can emerge. The probable simple answer may be as follows: partial truths (as well in the first as in the second sense) are acceptable in science, when errors or omissions are not very serious. For example, causal law may be quite acceptable as true when it correctly identifies the main causal factors, despite of omissions or even falsehoods concerning additional circumstances [Nowak 1976, p. 235-237]. Similarly, we can acknowledge scientific theory to be partially true, when range of its accurate predictions is quite wide (as for Newton’s theory, for instance). However, two main problems are connected with the answer: firstly, it is never certain that we recognize the important and unimportant factors correctly, secondly, hierarchy of importance is not fixed, and it takes shape and changes along with development of science. Thus our opinion on acceptability or unacceptability of a scientific theory with errors or omissions is always temporary.

---

[2] I assume here some form of realism in relation to scientific theories as a necessary condition of considering the problem of partial truths in science.

2. SOURCES OF OMISSIONS IN SCIENCE

Truth with no omission is not possible in science as well as in everyday life or legal procedure. The presence of omissions is thus universal. The sources of omissions may be however different. These mentioned below seem the most important of them.

2.1 Deliberate omissions

A class of deliberate omissions is the most closely considering by Haack and, as her examples show, it is first of all an ethical problem (and, of course, a legal one — because deliberate omissions of witnesses are punishable). It is also a problem considered by ethics of scientific community. From the psychological point of view Haack distinguishes opinion on falsehood and on partial truth with deliberate omissions. She writes:

> telling less than the whole truth is very often an especially attractive way of going about deceiving others; it is psychologically easier, because it is perceived as morally less offensive than lying [Haack 2011a, p. 22].

Nevertheless, the two situations, however psychologically different, seem more similar from the ethical point of view.

Ban of lying is probably one of the most controlled rules of scientific community's ethical code. A scientist caught at deliberate misrepresenting facts or fudging results of experiments usually loses his position and respect in scientific community. Opinion of deliberate omission seems more lenient, especially in present-day science practiced in close relations with industry. In pharmacology, biotechnology, engineering sciences exclusiveness and protection of results is sometimes perceived as much more important than free exchange of information, which was one of the traditional values of scientific ethical code. Suppressing of part of information is commonly considered as not very fair, but probably unavoidable in modern world. However, concealing scientific information is treated rather as necessary evil not as normal state of science.

For better analysis of ethical problems with deliberate omissions in science there are useful more precise distinctions of the status of different components of science. Whereas concealing some kinds of results and matters of research may be considered as acceptable (even though not ideal), the judgment as to some other elements of research is quite different in this respect. It concerns especially the methods used in research that may be needed to control the results. Omitting important information about the methods is treated as severe violation of scientific rules and breaking with the fundamental principle of rationality.

2.2 Misleading

Usually — except in pathological situations — the instances of deliberate omissions are not very damaging to science, even though they may decelerate its progress. However these situations have to be differentiated from other ones, in which omissions are deliberately used for misleading. Examples of that type of situations are given abundantly by Prof. Haack in the paper. They are frequently occurring in science as well as in everyday life and, especially often, at the border of both — e.g. in using results of scientific research for the public discussions on topics of politics or social life. Information particularly often omitted in those situations is that of important details of research or of the important exceptions to the alleged rules that have been discovered. For instance, if the results of opinion polls are published in context of political discussions, the details concerning used method of research or a margin of error are frequently omitted — not because there are uninteresting and incomprehensible to the general public, but in purpose of suppressing inconvenient circumstances.

There are many other instances of misleading information. If somebody tells that he will be at work "after 10 a.m.", we expect him before 10.30 a.m., not at 2.00 p.m., and if he shows at 2 o'clock we treat his statement as false, even though it is literally true. If somebody says that he has a fever of "more than thirty eight" we don't expect 39,5°C (unless we are his parents). If a student at the exam says that Descartes had lived "a long time ago, before the war", we treat this as a wrong answer, even though literally he it is true.

In analysis of what is wrong in these examples we may use e.g. the concept of implicature of H. P. Grice. The messages in the examples violate namely Grice's maxim of quantity, especially the first rule of it:

> Make your contribution as informative as is required (for the current purposes of the exchange) [Grice 1991, p. 26].

