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REVIEW

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This is the first in what will be a series of volumes devoted to the history of logic. The essays contained in each volume will be authored by specialists chosen for their expertise in a specific area, chronological or topical, in the history of logic. As such, the authors are given free rein to approach their subject according to their own intellectual judgment or inclination.

The disadvantage to this modus operandi becomes immediately evident in the unevenness of the treatments. Thus, for example, the lead essay in the volume at hand, by Julius Moravcsik, “Logic before Aristotle: Development or Birth?” (pp. 1-25) would, by most standards, be accounted a philosophical, rather than an historical, discussion, being far less interested in exploring the work of Aristotle’s predecessors, ordinarily considered to be the pre-Socratic philosophers, Plato and the Sophists, developing the concept of dialectics, towards the systematic development of logic, than in elucidating, in a necessarily speculative fashion, the intellectual prerequisites for a conception of logic as a subject. In this treatment, Moravcsik rejects the significance, widely accepted by historians, of Plato’s concern with developing an understanding of definitions, in the florescence of logic in Aristotle’s *Organon*, arguing that Plato did not likewise discuss a principle of inference; the conclusion drawn by Moravcsik is that Plato’s contributions were sufficient towards illuminating the conception and development of axiomatics, but not of logic. Here, Moravcsik is clearly implying the well-known distinction between an *axiomatic system* and a *formal deductive system*, equating the latter with a logical theory; but otherwise the distinctions and relations between an axiom system

and a formal deductive system are both left without comment or clarification. It is, as Moravcsik remarks (p. 20), an intellectual jump from the “definitions” “All A are B ” and “All B are C ” to the inference “All A are B and all B are C . Therefore all A are C .” These definitions provide “data” for the inference; but a conceptual development is required to make the leap of great abstraction from the definitions to the inference.

The question is raised, in this context, of the impact which Euclid’s *Elements* may have had in evolving the conception of a logical system. Moravcsik indeed mentions (p. 17) that Euclid’s geometry is an axiomatic system. He ignores the important historical question, however, of whether Aristotle was influenced by Euclid’s *Elements* to undertake in his treatment of logic a method for underwriting the proofs given by Euclid, or whether, instead, Euclid deliberately designed his proofs in accordance with the logical rules of inference laid down by Aristotle. There is, indeed, a vast literature on the subject of the influences of Euclid on Aristotle and/or Aristotle on Euclid (see, *e.g.* [Lee 1935], [Einarson 1936], [Gómez-Lobo 1977], [Smith 1977-78], and [Mueller 1981]).

In arguing that Plato’s worries about definitions were necessary, but hardly sufficient to lead Aristotle to enunciate a logical theory, Moravcsik objects that the development of grammar as a field of study is a prerequisite for linguistic analysis, but far from a propaedeutic for the development of a conception of logic. As evidence that grammar is no forerunner to logic, he notes (p. 6) that the first grammatical study, by Dionysius Thrax, appeared long after Aristotle had completed his work, *i.e.* in *circa* 120 B.C. Apart from the fact that Protagoras (*ca.* 495/480-*ca.* 410 B.C.) apparently composed a grammar, Moravcsik fails to note that Aristotle’s pupil and successor Theophrastus, in organizing the master’s *Nachlaß*, placed such writings as *De Interpretatione* and *De Categoriae*, which include material that can only be characterized as grammatical or linguistic, along with the *Prior* and *Posterior Analytics*, which we should readily admit as largely logical. While this ordering does not vouchsafe Aristotle’s comprehension of the unity, in some sense or other, of grammatical and logical studies, it suggests a perception among Aristotle’s closest followers that Aristotle saw a connection between certain grammatical or linguistic and logical matters. Moreover, much of what constituted “logic” or “dialectic” for the early medieval schoolmen of the Latin West, by the historical accident that the most readily available of the Aristotelian corpus during that period, consisted of *De Interpretatione* and *De Categoriae*,

and Porphyry's *Isagoge*, was what we would perforce call philosophy of language or [speculative] grammar.

Moravcsik's essay makes it clear that philosophical analysis cannot be substituted for historical scholarship, or even for historical interpretation, and there is a distinction to be made between conceptual relations or prerequisite developments on the one hand, and historical processes or developments on the other. Philosophy is *not* history.

