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Review of

EDMUND HUSSERL, *EARLY WRITINGS IN THE PHILOSOPHY OF LOGIC AND MATHEMATICS*

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Impressed by Karl Weierstrass's work to arithmetize analysis, Edmund Husserl set out in the late 1880s to provide a more detailed analysis of the concepts of arithmetic and a deeper foundation for its theorems by analyzing the concept of number. The results of those efforts are found in his 1887 "On the Concept of Number" and his 1891 *Philosophy of Arithmetic*.

While undertaking these analyses, however, Husserl encountered difficulties associated with certain developments in mathematics which defined all his efforts at logical clarification. He found the questions to be so compelling that he finally abandoned his original project and set out to try to solve the logical and epistemological problems which his investigations into the foundations of arithmetic were raising ([21, pp. 41–43]).

Published in this volume are English translations of selected articles, reviews, unpublished writings, notes and letters written by Husserl between 1890 and 1910 which chronicle his search for answers to his questions about logic and mathematics, and provide invaluable insight into the evolution his ideas underwent between the time he wrote the *Philosophy of Arithmetic* and the publication of his groundbreaking work the *Logical Investigations* in 1900-1901. The special nature of Husserl's mature philosophy of logic and mathematics was already showing its hand in these early writings which, in the words of their translator, the philosopher Dallas Willard, "cover the progression of Husserl's *Problematik* from the relatively narrow one of clarifying the epistemic structure of general arithmetic, to the all-encompassing one of establishing, through phenomenological research, the line between legitimate and illegitimate claims to know or to be rational, regardless of the domain concerned" (p. vii). All of Husserl's writing appearing in the *Aufsätze und Rezensionen* volume ([23]) of the Husserliana series are published in this collection. The other texts of the anthology have been published in German in other volumes in the Husserliana collection ([20], [25], [26]). Many of these works are available here in English for the first time.

In his forty page introduction to this book, Willard discusses the major conceptual developments presented through the texts in the anthology (p. viii; p. xlv). However, although he has been one of those most intent upon pointing out the importance of these works for twentieth century logic ([41], [42], [43], [44]), his introduction was principally written for phenomenologists, and does not really discuss the place of these writings within the history of mathematical logic, set theory and the foundations of mathematics. So that is what I intend to do here, what I have to say having greatly benefited from his pioneering writings on the subject.

First of all, in order to arrive at any correct assessment of the place of these writings in the development of modern logic, one needs to know something of the context within which they were written. Almost all the works published in this book were written during Husserl's fourteen years as a *Privatdozent*, a kind of unemployed professor, at the University of Halle in eastern Germany, where he was befriended by the father of set theory, Georg Cantor.

Before repairing to Halle in 1886, Husserl had studied mathematics under Karl Weierstrass and, after writing a doctoral thesis on the calculus of variations, served as his assistant. Husserl has said that it was Weierstrass's lectures on the theory of functions which awakened his interest in seeking radical foundations for mathematics, and has described how impressed he had been to see Weierstrass hard at work laying bare the original roots of analysis and grappling with the elementary concepts and axioms out of which the whole system of analysis might be rigorously derived ([37, p. 7]).

The first writings anthologized in this volume display the evolution in Husserl's thought regarding Weierstrass's basic convictions regarding the foundations of arithmetic and analysis. "With respect to the starting point and the germinal core of our developments toward the construction of a general arithmetic," Husserl wrote in about 1891 in "The Concept of General Arithmetic", "we are in agreement with mathematicians that are among the most important and progressive ones of our times: above all with *Weierstrass*, but not less with *Dedekind*, Georg *Cantor* and many others" (p. 1).

As a faithful disciple of Weierstrass, Husserl initially took the "domain of 'positive whole numbers' to be the first and most underivative domain, the sole foundation of all remaining domains of numbers" (p. 2). And this thesis served as the starting point of his "On the Concept of Number" and the *Philosophy of Arithmetic*. However, by 1891 we find him confessing that the main thesis of his work on the foundations of arithmetic that "the concept of cardinal number forms the foundation of general arithmetic soon proved to be false" (p. 13).