Employing a scale — marked with numbers or some less regular points (like important historical events) — suggests that in our statements we will use its characteristic values as the points of reference. What values are characteristic depends on calibration of the scale and habitual practical needs. A medical thermometer e.g. is readable to 0,1°C, but for a common practice (outside doctor's office) lesser accuracy of 0,5° is quite sufficient, so we expect that "more than 38°C" means "more than 38°C but less than 38,5°C". Similarly, "before the war" means commonly in Polish "before the Second World War and after the First World War".

An essence of the dishonesty in the above instances consists in deliberate omitting relevant information. The boundary between that kind of omission and falsehood is really thin and practically it may (and should) be neglected, so similar situations in science should be condemned as ordinary lying.

2.3 Unintentional omissions

Not every omission in scientific practice is deliberate or intentionally misleading. There are many examples of unintentional omissions, the simplest form of which are just mistakes either in applying research procedure or in defining of the scope of relevance. A scientist who (more frequently than others) makes mistakes in applying some method of research is, simply speaking, a bad scientist and his career should be hampered.

More serious is the problem of unintentional omissions resulted from incorrect defining of the scope of relevance. Omissions resulting from contingent mistakes of individual scientists within the well established body of science are relatively unimportant. However, in the avant-garde of science, where new areas are investigated, defining the scope of relevance is a part of the analyzed problem; and some systematic omission here might have grave consequences. The problem of accuracy of numerical data can serve as an example. Scientific procedures often conventionally define how many decimal places should be taken into consideration in calculations. However, there might be situations — and it is not known *a priori* if analyzed case is not one of them — where assumed degree of precision is insufficient. That was the case of Edward Lorenz: analyzed by him equations describing meteorological changes turned out to be very sensitive to the accuracy of initial data; omitting of umpteenth decimal places seriously changed the results of calculations and, as an effect, meteorological forecast [Gleick 1987].

The first two and partially the third one of the sources of partiality of truth in science, as mentioned above, concern mainly the problems of sociology of scientific society. More interesting for philosophers are the sources closer connected with scientific method, some of which will be mentioned beneath.

2.4 Scientifically uninteresting information

Not every truth is important in science, only interesting truth. This platitude has been often repeated (e.g. by Popper in a popular passage: "…we are not interested in mere truth but in interesting and relevant truth…" [Popper 2002, p. 312]) for a long time, at least since Jan Łukasiewicz's paper *O twórczości w nauce* (*Creative elements in science*) from 1912, where we read:

> Not all true judgments are scientific truths. There are truths that are too *trifling* for science [Łukasiewicz 1970, p. 1].

Information omitted in science as uninteresting is of many types. There is e.g. information which is not connected with the current system of knowledge, information which is not an answer to some current scientific questions etc. In the article *Questions of Science and Metaphysics* Joseph Agassi pointed out that there is much more potential problems than these actually analyzed by researchers [Agassi 1975b, p.

244]. As a reason he indicated connection or the lack of it between these problems and currently dominating metaphysical doctrines — probably, the list of reasons should be extended, but it is obvious that not every cognitive problem is also a scientific one [Agassi 1975b, p. 244; see also: Agassi 1975a, p. 209]. Scientists "deliberately" give up discovering the whole truth about the world.

One group of omitted truths is then the group of answers to some scientifically uninteresting questions. Closer analysis of different types of sciences helps to delineate some other groups.

Sciences that are examined most frequently by philosophers are physics and similar disciplines (the so-called nomothetic sciences).[3] The aim of these sciences is considered as consisting in formulating general laws and theories. And although formulating laws and theories is not possible without recording some particular facts, these facts as themselves are not interesting for scientists. As Władysław Krajewski notices:

> for the aims of physicists there is always possible to replace ones facts by other ones [Krajewski 1998, p. 224].

If so, some details connected with facts (e.g. with some circumstances of experiments) are not relevant to the matter of physics and are omitted without damage for science.

Connected with formulating laws and theories are the problems of generalization, idealization and *ceteris paribus* clause.[4] The nomothetic sciences omit details differentiating individual objects or events and focus only on similarities among them. Furthermore, these sciences omit factors, influence of which on analyzed systems is minimal or accidental (or difficult to take into account) and may be neglected (or has to). It can be said therefore that scientific laws are always true only partially — and, what is more, partially also in the first sense, as deforming reality and openly false.