The second essay is "Aristotle's Early Logic" (pp. 27-99) by John Woods and Andrew Irvine. It begins with a brief biography of Aristotle.¹ The cardinal point which the authors make is that the distinction between dialectics and logic is a false one, that Aristotle's work on dialectics, especially the *Sophistical Refutations*, is more than a prelude to Aristotle's work on syllogistics, but the start of his logical theory as a theory of refutations, and that this theory of refutations is in reality a theory of completeness, leading ineluctably to the syllogistic as a formal theory of devising a proof procedure for completeness. (One is here reminded of earlier claims by John Corcoran [1974] that Aristotle's formal theory is a full-blown theory of natural deduction, readily comparable to that of Gerhard Gentzen, a claim that is endorsed by the writers, who cite Gentzen's [1935] "Untersuchungen über das logischen Schließen".) For Aristotle, the syllogism must deal with propositions

¹The biographical sketch is historically questionable, if only for its ambiguity, if not outright error, concerning the demise of Aristotle's nephew Callisthenes of Olynthus. (*ca.* 360/370-328/327 B.C.). According to the authors (p. 28), Callisthenes was hanged, for refusing to bow to Alexander soon after Alexander ascended to the Macedonian kingship, in 336 B.C. Contemporaries differed as to whether Callisthenes was hanged or dragged around with Alexander's army, in which he died of disease, about seven months after his arrest; but all place the date at *ca.* 328/327 B.C., not in or around 336 B.C. The famous Roman historian Arrian (Flavius Arrianus; *ca.* 95-175 A.D.), in Bk. IV, 55.7, of his *Campaigns of Alexander* (see [Arrian 1971, 226]) reports both versions, and, like all writers, places the year as *ca.* 327 B.C., in Bactria, in central Asia. Modern historians, such as Peter Green [Green 1991, 378] and Michael Grant [1980, 81, col. 1], likewise report both versions, without deciding between them. Nearly four decades cannot reasonably be construed as what the authors call "soon" after Alexander ascended the throne and Aristotle returned to Athens from Macedon.

Another difficulty with the statement by our authors is that they simplify, and hence mislead readers, in stating the reason for Callisthenes's death. All sources, ancient and modern, make it clear that Alexander had already suspected Callisthenes of involvement in an assassination plot against him, and pre-arranged for Callisthenes to enter into a debate about the nature of kingship and the question in particular of prostration, which the classical Greeks construed as an expression of reverence due to gods but not to men, and which Callisthenes was to argue against. Callisthenes was arrested along with the pages implicated in the assassination plot.

that either affirm or deny no more than one property (predicate) to one thing (object, entity; subject) at a time; *i.e.* must be connective free, except for the copula connecting one and only one predicate to one and only one subject at a time. In our own terms, then, all propositions must be atomic. A sentence containing either a disjunction or a conjunction, then, in our terms a compound or molecular proposition, is not, for Aristotle, a legitimate proposition at all, and is excluded from his theory of deduction. (This raises the question, not dealt with by Woods and Irvine, of how to consider those, such as Charles Peirce, Hugh MacColl, and Bertrand Russell who advocated the translation of an Aristotelian syllogism of the form: “All S are M . All M are P . Therefore all S are P ” as: $((S \supset M) \& (M \supset P)) \supset (S \supset P)$ (see [Peirce 1849-1914], possibly as early as 1860, in the four-page “Doctrine of Conversion” from loose sheets of Peirce’s logic notebook of 1860- 1867 (MS 741), [MacColl 1902, 368] and [Russell 1903, 16]) or to respond to Moravcsik in asserting (p. 20), that it is an *intellectual jump* from the “definitions” “All A are B ” and “All B are C ” to the inference “All A are B and all B are C . Therefore all A are C .”) Thus a syllogism can be said to be a valid argument, *all* of whose statements are propositions (p. 40), for which the conclusion is included in, or necessitated by (in our terms, entailed or implied by) the propositions as premises. Following Plato, Aristotle then required all propositions to be simple (atomic), the model being Plato’s theory of grammar, for which a sentence must minimally have a name (noun) and a verb. The authors suggest (p. 41) that this requirement points towards Frege’s unsaturated predicates, where $\Phi(x)$ is incomplete, and requires the value of a variable, a name (constant), to “get somewhere”, as does $\Phi(\alpha)$, where α is a name. In this connection, it is worth noting, although Woods and Irvine do not, that Jean van Heijenoort [1974, 256; 1986, 21] remarked that Aristotle’s logic, contrary to what has typically been argued, does *not* demand that premises in a syllogistic argument necessarily be in subject-predicate form. He began [van Heijenoort 1974, 257; 1986, 21] by considering the four moods of the syllogism, A, E, I, O, to be capable of being rewritten as propositions (which van Heijenoort called “prime sentences”) “ Auv ”, “ Euv ”, “ Iuv ”, “ Ouv ”, where A, E, I, O are taken as four constants and treated as operators, and u, v are variables ranging over non-empty non-universal terms. Under this interpretation of the *Prior Analytics* (see [Aristotle 1928]), it permitted Aristotle to develop syllogistic as his “lucky strike”, hitting upon a part of logic in which quantifiers are unnecessary, so that syllogistic logic deals with one-place predicates and is a fragment of monadic predicate calculus. Since it “is well known that a system of