The results of his work on the fundamental principles of arithmetic appeared to Husserl to be "of the greatest importance ... for the logical understanding of all mathematical sciences" (p. 17), but they left him with a host of burning questions about logic, reasoning, and symbolization. He felt that his work had brought him "close to the most obscure parts of the theory of knowledge," and that he was standing before "great unsolved puzzles" concerning the very possibility of knowledge in general (p. 167). He would describe himself as having been someone "powerfully ... gripped by deep, and by the deepest, problems" (pp. 492–93).

"How is it possible," we find him asking in about 1890, "that a blind mechanism of sensible signs can replace and spare us logical thinking" (p. 436)? Scientific knowledge, he reasoned, "is totally based upon the possibility of our being able to abandon ourselves completely to thought that is merely symbolic or is otherwise most removed from intuition, or of our being able purposively to prefer such thinking, with certain precautions, over thought more fully adequated to intuition. But how, then," he asked, "is rational insight possible in science? And how with such a style of thought does one even come to mere empirically correct results?" (p. 167).

Husserl always maintained that it was questions surrounding "imaginary" numbers (a category into which he at various times lumped negative, irrational, and complex numbers, the transfinite, and the actual infinite) which had to be the ultimate stumbling block and had precipitated his intellectual crisis. As he explained in his 1890 "On the Logic of Signs (Semiotic)" (pp. 20–51):

> General arithmetic, with its negative, irrational and imaginary ("impossible") numbers, was invented and applied for centuries before it was understood. Concerning the signification of these numbers the most contradictory and incredible theories have been held; but that has not hindered their use. One could quite certainly convince oneself of the correctness of any sentence deduced by

> means of them through an easy verification. And, after innumerable experiences of this sort, one naturally comes to trust in the unrestricted applicability of these modes of procedure, expanding and refining them more and more —all without the slightest insight into the *logic* of the matter, which ... up to today, has made no essential progress (p. 48).

However, Husserl protested time and time again, "a utilization of symbols for scientific purposes, and with scientific success, is still not therefore a *logical* utilization" (p. 48), and he lamented the mental energy wasted in "the endless controversies over negative and imaginary numbers, over the infinitely small and the infinitely large, over the paradoxes of divergent series, and so on" (p. 49). How much quicker and more secure the progress of arithmetic would have been, he believed, "if already upon the development of its methods there had been clarity concerning their logical character. And there likewise can be no doubt," he maintained, "that for the future continued development of arithmetic also ... insight into its logical character must be of decisive influence, promoting progress" (p. 49).

He was persuaded that deeper "insight into the essence of signs and sign techniques" would ultimately empower logic "to devise such symbolic modes of procedure as have not yet occurred to the human mind, and to establish rules for devising them" (p. 51). But he thought one might "search logical works in vain for light on what really makes such mechanical operations, with mere written characters or word signs, capable of vastly expanding our actual knowledge concerning the number concepts" (p. 50),

So the results of his investigations into the foundations of arithmetic appeared to him "to push us toward important reforms in logic" (p. 17). "Vainly we turn," he complained, "... to the old logic or the new. They totally leave us in the lurch. Logic ... must concede ... that all science is a mystery to it" (p. 168). He knew of "no logic that would even do justice to the very possibility of a genuine calculational technique" (p. 17). And set off on his own to find the answers to his questions.

The particular nature of Husserl intellectual crisis becomes clearer when we remember that at the time Husserl was keeping company with Georg Cantor who during Husserl's tenure in Halle was hard at work exploring, mapping and defending the uncharted, rich and strange world of transfinite sets. The new numbers and countless infinities Cantor was creating at the time were certainly counter-intuitive and paradoxical enough to shake most almost anyone's logical assumptions, and Cantor's work could have easily inspired in Husserl an acute awareness of the logical questions the introduction of such new numbers might raise. Remember that it was in the late 1880s that Cantor did some of his strangest work with numbers, creating what Joseph Dauben has called "dinosaurs of his mental creation, fantastic creatures whose design was interesting, overwhelming, but impractical to the demands of mathematics in general" ([3, p. 159]).

