

FORMAL LOGIC AND DIALECTICAL-MATERIALISM IN THE SOVIET UNION

Fania Cavaliere, *La logica formale in Unione Sovietica: Gli anni del dibattito, 1946 – 1965* (Firenze, La Nuova Italia Editrice, 1990. 140pp., Lira 42.000) and A.R.D. Mathias, "Logic and Terror," *Jahrbuch 1990 der Kurt-Gödel-Gesellschaft* (Wien, Kurt-Gödel-Gesellschaft, 1991), 117–132.

Reviewed by

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§1. There have been no sustained histories of the over-all development of Soviet work in logic since the appearance in 1959 of Sof'ya Aleksandrovna Yanovskaya's hundred-plus page survey on "Mathematical logic and foundations of mathematics" in the USSR of the period 1947–1957. This survey was preceded by Yanovskaya's far shorter survey on "Foundations of mathematics and mathematical logic" in the USSR for the period 1917–1947, which appeared in 1948. Although this earlier historical survey covered four decades, compared to the single decade surveyed by Yanovskaya's later work, the older paper was far shorter — by about sixty percent.

Cavaliere's book is the first serious and extended recent treatment of a crucial period in Soviet intellectual life, and in particular of the philosophical issues that led to, and help explain, the differences between Yanovskaya's two surveys. It is not the case that there was far less work in logic being carried out by Soviet researchers during the 1917 – 1947 period than during the following decade. In fact, much important work was done in logic, set theory and foundations during the immediate post-revolutionary period. One needs only think of the names of Kolmogorov, P.S. Aleksandrov, P.S. Urysohn, and N.N. Luzin, to name only the better-known Soviet logicians and set theorists of the period, to realize that important work was being carried out in intuitionistic logic, set theory, and theory of analytic functions by Soviet logicians. To this list of more familiar names, may be added the names of other figures, no less important, but less well known — for example D.A. Bochvar (b. 1903), who contributed to set theory and who offered non-classical systems as a means of dealing with the Russell paradox, and Ivan Ivanovich Zhegalkin (1896-1947), who in 1927–29 developed truth-tables for propositional logic, independently of Wittgenstein, Post, or Łukasiewicz, all in 1921 (and even for first-order quantification theory). The

students of some of these earlier figures, for example P.S. Novikov and A.A. Markov the Younger, whose work is familiar to all logicians, did much of that work in the late 1950s. They could not have done their work were it not for the advances made by their teachers in the preceding generation.

If we compare the length of Yanovskaya's two surveys *together with* their respective titles, what the differences indicate, as a simple comparison of length alone cannot, is a deep change in the philosophical climate of intellectual life in the USSR. This philosophical climate was formed by the ideological confrontation between "formal" logic and dialectical logic that Cavaliere's book describes. There have been numerous, but usually very brief, attempts by Western historians and philosophers of logic to give the history of this confrontation, for example by J.M. Bocheński, D.D. Comey, J. Hänggi, and Guido Küng and by Soviet émigré historians and philosophers of logic such as Alexander Phillipov. But Cavaliere's book is the first sustained and systematic full-length treatment of this history in twenty years. (See §5 below for a list of the major western-language studies.)

§2. Soviet logicians and philosophers were as concerned during the first six decades of the twentieth century with foundational issues as were their Western colleagues. Bochvar's nonclassical systems, as mentioned, were designed to provide an antidote to the Russell paradox, by developing in particular multiple-valued systems in which the paradox is resolved, as was Novikov's system § in the 1950s. But the constructivism of Kolmogorov and the intuitionism of Valerii Ivanovich Glivenko (1897–1940) were meant not merely to serve in the classical foundational debates between Logicism, Formalism, and Intuitionism; the constructivism of Kolmogorov and Markov was also meant to provide a formal system which would also be ideologically compatible with dialectical logic. The algorithmic constructivism developed by Markov in the late 1940s through the 1950s took a linguistic approach which was fully in consonance with Stalin's famous "Letters on Marxism and Linguistics" which appeared in the newspaper "Pravda" in September 1950, while at the same time being scrupulously faithful to mathematics (as such Soviet work in constructive real analysis by G.S. Tseitin, B.A. Kushner, and N.A. Shanin and their colleagues over the past three decades has shown). It is thanks to the work of the Markov school that logicians were no longer forced, as the Georgian set theorist Levan Petrovich Gokieli (1901–1975) had been, in his paper (1937) "On the Concept of Function," to redefine the concept of a *function* to suit the criteria formulated by the dialectical strictures developed in Karl Marx's mathematical manuscripts.