monadic logic with quantifiers can be translated—with no loss at all—into a quantifier-free Boolean calculus” [van Heijenoort 1974, 256; 1986, 22], Aristotle was able to “develop a logic without quantifiers, hence without prime sentences in the subject-predicate form” [van Heijenoort 1974, 257; 1986b, 22]. “Aristotle,” [van Heijenoort 1974, 257; 1986b, 22] wrote, “was carried away by the success of his quantifier-free logic.” But, it should also be understood, he continued [van Heijenoort 1974, 257; 1986, 22-23], that:

This new doctrine was far from covering the whole field of logic; many questions and problems were left aside. The very success of Aristotle in developing the syllogistic created, for him, an unbalanced view of logic. [...] One of the problems of logic that never came to the center of Aristotle’s attention is the relation of the subject-predicate form of sentences strongly suggested by the *Categories* and the form of the primitive sentences in the syllogistic (*Auv*, and so on). There is, however, a remarkable passage in Aristotle where a connection between the two forms is touched upon. In the *Prior Analytics*, I, 1, 24b, lines 29-31, he writes: “we say that one term is predicated of all of another [this is Aristotle’s standard way of speaking of ‘*Auv*’] whenever no instance of the subject can be found of which the other term cannot be asserted.” Now, we can follow this sentence word by word and transcribe it into the notation of contemporary logic; thus we obtain: ‘*Auv*’ for ‘ $\sim \exists x(u(x) \& \sim v(x))$ ’ (which we know is another way of writing ‘ $\forall x(u(x) \supset v(x))$ ’). Here, we are back to a situation where we have individuals, each of which a property is asserted or denied. The operator ‘A’, which, like ‘E’, ‘I’, and ‘O’, is generally treated by Aristotle as primitive, is here defined, and is brought back into the sphere of the individual-property distinction, or, on the syntactic plane, of the subject-predicate analysis.

This last point led van Heijenoort [1974, 257; 1986, 23] to “speculate about what would have happened if Aristotle had developed this insight. Armed with quantifiers, he could have broken through the limitations of monadic logic. And,” *nota bene* (!), “perhaps a Greek version of the *Begriffsschrift* would have been written twenty-two centuries before Frege.”

Examining in detail the account of Woods and Irvine, we note that they take logic's function to be the organization and control, in accordance with established rational laws, the discursive power of *logos* and argumentation. Thus, Aristotle began by setting out his refutations of *Sophistical Refutations*, the fallacies of reasoning in which argumentation has, in the authors' words (p. 29), "run amok." After diagnosing pathological argumentation, Aristotle undertook, in *Categories*, *Interpretation*, and *Topics*, to provide sound guidelines for formulating and constructing definitions and propositions. He then is ready to provide the details of a formal deductive system in the two *Analytics*, in which are developed the theory of syllogism as a theory of deduction for valid reasoning.

In what follows, the authors treat Aristotle's theory in modern terms, and it is argued, against those who might think otherwise, that "Aristotle's validity is core Gentzen-validity," and that "Aristotle's implication is the converse of Gentzen-deducibility" (pp. 50ff.). The difference between "syllogisity" and Aristotle's validity is in the detail. Specifically, syllogisms are irreflexive and nonmonotonic. That is *the* crucial difference. The remainder of the essay elaborates on this difference.

In arguing for the importance of the *Sophistical Refutations*, in *Categories*, *Interpretation*, and *Topics* for Aristotle's development of logic, Woods and Irvine touch upon the problematic issue of the chronology of the composition of Aristotle's *Organon* ([Allen 1995] is mentioned, for example, but not [Brandis 1833] or [Shute 1888]). They do not, however, offer a programmatic treatment of the history of this difficult and abstruse subject. Rather, their conception turns upon Aristotle's need to diagnose, analyze, and offer treatments for pathological argumentation as a prelude to ordering the analytics as the prescribed regimen for avoiding the pathologies.