Husserl was also on hand as Cantor began discovering the antinomies of set theory ([3, pp. 240–270]). So in contemplating the intellectual evolution chronicled in this collection of Husserl's early writings, it is also helpful to remember that Husserl was not the only one whose logical assumptions were shaken upon coming into contact with Cantor's ideas. The ideas of the founder of set theory played a role in rocking the ground upon which Bertrand Russell, Gottlob Frege, Richard Dedekind and many others had hoped to derive arithmetic too. For it was in studying Cantor's 1891 proof by diagonal argument that there is no greatest cardinal number that Russell came upon the famous contradiction of the set of all sets that are not members of themselves which made him too call for important reforms in logic ([8], [9], [15, p. 1]).

Husserl's early first-hand experience of inconsistent sets and some of the more logic defying aspects of Cantor's theory of sets might actually have permanently innoculated the future founder of the phenomenological movement against any recourse to sets or classes. For Husserl would express grave doubts about extensional logic, by which he meant a calculus of classes (p. 443, for example), for the rest of his career. He would say that extensional logic was naïve, risky, doubtful and the source of many a contradiction requiring every kind of artful device to make it safe for use in reasoning ([19, pp. 74, 76, 83]; [18, p. 153]), a wariness already evident in "The Deductive Calculus and the Logic of Contents" and related articles (pp. 92–114, 115–120, 121–130, 135–138, 443-451) in which we find Husserl intent upon laying bare the "the follies of extensional logic" (p. 199) which he would replace by a calculus of conceptual objects. In these texts he seeks to show "that the *total* formal basis upon which the class calculus rests is valid for the relationships between conceptual objects," and that one could solve logical problems without "the detour through classes" (p. 109), which he considered to be "totally superficial" (p. 123). In the *Philosophy of Arithmetic* Husserl had attacked certain of Gottlob Frege's ideas about extensionality ([17]), but in this volume of writings Husserl's chief target is Ernst Schröder, which brings us to another interesting matter.

Buried in history has been the fact that Ernest Zermelo also discovered "Russell's" contradiction of the set of all sets which are not members of themselves. On April 16, 1902, Zermelo conveyed his proof to Husserl who duly recorded it, providing us with the only known record of Zermelo's version of the famous contradiction ([32]). Happily Husserl's record of Zermelo's finding has made its way into this book (p. 442).

Zermelo's exchange with Husserl turned upon certain remarks Husserl had made in his 1891 review of Ernst Schröder's *Vorlesungen über die Algebra der Logik* (pp. 52–91, 421–441). In the *Vorlesungen*, Schröder had tried to show that bringing all possible objects of thought into a class gives rise to contradictions. In his review, Husserl had written that though Schröder's argument might appear astonishing (*verblüffende*) at first glance, it was actually sophistical, but was prepared to concede that:

> in the case where we simultaneously have, besides certain classes, also classes *of* those classes, the calculus may not be blindly applied. In the sense of the calculus of sets as such, any set ceases to have the status of a set as soon as it is considered as an element of another set; and this latter in turn has the status of a set only in relation to its primary and authentic elements, but not in relation to whatever elements *of* those elements there may be. If one does not keep this in mind, then actual errors in inference can arise (pp. 84–85).

In Zermelo's opinion, however, Schröder had been basically right, but his reasoning had been faulty. According to Zermelo's argument as recorded by Husserl: given a set M which contains each of its sub-sets $m, m' \ldots$ as elements, and a set M_0 which is the set of all sub-sets of M which do not contain themselves as elements, it can then be shown that M_0 both does and does not contain itself (p. 442).