There are several aspects to the nature of the debate between formal logic and dialectical logic. First and foremost, zealous dialectical philosophers (most notably Arnošt Kol'man and V.N. Molodshij) regarded formal logic — meaning traditional syllogistic as well as modern mathematical logic — as ideologically unsound, even dangerous. It is "idealistic" in the philosophical sense that, as "formal", it is abstract and subjective, based upon ideas

rather than upon objective material reality. The response of the defenders of formal logic was to show the practical “usefulness” of formal logic. Thus, the first part of Yanovskaya’s 1948 survey was devoted to the contributions which formal logicians can have for the advance of materialist science — for example the role which Boolean algebra plays in the construction of electrical relay circuitry. It should not be surprising, therefore, that many Soviet logicians during the period 1917–1957 were interested in, and contributed to, cybernetics and electrical circuitry design.

On another level, dialecticians regarded formal logic as an insignificant fragment of dialectical logic. On this view, dialectical logic is the logic of motion and change, and formal logic is the logic of the “frozen moment”. For dialectical logicians, this dynamic logic depended, even thrived, upon the contradictions between thesis, antithesis, and unifying synthesis of the Hegelian triadic logic. No doubt the enthusiasm for developing axiomatic systems of formal logic free of the Law of Excluded Middle was influenced by the need for Soviet logicians to accommodate the dialecticians; and no doubt the willingness of mathematical logicians to work on such systems as constructivist logics, multiple-valued logics, and paraconsistent logics, to develop formal systems free of Excluded Middle, contributed to the eventual acceptance by dialecticians of the work of their mathematical colleagues. So at this level, the dialecticians were eventually able to accept a “peaceful coexistence” with their mathematical colleagues, while retaining a sense of missionary superiority over formal logicians. In response, mathematical logicians such as Yanovskaya endeavored, to show that they, too, like the dialecticians, were defenders of the revolution. In a series of papers on the geometry of Lobachevskij in the early 1950s, for example, Yanovskaya showed how Lobachevskij’s non-euclidean geometry not only was not “idealistic”, but was “progressive”, even revolutionary for science and for human thought. By implication, the same was said about mathematical logic. This did not immediately obviate the need for Yanovskaya and her colleagues to engage, at times, in “self-criticism” in response to the attacks of dialecticians such as Molodshij and Kol’man. Nor did it save Gokieli, in the early Soviet years, from having to define a function in dialectical terms, but at least it became possible for constructive mathematicians to define functions constructively, in the mathematically respectable terms of algorithms of a certain kind. In the 1980s, however, Shanin has gone even further, by developing his “finite mathematics” as “constructive mathematics without the underlying constructivist philosophy.”

There was, finally, the more familiar foundational question raised by the set-theoretic paradoxes and, later, by Gödel’s incompleteness results. Dialecticians took these results to show the bankruptcy of formal logic. The work of Kolmogorov, Bochvar, and others in developing formal systems of logic without Excluded Middle — constructive logic, multiple-valued logics and set theories, and paraconsistent logics — during the 1940s–50s, was rooted in the need to continue work in formal logic while avoiding the “pitfalls” of the classical systems that were under attack by dialecticians.