Some of the themes at which Woods and Irvine merely hinted are explored in George Boger's chapter on "Aristotle's Underlying Logic" (pp. 101-246), which also elucidates the details of the categorical syllogism as set forth in Aristotle's *Prior Analytics*, but does so from the standpoint again of the contemporary conceptions of formal logic. Of particular note in Boger's discussion is his concern to distinguish traditional "Aristotelian" logic from Aristotle's logic, the former being comprised of the metaphysical, linguistic, and psychological accretions that adhered to the core of Aristotle's original pristine logic in the circumscribed treatments by which it was known to the medieval schoolman, mediated by the extant portions of Aristotle's *Organon* that were available prior to the Renaissance, and by the generally hostile attitudes towards that logic as advanced in the early modern era

by philosophers such as Petrus Ramus (Pierre de la Ramée) and René Descartes. It was the “Aristotelian” logic, rather than Aristotle’s logic, that drew the attention of critics, both in the era of the Renaissance through the seventeenth century, and in the nineteenth and early twentieth century by adherents of traditional logic from Richard Whately to Ralph Monroe Eaton. These critics, Boger holds, have misunderstood Aristotle: the syllogism is Aristotle’s device for constructing valid arguments, whereas traditional logicians, like their medieval counterparts, talk about valid and invalid syllogisms, with some syllogisms being universally valid, others being conditionally valid.. Unfortunately, Boger fails to establish that this manner of classification is extraneous to Aristotle, but due to the medieval logicians and to the modern advocates of traditional, “Aristotelian”, logic. In fact, medieval scholars used to identify the four moods, four figures, and the resulting 256 forms of syllogisms, and to distinguish the twenty-four of these which are valid, together with the rules of obversion, conversion, contraposition. Moreover, Boger fails to make the distinction between a proof and a decision procedure.

In *Prior Analytics*, Bk. I, Chapt. 2, Aristotle defined a syllogism thusly:

A syllogism is discourse in which, certain things being stated, something other than what is stated follows of necessity from their being so. I mean by the last phrase that they produce the consequence, and by this that no further term is required from without in order to make the consequence necessary.

Clearly Aristotle was thinking, then, of a syllogism as a proof, and thus as valid, rather than as a decision procedure for determining whether a “proof” is valid or invalid. Thus, Boger is correct in his interpretation; but he fails to provide evidence. Instead, he attributes these failings to the critics and argues that they fail to notice that their confusion is based upon their inability to notice that Aristotle made a distinction between logic and metalogic. The same error is committed, Boger argues, by modern interpreters of Aristotle who endeavored to interpret Aristotle’s syllogistic logic in modern mathematical terms, whether as an axiomatic system, as Łukasiewicz had done (see, *e.g.* [Łukasiewicz 1951]), or as a system of natural deduction, as John Corcoran, for one, has done, the former taking syllogistic as an uninterpreted system (see, *e.g.* [Corcoran 1974]), the latter taking it as an interpreted system.

For the rest of his lengthy essay, Boger develops and elucidates Aristotle's "underlying" logic, namely the logic underlying the metalogical study of the syllogistic as a deductive system. The *Prior* and *Posterior Analytics*, Boger writes (p. 107), were composed in order "to establish a firm theoretical and methodological foundation for ἀποδεικτικὴ ἐπιστήμη (*apodeiktikê epistêmê*) or demonstrative knowledge" (*Pr. An.* 24a10-11). Aristotle understood deduction to be a "kind of computational process," and *συλλογίζεσθαι* (*sullogizesthai*) is mathematical computation for Aristotle. It is distinct from demonstration (*apodeixis*), and Aristotle makes it clear that while "[every] demonstration is a deduction, [...] not every deduction is a demonstration" (*Pr. An.* 25b30-31). It is Aristotle's colloquial Greek in this instance that, distinguishing demonstration and proof, despite Boger's assertions to the contrary, made it possible for the medieval logicians and their modern counterparts to distinguish, whatever Aristotle himself may have actually meant, to talk about valid and invalid syllogisms, the valid syllogisms being demonstrations (proofs), the invalid syllogisms being deductions which are not (or, in the case of conditionally valid syllogisms, not always) proofs. Boger's treatment, then, suffers, I would suggest, from its ahistoricity; it is a philosophical reconstruction, rather than an historical exposition, of Aristotle.