Three remarks may help remove some perplexity readers should feel upon examining the exchange between Husserl and Zermelo as it is presented in Willard's translation. First of all, Willard has Zermelo commenting that "In fact, Schröder is incorrect in his reasoning." However, I think Rang and Thomas did well to interpret the words "*In der Sache, nicht in der Beweisführung hat Schröder Recht*" ([23, p. 399]) as meaning that Zermelo considered Schöder to be right "in the issue", but that his reasoning was flawed ([32, p. 16]; [23, p. xx]), which is more in keeping with the point Zermelo actually makes. Second, a note indicating that Husserl wrote the last paragraph in pencil, not in ink ([23, p. 472]) would help explain why the idea in it expressed seems inconsistent with Zermelo's argument. The last paragraph was probably Husserl's addition ([32, pp. 17, 20]). Finally, Willard has Husserl writing that Schröder's argument is "at first glance quite impressive" (p. 84). Husserl, however, probably used the word "*verblüffende*" ([23, p. 36]) to describe a kind of astonishment more in line with what Frege meant when he wrote of Schröder's contradiction that it "comes like a thunderbolt from the clear sky. How could we be prepared for anything like this in exact logic! Who can go surely for it that we shall not again suddenly encounter a contradiction as we go on? The possibility of such a thing points to a mistake in the original design" ([6, p. 91]).

A further dimension of the intellectual crisis which led to the development of phenomenology finds its way into the "Personal Notes" which have made their way into this collection (pp. 490–500). There Husserl tells of how, "while laboring over projects concerning the logic of mathematical thought and of the mathematical calculus in particular" he had been "tormented by those incredibly strange real worlds: the world of the purely logical and the world of actual consciousness" (p. 490).

By "pure logic" Husserl meant "the traditional syllogistic, but also the pure theory of cardinal numbers, the pure theory of ordinal numbers, of *Cantorian* sets ... the pure mathematical theory of probability" (p. 250). So once again the nature of his torment becomes clearer when we realize that at the time Husserl was keeping company with Cantor, in whose writings consciousness and numbers mingle most promiscuously. For instance, during those years we find Cantor writing that certain knowledge "can only be obtained through concepts and ideas, ... which are principally formed through inner induction, like something which, ... already lay within us and is only awakened and brought to consciousness" ([1, p. 207, n. 6]; [11, p. 15]). For Cantor, "the act of abstraction ... effects or awakens in my intellect the concept 'five' " ([1, p. 418, n. 1]; [11, p. 128]), and the cardinal number belonging to a set was "an abstract image *in our* intellect" ([1, p. 416]; [11, p. 128]) ([16]).

Husserl ultimately concluded that "the profound difficulties which are tied up with the opposition between the subjectivity of the act of knowledge and the objectivity of the content and object of knowledge" (p. 250) could only be resolved through what he began calling phenomenological analyses. According to his new theories, pure logic would not itself include anything mental, any reference to acts, subjects, or real people. He would not, however, develop a theory of logic independent of all intuition and experience in Frege's sense. For it was Husserl's abiding conviction that

> one can considerably advance logical understanding of the soundness of symbolic thought (and above all, of course, mathematical thought) without a more penetrating insight into the essence of those elementary processes of intuition and the Representation which everywhere make that thought possible. But without such insight one cannot obtain a full and truly satisfactory understanding of symbolic thought or of any logical process (pp. 168–169).

For modern logicians wary of talk of phenomenological analyses or of any preoccupation with what Husserl called "that peculiar kind of psychological foundation which truly *is* indispensable for the illumination of the sense of the pure concepts and the laws of logic" (p. 208), a look at the connections between Husserl's ideas and those of David Hilbert can help set the issue into perspective and make Husserl's ideas more comprehensible. Remember that Hilbert wrote on several occasions that "the efforts of Frege and Dedekind were bound to fail" because:

> No more than any other science can mathematics be founded by logic alone; rather, as a condition for the use of logical inferences and the performance of logical operations, something must already be given to us in our faculty of representation (in der Vorstellung), certain extralogical concrete objects that are intuitively (anschaulich) present as immediate experience prior to all thought. If logical inference is to be reliable, it must be possible to survey these objects completely in all their parts, and the fact that they occur, that they differ from one another, and that they follow each other, or are concatenated, is immediately given intuitively, together with the objects, as something that neither can be reduced to anything else nor requires reduction. ([14, pp. 464–465]; also [13, pp. 376, 392]; [12, p. 162]).

This, Hilbert said, was the basic philosophical position that he regarded "as requisite for mathematics and, in general, for all scientific thinking, understanding and communication" (*Ibid.*).