One of the more particularly bizarre developments in the debate between formal and dialectical logic, already mentioned, occurred when renowned Georgian set-theorist L.P. Gokieli sought to redefine functions in dialectical terms. In general, much valuable energy was used by Soviet logicians and mathematicians in their polemical exchanges with dialecticians. These ranged from defenses of formal logic and mathematical logic, as exemplified by the collection of papers (Сборник статей по философии математики), edited by Yanovskaya and published in 1936, which included articles by such noted researchers as Kolmogorov, the algebraist A.G. Kurosh, as well as by Yanovskaya herself, logicians Glivenko and by their most bitter opponent Molodshij; to V.F. Asmus's refusal to publish a second edition of his famous logic textbook of 1947; to the assertions in such logic textbooks as that of M.S. Strogovich in 1949 in which we find such statements as those declaring that "the laws of thought have an empirical character" even though logic is "the science of correct reasoning;" to the infamous "self-criticisms" such as Yanovskaya's "Letter to the Editor" in the third number of volume 4 of the journal *Voprosy Filosofii* ("Problems of Philosophy") in 1950. The illness and death of Yanovskaya has been said (by her student, historian of mathematics S.S. Demidov of the Academy of Sciences; personal conversation) to have been caused by the vicissitudes of the formal/dialectical logic debates in which she was forced to participate and in which she had to endure the attacks of Molodshij.

As readers of the *Mathematical Intelligencer*, as well as readers of recent issues of journals such as Историко-математические исследования (*Historico-mathematical Studies*) and *Philosophia Mathematica* will know, the formal logicians were not alone in facing the onslaught against formalism and the attacks of the dialecticians. Egorov, Luzin, and others faced the same kind of debate. Most articles dealing with these cases, however, emphasize the political aspects, for example the expulsion of Father Pavel Florenskij from Moscow State University for his religious and idealistic turn, the squelching of Egorov's career, and the isolation of Luzin. Cavaliere's book, however, examines in detail the philosophical and broader intellectual aspects of the debates between the formal logicians and the dialecticians. It is the only book to date in a Western European language to do so. It is restricted, however, to the pivotal period of 1946–1965, when mathematical logic was making a transition from ideological pariah to legitimate discipline in the USSR.

This transition is exemplified, as we have noted, by the differences between Yanovskaya's 1948 and 1959 surveys of Soviet research in mathematical logic and foundations of mathematics. That I have selected Yanovskaya as the person around whom to examine the theme of Cavaliere's book is explained by the fact that the change in status of mathematical logic owes much, if not more, to Yanovskaya's tireless efforts than any other single person.

A notable change in climate occurred in Soviet cultural and intellectual life between 1950 and 1960, in particular in the debate between logicians and dialecticians. This change

is the core of the history which Cavaliere recounts. The decisive moment came in the guise of Stalin's famous letter on Marxism, and linguistics. Against overzealous dialecticians and dialectical-materialist philologists who argued that language is a weapon of class warfare and in the control of the ruling politico-economic class, Stalin argued that a language belongs to all of its speakers. This was seen to apply equally to logic as *formal* language, and to mathematics as the language of science. (Markov's algorithmic constructive mathematics is a good example of this kind of thinking; here, an *algorithm* is a *prescription* for uniquely determining constructive processes, that is for the manipulation of words which are names of mathematical objects. This is hardly to say that Markov's thinking along these lines resulted from Stalin's letter, of course. On the contrary, Prof. B.A. Kushner (personal communication (2 August 1993) reminds us that Markov did not have this letter in mind while developing his constructive approach, but conceived it, in his own words a good deal before the war). From this perspective, logic is no longer an *ideal* language—ideal in the sense of opposition to materialism. Formal logic could now be codified—if not canonized—as a subspecies of the wider dialectical logic, and its legitimacy is thereby established. During this period, we see important conferences taking place to examine the role of formal logic within the scientific architectonic; alongside of these, other conferences that took place to create the doctoral degree program of mathematical logic at Moscow State University, to improve the logic curriculum at secondary and collegiate levels at all of the schools in the USSR, and to improve the textbooks that would be used for these new or improved logic courses. This change may be exemplified as much by a comparison of the history of V.F. Asmus's logic textbook in the earlier period with the rapid appearance in the second half of the 1950s of such textbooks, for example, as P.S. Novikov's *Elements of Logic*, a textbook certainly on a par with the best logic textbooks in the West of the same time, and to some extent superior to some of its Western counterparts, as by a comparison between Yanovskaya's two surveys.