Aristotle, Boger declares, was concerned with the *pattern* of syllogisms, and the Laws of Non-Contradiction and Excluded Middle are, in this conception, schemata, hence uninterpreted inference rules. Thus, the *Prior Analytics* is a study of the *syllogistic deduction system* (p. 117); together with *De Categoria* and *De Interpretatione* and parts of the *Metaphysics*, the *Prior Analytics* is Aristotle's study of the underlying logic of the syllogism. The *Categories* is a metalinguistic study of predication, the *Interpretation* a metalinguistic study of the syntactic and semantic aspects of language (p. 119).

Aristotle's task in the *Organon* is "having modelled his syllogistic as an underlying logic according to the practices of a modern mathematical logician. In *Prior Analytics* he especially articulated the logical syntax of his syllogistic system while, nevertheless, always presupposing its applicability to various axiomatic sciences," including especially geometry. And he "conceived of his system as a formal calculus, akin to mathematical calculi, since his aim was to establish a reliable deduction instrument for *epistêmê apodeiktikê*" (p. 242).

Boger's construction of Aristotle's efforts seem in fact to be anachronistic, a philosophical reconstruction of Aristotle's supposed intentions, interpreted in the light of a twentieth-century conception of logic, having both axiomatic and natural deductive aspects, with the latter being

the central focus of Aristotle's work. This is the view that seems to pervade and direct all of the treatments of Aristotle's logic within the handbook, and there is little, if any, serious attempt to present an historical exposition of Aristotle's work, from the perspective of Aristotle. In the essay "Aristotle's Modal Syllogisms" by Fred Johnson (pp. 247-307), the substitution of modernistic reconstruction for historical exposition is even more blatant.

Johnson sets out to demonstrate how Storrs McCall's [1963] extension of Łukasiewicz's decision procedure for a four-valued logic L-X-M (as found in the second, 1957, edition of [Łukasiewicz 1951]) is capable of capturing Aristotle's judgments about which of the assertoric syllogisms (of n -many premises, $n \geq 2$), are valid or invalid. Johnson then examines McCall's syntactic calculus Q-L-X-M to consider Aristotle's contingent syllogisms. Finding that Q-L-X-M leads to "unAristotelian" features, Johnson proposes a modified QLXM' system, the semantics of which enables him to "provide formal countermodels for a large percentage of the assertoric, apodeictic or contingent syllogisms that Aristotle explicitly considered to be invalid" (p. 247).

Here there is no attempt whatever to be historical: the focus is on the exposition and analysis of Łukasiewicz's, McCall's, and Johnson's own modern systems, and appraisals of how well or poorly they reflect Aristotle's modal logic. (For an historical exposition of Aristotle's modal logic, one might wish to perhaps turn instead to [Patterson 1995].) It is also worth adding, however obvious, the fact that, wittingly or unwittingly, Johnson's point that there were judgments made by Aristotle about "assertoric, apodeictic or contingent syllogisms that Aristotle explicitly considered to be invalid" (p. 247), seems to contradict the assertion by Boger that the syllogism is Aristotle's device for constructing valid arguments. How, one might inquire, can there be *invalid* syllogisms in Aristotle's logic if for Aristotle the syllogism is Aristotle's device for constructing *valid* syllogisms? Could it possibly be that the medievals and their followers among the modern traditionalist logicians, were correct after all, and that Boger is mistaken, that there are *invalid* as well as *valid* syllogisms?

The account of "Indian Logic" by Jonardon Ganeri (pp. 309-395) opens with a sample of a dialogue, the aim of which is to elicit information. Thus one is reminded immediately of the Socratic method. But it becomes clear quite soon that the choices available do not aim at yielding definitions, in abstract terms, of Platonic ideals (Truth, Beauty, Goodness, Justice, *etc.*), but at opening up multiple levels of possibilities. The answers elicited in these dialogues have no relevance for a strictly bivalent logic: a satisfactory response may be "neither

yes nor no” or “both yes and no.” This carries us to the salient point of all species of Indian logic, namely that the Laws of Noncontradiction and Excluded Middle play no appreciable role. As generally understood, Indian logic, whether Hindu, Buddhist, or Jaina, and their various schools, allow for choices in a manner that bivalent logic does not and cannot. It permits a degree of vagueness that is historically unacceptable to classical [western] logic.²

Once Ganeri advances to detailed technical consideration of what we might term “dialogual” logic examines the formal aspects of Indian logic, the tendency to interpret that logic in terms of contemporary propositional logic comes to the fore. Thus, for example, Ganeri sees in the *ropanā*, or demonstration of inconsistency, an “‘anticipation’ of propositional logic,” and the first four steps “looks like an application of the definition of material implication or its term logic equivalent...” (p. 317). Indeed, the *ropanā* appears as the final step in proof by contradiction. One begins with an initial thesis (*theranā*), moves on to the derived implication (*pāpanā*), and concludes with the *ropanā*. The final step in the *ropanā* is understood by Ganeri as an application of *modus ponens*.