Moreover, since the 19st century the most widespread form of scientific laws have been statistical ones (see above). They are typical for social sciences, modern biology (theory of evolution, genetics, molecular biology) and physics. These disciplines assume in starting point that they are not interested in particular objects, as human individuals, organisms or gas particles, but in societies, populations or sets of gas particles. François Jacob describes an attitude of the scientists who originated the statistical thermodynamics as follows:

> For Boltzmann and Gibbs (…) statistical analysis and the theory of probability supplies the rules for the logic of the whole world. Large numbers are studied not so much because it is impossible to investigate the individual units, but mainly because their behavior is of no interest at all. Even if they could be analyzed in detail and subjected to a mathematical treatment, individ-

---

[3] The typology that divides sciences on nomothetic and idiographic is to a large extent obsolete and inadequate, but it is quite sufficient for our current purposes.

[4] I agree with these methodologists who claim that idealization is not distinctive character of scientific laws, but it is a typical feature of natural language. Nevertheless I am omitting here this reservation.

> ual cases could teach no more than the population taken as a whole. What could be the advantage of knowing the distance travelled by a particular molecule? Or of learning that a given molecule in a gas-filled vessel has collided with the wall at a given time and place and under certain circumstances? (…) There is no point in knowing which particles collide at a given moment, what is important is the average number of collisions and the probability of any given particle participating in one [Jacob 1993, p. 196].

The same attitude in the same time was characteristics e.g. for Charles Darwin and for representatives of social sciences.

Now, although the sciences contrasted to the nomothetic ones, namely the idiographic sciences, are described as "the sciences of facts", they also are not interested in every fact. Prof. Haack gave an example of the situation in her essay. She wrote about history:

> Any account of a past event — a battle, say, the fall of an empire, the birth of a nation — will, inevitably, be incomplete. A report of a battle, for example, will surely tell us which side won, what the consequences of this battle were for the war and perhaps for subsequent events, perhaps how many combatants were killed and how many injured, which commanders performed notably well or notably poorly, perhaps what the weather or the terrain contributed to the result, maybe even something about this general's insistence on taking a bath every morning no matter the circumstances, or that drummer-boy's heroism, and so on; probably not, however, how many horses were killed or tanks destroyed, and surely not how many ants or flowers were crushed during the battle, or …, etc. It conveys only part of the whole truth about "what really happened" [Haack 2011, p. 17].

And however an actual report on the battle may differ in some points from the cited instance (e.g. information about killed horses or destroyed tanks is usually important from the military point of view), it is obvious that every such report omits many data which are possible to collect but insignificant for the purposes of the author or addressee.

Władysław Tatarkiewicz once proposed replacement of the 'idiographic sciences' label by the 'typological sciences' one, as he considered that the main aim of these sciences is distinguishing different types of analyzed phenomena [Tatarkiewicz 1945, p. 31]. That profile perhaps does not apply to all traditionally idiographic sciences (like a large part of political history), but applies to sufficiently many of them (as biological systematics, history of art or some parts of archeology) to make it clear that in these sciences even newly discovered phenomena of potentially relevant kind may bring about rather superfluous information (as in the case of e.g. another specimen of beetles or umpteenth ceramic potsherd belonging to one of already well described types).

Stipulations mentioned above are seriously complicated by the circumstance that the domain of relevance is usually not delineated in advance. It is shaped during the process of development of a scientific discipline and its shaping is an essential part of this process. It is at first established hypothetically, for the sake of purposes of initial research, and then, in the process of research, it changes and becomes adapted to the received results. Consequently, what is important for science or what may be omitted without loss, is also hypothetical and changeable.

2.5 Unobtainable knowledge

Aside from information which is not important or not interesting for science, there is a lot of facts and regularities which are not accessible due to physical or logical reasons. Our knowledge always will be partial, because we simply cannot find out many things however important or interesting they would be. The list of inaccessible aspects of the world includes e.g. remote regions of space, some features of micro-particles, some past events or features of past states and beings.[5]