Cavaliere examines three broad issues: (1) the relationship between formal logic and dialectical logic; (2) the status of mathematical logic with respect to mathematics and philosophy; and (3) the problems of contradiction and of its reflection in thought as these problems shaped the development of the debate on the connections between formal logic and dialectical logic. These three themes correspond to the three aspects or levels of the debate between formal and dialectical logic which I have outlined, and Cavaliere's book is thus a thorough history of the conflicts between formal logic and dialectical logic as I have outlined it. Her account ends in 1965. This is a most appropriate choice. It was in 1966 that I.S. Narskij, in his policy-making paper «О положений в логике и ее месте в университетском образовании» (On the state of logic and its place in university education; *Философские науки* 3 (1966), 101-110) set the ground-rules for role that logic should play in university education, after the bitter battles from the 1930s to mid-1950s between zealot dialecticians such as Arnošt Kol'man and V.N. Molodshij and mathematicians, logicians

and historians of logic and mathematics such as S.A. Yanovskaya. It was in this paper — a paper not considered by Cavaliere — that Narskij was able to declare that traditional logic no longer exists, that formal logic now *is* mathematical logic. From this time forward, Soviet logicians and mathematicians were able to work largely unencumbered by the need to guard against dialectical zealotry. Within the next few years, mathematical logic gained a strong independent and respected place in the USSR and Soviet logicians came in the 1970s to regain the place in the universal community of logicians that had been occupied in the early Soviet years, especially in the 1920s, by such predecessors as P.S. Aleksandrov, V.I. Glivenko, A.N. Kolmogorov, N.N. Luzin, and P.S. Urysohn.

In a random scan of Cavaliere's book I noticed frequent misprints that pertain to the spelling of names. Here, for example, is a partial list of this type of misprint: in footnote 24 on p. 18, "I. N. Žegalkin" should be "I. I. Žegalkin"; in footnote 5 on p. 27, footnotes 25 and 27 on p. 36, and in the bibliography on p. 126 "Hanggi" should be "Hänggi"; on p. 136 in the bibliography "Resher" should be "Rescher"; on p. 67 and p. 136 in the bibliography "Ružavin" should be "Ruzavin"; and in one of the bibliographic entries on p. 139 for "Vojšvillo", we also find the spelling "Voišvillo".

§3. A much less systematic, less detailed account of the history of the attacks on formal logic by the dialecticians is given by Mathias. Although his account is accurate, it is more impressionistic and more focussed on personalities than issues. Moreover, it relies very heavily on secondary sources, most notably Phillipov's polemical and prejudiced account in *Logic and dialectic in the Soviet Union* (New York, Varangian Press, 1952). It is written at a level suitable for the *Mathematical Intelligencer*, and readers of the *Intelligencer* will already have as much information about the subject, albeit as applied to Egorov and Luzin instead of Asmus. Phillipov's book is handicapped by its definition of "formal logic" as consisting of what usually gets covered in philosophy department introductory logic and symbolic logic courses — propositional logic, categorical syllogisms, some first-order functional calculus (enough, at least to talk about Gödel's incompleteness theorems), and some set theory (enough at least to talk about the Russell paradox and the theory of types).