Having once asserted that the *ropanā* appears to utilize the term logic equivalent of the definition of material implication, it is natural for Ganeri to next take up (p. 321) the assertion by Henry Thomas Colebrooke (1765-1836) [Colebrooke 1824] that he had discovered the “Hindu syllogism.” In response to Colebrooke’s claim Ganeri notes that Colebrooke knew much less about the history of logic in India than we do today. Ganeri’s salient point in this is that Indian logicians considered informal logic and that there were anticipations of propositional calculus in the *Kathāvatthu*, or *Points of Controversy*, dating from around the third century B.C. (p. 314). Moreover, we know much more today that did Colebrooke, of the theories on formal criteria for inference of the Buddhists Vasubandhu (*ca.* 400-480 A.D.) Diñnāga (*ca.* 480-560 A.D.), and Dharmakīrti (*ca.* 600-660 A.D.); that Daniel Ingalls [1951, 65-67] had discovered formulations of De Morgan’s Laws in the *Navya-Nyāya*; or new *Nyāya* logic, originating with Gangesa Upadhyaya (*ca.* 1325), and that even now we know little or nothing of the treatments of negation, logical consequence, and quantification in that work. Ganeri’s task is to trace all of these developments, and

²It is in this sense that we can perhaps understand why fuzzy logic and set theory were, at least initially, accepted so widely and enthusiastically in Asia, and especially Japan, and why occidental writers on the history of fuzzy logic and set theory find Buddhist logic to be something of the ancestor of their subject; see, *e.g.* [Kosko 1993] and [MacNeill & Freiberger 1993].

more, in the history of logic in India, and to do so in contemporary terms. He even goes so far as to place Jaina logic alongside Jaśkowski's [1969] treatment of paraconsistent propositional logic in "Propositional Calculus for Contradictory Deductive Systems".³

Considering Ganeri's historiographic methodology, we can perhaps be grateful that he does not follow those who, like Sadajiro Sugiura a century ago, have claimed that Aristotle learned the syllogism from Indian logicians. Sugiura, in *Hindu Logic as Preserved in China and Japan* [Sugiura 1900] argued that since the Mahādinnâga version of *Hetuvīdyā* [science of reasoning] shows "great similarity" to "Aristotelian formulæ of reasoning", there were those who held that Alexander the Great's (356-323 B.C.) invasion of India may have been a factor in bringing the "Eastern syllogism" to Greece, which Aristotle then developed. But this influence is highly improbable, if not impossible, since not only did Alexander not invade India until just four years before Aristotle died, but Mahādinnâga (*fl. ca.* 300-350 A.D..) clearly lived many centuries *after* Aristotle (see ["T.S." 1901-02, 146]). Moreover, there is an Indian text, dating from *ca.* 230 A.D., but containing material from two centuries earlier, the astronomical treatise *Gargi Samhita*, which credits the "Yavonians", *i.e.* the Hellenic Ionians of the Aegean, with originating the science of astronomy, and who therefore ought to be "worshipped as gods"; thus, historian Michael Grant, a specialist on Hellenistic and Roman history, wrote [Grant 1982, 88] that the Indians borrowed widely from the sciences of the Hellenistic world, whereas the Greeks knew "nothing" of the primary sources or current developments of the sciences in India during this period. [Grant 1982, 88, 233] adds that later Greek philosophers, including in particular Phyrro, had had discussions with Indian sages, but that these exchanges amounted, for practical purposes, to little, if anything, whereas the assertions that Pythagoras, Democritus, and Plato had journeyed to India were later, legendary accretions, and that, even after Greek intellectuals accompanied Alexander to India, the "actual Indian influence on Hellenistic thought remained slight." We cannot conclude from this that Indian logicians did not have the syllogism; nor can we conclude that the syllogism infiltrated Greek thought by some other route than from Mahādinnâga to Aristotle. But we can and should beware of detecting influences or "anticipations" on the basis of the application of contemporary reconstructions to an historically distinct construction by logicians or mathematicians of the past, but seek to understand their work, insofar as possible, on their own terms. In short, while doing

³Originally published in Polish in 1948; see [Jaśkowski 1948]).