Reasons of the inaccessibility may be fundamental as well as accidental. There are physical laws which preclude getting some information — Heisenberg's uncertainty principle is probable the best known example of them. Numerous instances of unobtainable information are provided by historical sciences — human history as well as geological or paleontological history of the Earth. It is well known that our knowledge of paleontology is full of accidental omissions — or, as one might say, our whole paleontological knowledge is almost accidental. Fossilization of dead organisms is rare exception, so our successful discoveries of fossil sides, mollusks or dinosaurs are rather lucky accidents than normal practice — despite the fact, that modern paleontologists know more or less where to look for them. Some authors see in that circumstance a great difference between (micro-)physics and prehistory. For example Derek Turner writes on "asymmetry of background theories" between these two domains. In physics background theories provide new means for observing and researching micro-particles, background theory of paleontology — taphonomy — inform us, how little of prehistory we can learn [Turner 2007]. Although the contrast drawn out by Turner seems too sharp — taphonomy provides also much information about places and circumstances in which paleontologists can find some fossils — general conclusion of it must be that we will never know about prehistory as much as we want to. Moreover, apart from information of past species we probably will never find, there is some information about past organisms whose fossils luckily are uncovered, that we'll never get. Colors of dinosaurs is a well-known instance of that kind of information — as skin or feather doesn't remain so long in fossilized state, we never get to know of that aspect of dinosaurs' appearance.

2.6 "Non-ready-made" world

Partiality of truth as described above was treated generally as some weakness of science — weakness of scientists who do not want to or are not able to escape omis-

[5] For more on the problem see e.g. [Barrow 1998].

sions, or weakness of science itself which does not "catch" the whole truth about nature. However, behind the charge there is hidden an assumption that the world examined by science is "ready-made", as Hilary Putnam said. Such a world in principle might have been examined *in toto*, had the science adopted such a goal (which was not the case only because of human imperfection or selective interest). This assumption however, realistic as it is in a strong sense (it is a "metaphysical realism" in Putnam's words), is questionable in many ways. One of the most intriguing of them is Putnam's "internal realism" and — being a kind of development of it — "pluralistic realism" of Adam Grobler. The shared belief of both is that there is not one "ready-made" world, which is in some way reflected by science. The construction of the world is co-determined by our conceptual schemes or necessary conditions of our cognition. Apart from the details of these both conceptions, what is important for the purpose of the present typology is the statement that concept of the "whole truth" within science (as well as outside of it) is just empty.

Putnam's realism is not very convenient in proceedings with the present topic, because Putnam's attitude towards the correspondence theory of truth is not quite straightforward. Grobler, in the contrary, tries to connect his pluralistic realism with Tarski's theory of truth, suitably (and somewhat "heretically") interpreted. He proposes a concept of truth in a conceptual scheme, attuned to our specific cognitive necessities. Grobler's conceptual schemes are of local, not global nature. And he explains:

> This involves taking a conceptual scheme as something that organizes a segment of our experience, with respect to specific cognitive interests… [Grobler 2000, p. 153].

And schemes are comparable and evaluated as better or worse, because truth keeps its normative character. For illustration of his idea, Grobler uses an analogy of different kinds of maps. Maps do not mirror landscape in exactly the same manner but vary in type according to different purposes they serve; but within the limits of their kinds they may be compared and evaluated [Grobler 2006, p. 302-309]. The same analogy is used by other authors, who try to find the golden proportion between somewhat naïve metaphysical realism and radical constructivism. For example Martin J.S. Rudwick writes:

> Bookish people with no practical experience of mapping often assume that a map is an unproblematic replica of reality, or merely a miniaturized version of what one would see from the air. Those who make intensive use of cartography know on the contrary that any map is a pervasively conventional representation. They also know that an indefinite number of different maps of the same area can be made for different purposes, yet all may be equally valid representations of the same natural reality. Even where such maps prove to be mistaken, they are always corrigible; but it makes no sense to talk of ever achieving a uniquely 'perfect' representation, or a complete 'correspondence' with reality, since different kinds of map are designed for different uses, and there is no limit to the further representations that may be needed for new and unforeseen purposes.

> It should be clear that the analogy of mapping yields a way of retaining the constructivists' insistence on the social processes that went into the making of a piece of scientific knowledge […], while also allowing the realists' insistence that the real natural world […] had a more than marginal effect on that claimed knowledge [Rudwick 1985, p. 454].

There is no place to expand the question of realism, especially that it would require taking up a topic of truth in much broader scope. In short may be only said that, according to authors mentioned in this paragraph, the partiality of truth springs not so much from the nature of scientific practice or of investigated world as from the nature of truth itself.