The first four pages of Mathias's article are given over to a capsule history of the concept of "dialectic" and of logic without the Law of Excluded Middle, from ancient Indian logic to Brouwer, with particular attention to Hegel, Marx, and Engels. A few words from Lenin open the way to the central concern of Mathias's paper. The paper takes up its subject from the late 1920s (1929 is specifically mentioned as the year that Asmus quoted Hegel in attacking the Law of Excluded Middle). The narrative leaves off at precisely the moment when Soviet logicians and philosophers were beginning to react to Stalin's theory on Marxian linguistics searching for a way to apply the theory to formal logic. Coincidentally, Mathias's account does not go beyond the time frame established by Phillipov's book, in particular its publication date. Mathias's paper, relying as it does on Phillipov's

history and Phillipov's restricted conception of formal logic, focuses exclusively on the negative aspects of the dialactical/formalist debates rather than on some of the creative aspects, such as Yanovskaya's valiant efforts to defend formal logic.

§4. The restriction of the subject to *philosophy* of logic in both Cavaliere's book and Mathias's paper forces both to neglect the work of mathematicians such as Shestakov and Trakhtenbrot in the 1940s and early 1950s who were concerned with practical applications of formal logic, e.g. in working in Boolean algebra for applications to electric-relay circuitry, in an effort to demonstrate the value of their subject; or the work of their colleagues who, like Luzin and Mal'tsev were able to carry out work in logic and set theory under the umbrella of other mathematical disciplines such as analysis, topology, or algebra, gaining for their work some measure of protective coloration, however precarious; or the work of those like Kolmogorov and Markov who developed formal logics free of the law of excluded middle and could thereby gain for mathematical logic some acceptance by dialecticians.

§5. The majority of Western-language surveys of logic in the USSR are brief and tend to define logic narrowly, to include primarily classical logic and introductory symbolic logic (equivalent in scope and depth to the logic found in introductory symbolic logic textbooks for philosophy students). This can be traced back, in part to Phillipov's book, which (a) gave the impression that nothing beyond this elementary level work in logic was being carried out by Soviet logicians and (b) ignored the work of logicians with a mathematical background, such as Luzin, Markov, Kolmogorov, Novikov, their colleagues and students. Moreover, these studies focused attention on the philosophical aspects of Soviet work in logic, and in particular on the ideological-philosophical difficulties which dialecticians placed in the path of researchers in formal logic, ignoring the important technical "mathematical" work in logic being carried out by Luzin, Markov, Kolmogorov, Novikov, their colleagues and students. This was again due in part to the focus of Phillipov's book. To these factors, we may add the consideration that the majority — which of course does *not* mean ALL — of those writing about logic in the USSR were themselves primarily philosophers rather than mathematicians.

The most important, influential and easily accessible of the western-language studies of general logic in the USSR are the following:

J.M. BOCHENSKI. 1961. *Soviet logic*, *Studies in Soviet Thought* 1, 29–38.

F. CAVALIERE, 1985. *Cenni sul recente dibattito nell'ambito delle logiche formali in Unione Sovietica*, *Epistemologia* 8, 321–328.

— . 1988. *Il dibattito sulla logica in Unione Sovietica (1945 – 1965)*, *Rivista di Storia della Filosofia*, n. 3, 533–569.

—. 1990. *La logica formale in Unione Sovietica: Gli anni del dibattito, 1946 – 1965*, Firenze, La Nuova Italia Editrice.

D.D. COMEY. 1962. *Two recent Soviet conferences on logic*, *Studies in Soviet Thought* 2, 21–36.

—. 1966. *Current trends in Soviet logic*, *Inquiry* 9, 94–108.

J. HÄNGGI. 1967. *Die Entwicklung der Diskussion um die formale Logik in der Sowjetunion*, *Studies in Soviet Thought* 7, 142–153.

—. 1971. *Formale und Dialektische Logik in der Sowjetphilosophie*, Winterthur.

—. 1971. *Bibliographie der Sowjetischen Logik*, Winterthur.

G. KÜNG. 1961. *Mathematical logic in the Soviet Union (1917 – 1947 and 1947 – 1957)*, *Studies in Soviet Thought* 1, 39–43.