“violence” to a text of the past, as Heidegger recommended to wring out its contemporary significance, may be philosophically viable and justified, the best way, I suggest, to understand how the creators understood their work is to first attempt to see that work within its own context, allowing it to “speak for itself” rather than through imposition and interpolation of alien—or anachronistic—perspectives. One can appreciate the efforts of the authors of the present volume to translate the work of the early Greeks and Indians for readers. But we must then understand that they thereby present us with a text that is much more of a philosophical reconstruction than with a history of logic; and again: philosophy is *not* history.

Robert R. O’Toole and Raymond E. Jennings’ “The Megarians and the Stoics” (pp. 398-522) is a vindication of the judgments of Łukasiewicz ([Łukasiewicz 1934]; see [Łukasiewicz 1970] and Mates [Mates 1953] on the Stoics against the attack launched against them, and in particular against Chrysippus, by Carl Prantl (1820-1888) in his *Geschichte der Logik im Abendland* (see especially [Prantl 1855-1870, I, 404], quoted by [Mates 1953, 87]. Prantl asserted, without either comprehension or argumentation, that the Stoics contributed nothing of their own to logic. He went so far even as to claim that they merely repeated what had already been presented by the Peripatetic logicians (those who followed Aristotle and adopted syllogistics and term logic) and the Megarians, albeit without the skills of those from whom they borrowed. O’Toole and Jennings attribute this attitude on Prantl’s part to a failure to understand the difference between term logic and propositional logic (p. 398). O’Toole and Jennings’ defense of the contributions of the Stoic philosophers to logic follows upon the heels of the same enterprise by Jonathan Barnes’ [Barnes 1997] *Logic and the Imperial Stoa*, which argues, contrary to the standard interpretation, that logic was alive and well among the Stoic philosophers in the years of the Roman Empire, especially Epictetus.

O’Toole and Jennings focus primarily upon the linguistic aspects of Stoic thought, both syntactic and semantic, and upon the ontological interpretation of the syntax of language, and especially upon their semiotics, or theory of signs, and pragmatics. Some of Prantl’s more severe critics, *e.g.* J. M. Bocheński [Bocheński 1970, 6], claimed that the underlying purpose of his history was to demonstrate the truth of Kant’s assertion that, except for some minor tinkering by the medieval logicians and a handful of philosophers of the period of the Enlightenment, logic had no history, having been brought to completion and near perfection by Aristotle himself (see [Kant 1964, B vii; 1884, 10;

1974, 23-24]). Charles Peirce at one point wrote to Christine Ladd-Franklin [Peirce 1891-1908, L237:134] regarding Prantl's book, and in particular regarding what Prantl wrote there about propositions, that "surely nobody can attach any importance to Prantl's authority considering his numberless absurd vagaries." Others, taking a milder view of Prantl's work, considered that he was at a disadvantage in his effort to write a history of logic by the simple fact that he was working in the formative years of mathematical logic, and so did not have the resources to attempt a balanced or comprehensive account of the history of mathematical logic. Thus, for example, Heinrich Scholz, in criticizing Prantl's book, was of the judgment that Prantl, whose work chronologically covered the period from Aristotle to the end of the fifteenth century, did not have the advantage while writing his history of logic of having available "the type of formal logic" now available "in the shape of symbolic logic" [Scholz 1931, VI; 1961, vi]. The kindest treatment of Prantl's history seems to have come from the pen of L. Susan Stebbing, who, reviewing Heinrich Scholz's [Scholz 1931] *Geschichte der Logik*, declared [Stebbing 1933, 117] that: "Everyone would admit that Prantl's great work on the history of logic (1855-70), though not exactly out of date, needs considerable supplementation in the light of recent developments in the theory of logic."