3. SOME REMARKS IN CLOSING

The above typology is undoubtedly rough and can be developed and specified. Even in the present form however it can show that the question of partiality of truth in science is connected with wide scope of problems from different fields of study on science. It is important for the analysis of scientific communities in many aspects — as an element of scientific ethical code that condemns lying and lack of professionalism or as a contribution to pragmatics of communication, taking conversational implicatures into consideration. It is also connected with the constatation that the results of the scientific research itself co-define the limits of scientific accessibility. Finally, it touches philosophical problems connected with the definition of truth and the problem of realism, as well as the problem of progress in science. The typology can thus be used as an argument for purposefulness of interdisciplinary analyses of problems connected with phenomenon of science. On the other hand, it seems that a depiction of the problem of truth's partiality on the level of the logical value of individual sentences, as Prof. Haack tries to do it in some parts of her article, is little fruitful. Partiality of truth seems to have much to do with relevance and comprehensiveness of our knowledge than with attributing logical values to individual sentences.

BIBLIOGRAPHY

Agassi J. [1975a], *The Nature of Scientific Problems and Their Roots in Metaphysics*, in: J. Agassi, *Science in flux*, Dordrecht-Boston: D. Reidel Pub. Co., p. 208-239.

Agassi J. [1975b], *Questions of Science and Metaphysics*, in: J. Agassi, *Science in Flux*, Dordrecht–Boston: D. Reidel Pub. Co., p. 240-269.

Barrow J.D. [1998], *Impossibility. The Limits of Science and the Science of Limits*, Oxford: Oxford Univ. Press.

Gleick J. [1987], *Chaos. Making a New Science*, New York: Penguin Books.

Grice H.P. [1991], *Logic and Conversation*, in: H.P. Grice, *Studies in the Way of Words*, Cambridge, Mass.: Harvard University Press.

Grobler A. [2000], *Prawda a względność* [*Truth and Relativity*], Kraków: Aureus.

Grobler A. [2006], *Metodologia nauk* [*Methodology of Sciences*], Kraków: Aureus, Znak.

Haack S. [2011a], *The Whole Truth and Nothing but the Truth*, this volume, *Filozofia Nauki* R. XIX nr 4(76), p. 7-23.

Haack S. [2011b], *Professor Twardowski and the relativist menace*, this volume, *Filozofia Nauki* R. XIX nr 4(76), p. 25-33.

Jacob F. [1993], *The logic of life. A history of heredity*, transl. B. E. Spillmann, Princeton: Princeton Univ. Press.

Krajewski W. [1998], *Prawa nauki. Przegląd zagadnień metodologicznych i filozoficznych* [*Laws of Science. Survey of methodological and philosophical issues*], Warszawa: Książka i Wiedza.

Łukasiewicz J. [1970], *Creative elements in science*, in: J. Łukasiewicz, *Selected works*, ed. L. Borkowski, Amsterdam: North-Holland, Warsaw: PWN, p. 1-15.

Nowak I. [1976], *Prawda cząstkowa — prawda względna — prawda absolutna* [*Partial truth — relative truth — absolute truth*], in: *Teoria a rzeczywistość*, Poznańskie Studia z Filozofii Nauki, vol. 1, Warszawa-Poznań: PWN, p. 225-255.

Popper K.R. [2002], *Truth, rationality, and the growth of knowledge*, in: K.R. Popper, *Conjectures and Refutations*, London-New York: Routledge, p. 291-338.

Putnam H. [1983], *Why there is not a ready-made world*, in: H. Putnam, *Realism and reason. Philosophical Papers*, vol. 3, Cambridge: Cambridge Univ. Press, p. 205-228.

Putnam H. [1987], *The many faces of realism*, in: H. Putnam, *The many faces of realism*, La Salle, Ill.: Open Court Pub. Co., p. 1-91.

Rudwick M.J.S. [1985], *The Great Devonian Controversy. The shaping of scientific knowledge among gentlemanly specialists*, Chicago-London: The Univ. of Chicago Press.

Tatarkiewicz W. [1945], *Nauki nomologiczne a typologiczne* [*Nomothetic and idiographic sciences*], "Sprawozdania PAU", XLVI, nr 1-5, p. 28-34.

Turner D. [2007], *Making prehistory. Historical science and the scientific realism debate*, Cambridge: Cambridge Univ. Press.