—. 1962. *Bibliography of Soviet work in the field of mathematical logic and the foundations of mathematics, from 1917 to 1957*, *Notre Dame Journal of Formal Logic* 3, 1–40.

A.R.D. MATHIAS. *Logic and terror*, *Jahrbuch 1990 der Kurt-Gödel-Gesellschaft* (Wien, Kurt-Gödel-Gesellschaft, 1991), 117–132.

A. PHILLIPOV. 1952. *Logic and dialectic in the Soviet Union* (with a Foreword by E. Nagel), New York, Varangian Press, *Studies on the USSR*, no. 1, lithographed; Research Program on the USSR (East European Fund, Inc.).

A. WINKELMANN. 1956. *Die Stellung der formalen Logik im Sowjetunion*, *Scholastik* 1, 85–89.

A. A. ZINOV'EV. 1968. *Logic in the USSR*, in R. Klibansky (editor), *Contemporary philosophy, a survey, I. Logic and foundations of mathematics* (Firenze, La Nuova Italia Editrice), 209–219.

Finally, Luciano Pennino's *La logica simbolica nella produzione scientifica in lingua russa (1961 – 1983)*, reviewed below, is, despite its title, a much more specialized study. (It should also be noted that Guido Küng's survey and bibliography are explicitly and directly derived from Yanovskaya's two surveys.)

In addition to the studies listed, I undertook in 1982 the writing of a full-scale multi-volume technical survey of the history of mathematical logic in Russia in the Soviet period (1917 – 1992); work on the first volume, dealing with the historical background of Soviet work in logic and a survey of Soviet work in general logic and foundations is nearly completed and should be ready for publication in 1996.¹ Surveys of Soviet work in the specialized subfields (model theory, Boolean algebras and algebraic logic, set theory,

¹It is anticipated now that the first volume will be expanded, in collaboration with V.A. Bazhanov, to include a full-scale history of logic in Russia in the pre-Soviet period as well.

recursion theory, proof theory, constructive mathematics, non-classical logics, and applications of logic) are still in the planning stages. for succeeding volumes. The over-all project was announced and described in *History and Philosophy of Logic* 8 (1987), 71–76 and *Historia Mathematica* 14 (1987), 285–287. (As far as I am aware, the only general history of logic in Russia from the tenth to late nineteenth centuries in any western language is my “Theology Against Logic: The Origins of Logic in Old Russia,” *History and Philosophy of Logic* 13 (1992), 15–42, which emphasizes the period of the pre-Petrine to Catherinian eras from the late fifteenth to mid-eighteenth centuries, and especially the Petrine era from the late seventeenth to early eighteenth centuries; my related paper, on “Logic in Russia’s Western Lands, Sixteenth – Eighteenth Centuries,” meanwhile remains unfinished.)

Luciano Pennino, *La logica simbolica nella produzione scientifica in lingua russa (1961 – 1983)*, Aleph: Collona di Logica Universale E Filosofia 4, Roma/Napoli, LER, 1990.

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The title of this book promises much more than is actually produced. The reader who, even in a casual way, took note of the writings of Soviet logicians will not be surprised by this. After all, if Yanovskaya was able to produce over a hundred pages to survey the work of her colleagues over the decade 1947 – 1957, one might easily anticipate that more than ninety-eight pages would be required to survey the logical research of Soviet logicians writing in Russian over the twenty-three year period 1961 – 1983, in particular when this was one of the most prolific and profound periods for Soviet work in logic. A closer look reveals that there are barely eight-six pages of text in Pennino’s book, provided one includes the bibliography in the count. The amount of textual content is further reduced by the oversized (13 point) type, which appears ever larger because of the unusual style chosen (*boldface italic*).

Apart from the unusual style of typography, there are other typesetting features marring the presentation: logical symbols and Greek letters are written in by hand, and so are superscripts and subscripts, even when requiring only letters from the Roman alphabet or a