Now Husserl's phenomenological analyses would perform precisely the task Hilbert described as being so necessary. Moreover, the philosophy of logic and mathematics which Husserl began developing in the early 1890s actually has a formalist flavor which was already making itself known in the reaction Husserl had in 1891 to Frege's article "On Formalist Theories of Arithmetic". In the dispute between Hilbert and Frege over formalism, Husserl would side with Hilbert. Partial copies of letters Frege sent to Hilbert were even found among Husserl's papers ([18]).

Further support for Husserl's conviction that "logic must not be a mere formal (mathematical) theory ... but requires phenomenological and epistemological elucidations in virtue of which we not merely are completely certain of the validity of its concepts and theories, but also truly understand them" (p. 215) has come from Kurt Gödel, a secret admirer of Husserl's phenomenology. In a posthumously published paper called "The modern development of the foundations of mathematics" ([7, pp. 374–387]), Gödel argues that

> the certainty of mathematics is to be secured not by proving certain properties by a projection onto material systems—namely the manipulation of physical symbols—but rather by cultivating (deepening) knowledge of the abstract concepts themselves which lead to the setting up of these mechanical systems, and further by seeking, according to the same procedures, to gain insights into the solvability, and the actual methods for the solution, of all meaningful mathematical problems (p. 383).

Gödel thought that the procedure by which it might be possible to extend knowledge of the abstract concepts in question was most nearly supplied by the systematic method for clarifying meaning prescribed by Husserl's phenomenology where, as Gödel writes, "clarification of meaning consists in focusing more sharply on the concepts concerned by directing our attention in a certain way, namely, onto our own acts in the use of these concepts, onto our powers in carrying out our acts, etc." (p. 383). Gödel viewed phenomenology as "a procedure or technique that should produce in us a new state of consciousness in which we describe in detail the basic concepts we use in our thought, or grasp other basic concepts hitherto unknown to us" (p. 383). According to Gödel, Husserl's theories could "safeguard for mathematics the certainty of its knowledge" and "uphold the belief that for clear questions posed by reason, reason can also find clear answers" (p. 381).

Finally, a word about the translation. Dallas Willard's choice of terms to translate some of the notoriously ambiguous terminology of the late nineteenth century is excellent (pp. xlv–xlvi). And his translation does justice to the clear, readable style of these texts which were written at a time in Husserl's life when he could still say: "I unfortunately do not have the gift of first coming to clarity in the process of writing and rewriting. But once I have come to a clear understanding, everything moves along rapidly" (p. 13).

For those interested in the development of symbolic logic and twentieth century logic in general, however, it is useful to add the following remarks. The extremely ambiguous German word "*Vorstellung*" was translated by Russell as "presentation", but has very often been translated into English by "idea" or "imagination". Willard uses "representation", a good choice. He has translated the *uneigentlich* of *uneigentliche Vorstellungen* as "inauthentic". It is helpful here to note that Husserl's distinction between *eigentliche Vorstellungen* (what is known directly through perception, intuition, memory, etc.) and *uneigentliche Vorstellungen* or *symbolische Vorstellungen* (what can only be known indirectly through signs, concepts, descriptions, etc.) is closely related to Russell's distinction between knowledge by acquaintance and knowledge by description as both men were influenced by Franz Brentano's distinction between authentic and symbolic presentations ([15, pp. 58–66, 125–135]).

Another extremely difficult term to translate is "*Inhalt*". Willard has chosen to use "content", which is correct. However, in certain logical contexts when the word is used to refer to the content of a concept, or when *Inhalt* is contrasted with *Umfang*, extension, the issues become clearer when "intension" is used in the place of "content". This is particularly the case in Husserl's discussions of an extensional logic of classes as opposed to an intensional logic of conceptual objects.

Particularly commendable is Willard's decision to use capital letters to indicate that Husserl used certain key terms (ex. Evidence, Idea, Representation, Illumination, Moment) in ways which have no exact English equivalent (pp. xlv–xlvi). This is surely preferable to inventing, as others have, a bizarre terminology which distorts Husserl's words and obscures and confuses the thought of the man we find writing in these pages: "I do not strive for honor and fame. My aim is not to be admired ... Only one thing will fulfill me: I must come to clarity! Otherwise I cannot live. I cannot endure life without believing that I shall attain it ... " (p. 494).

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