If we focus upon O'Toole and Jennings' treatment of Prantl as being unable to distinguish term logic from propositional logic, then we might conclude that, in some respects, despite his muddle, and inadvertently, he was already in advance of some, and at least synchronous with some other, of the leading logicians of the *fin de siècle*. Thus, for example, in an entry into his *Logic Notebook* for 14 November 1865 (see [MS 114; Peirce 1982, 333]), Peirce first declared that "[t]he subject, is a sign of the predicate, the antecedent of the consequent," thus virtually, if not yet actually, equating the copula of predication with implication and opening the way to eventually represent the syllogism *All S are M, All M are S, Therefore all S are P* as $[(S \supset M) \& (M \supset P)] \supset (S \supset P)$. This translation is strongly suggested in Peirce's paper of 1870, "Description of a Notation for the Logic of Relatives ..." [Peirce 1870], and by MacColl in Part I of his "Symbolic Reasoning" [MacColl 1880, 51-52], where he wrote that we can

from two implicational premisses $A : B$ and $B : C$
draw *implicational* conclusion $A : C$. That is to say
[...]

$$(A : B)(B : C) : (A : C),$$

where, in his Definition 3 ([MacColl 1880, 50-51]), $A : B$ is said to mean that A *implies* B , writing specifically:

The symbol $:$, which may be read “implies,” asserts that *the statement following it must be true, provided the statement preceding it be true.*

Thus, the expression $a : b$ may be read “ a implies b ,” or “If a is true, b must be true,” or “Whenever a is true, b is also true.”

MacColl makes this reading fully explicit again, in case it still needed to be by this time, in part IV of his “Symbolic Reasoning” [MacColl 1902, 368], where he wrote that, in the case, for example, of the Barbara syllogism “All A are B , All B are C , *therefore* All A are C ,

the syllogism, or any other argument, thus worded *is not a formal certainty*, it is false, whatever the conclusion may be; and it is also false when the conclusion is false, whatever the premisses may be. Barbara should be worded as follows: “*If* all A is B , and all B is C : *then* all A is C ”. In this form the syllogism is true whether premisses or conclusion be true or false, and must, therefore, be classed amongst the *formal certainties*. Now a statement is called a formal certainty when it follows necessarily from our formally stated conventions as to the meanings of the words or symbols which express it; and until a language has entered upon the propositional stages those conventions (or definitions) cannot be formally expressed and classified.

This translation of the syllogism was fully accepted by Russell in *The Principles of Mathematics* [Russell 1903, 16], who rendered it as: “If p implies q and q implies r , then p implies r ” and which in its logical form can therefore of course readily be rendered $(p \supset q \bullet q \supset r) \supset (p \supset r)$, as Russell did symbolically render it in the manuscript “Classes” of 1903 (an early draft of *12- *16 of the *Principia Mathematica*, written some time during the first five months of 1903 and published in [Russell 1994, 337]; see [Russell 1994, 22]), noting that in terms of “subordinate implication”, where $p \supset p$ becomes $a \subset a$, we have a form of the Barbara syllogism $a \subset b . b \subset c . \subset . a \subset c$. (Apropos this translation, we may note that, in the second edition of his *Formal Logic* [Prior 1962, 116], Anthony Prior remarked that Aristotle’s assertoric syllogisms should be read as inference schemata, and Lynne E. Rose in *Aristotle’s Syllogistic* [Rose 1968], starting from Prior’s remark,

developed this notion in some detail, arguing that these syllogisms should be regarded as inference schemata of a metalanguage rather than as implications in the object language. Łukasiewicz [Łukasiewicz 1957, 21-22] distinguished Aristotle's syllogistic from traditional syllogistic, and argued that Aristotle's syllogisms were inferences, whereas the syllogisms of traditional logic were not.) Reflecting on three decades of his own work in logic while discussing the third volume of Schröder's [Schröder 1895] *Vorlesungen über die Algebra der Logik*, Peirce [1896, 32], in "The Regenerated Logic", wrote

I have maintained since 1867 that there is but one primary and fundamental logical relation, that of illation, expressed by *ergo*. A proposition, for me, is but an argumentation divested of the assertoriness of its premiss and conclusion. This makes every proposition a conditional proposition at bottom.

Even as early as possibly 1860, in the four-page "Doctrine of Conversion" from loose sheets of Peirce's logic notebook of 1860-1867 (MS 741), we find him rewriting the syllogism "All men are animals. X is a man. Therefore X is an animal." as "If man, then animal. But man. Therefore animal." Thus, according to Peirce, arguments in the propositional form $[(S \supset M) \& (M \supset P)] \supset (S \supset P)$ (see [Peirce 1849-1914]).

The pivotal concept of Stoic logic is *λεκτόν* (*lekton*), the utterance, that which can be spoken. It is associated with the *πράγμα* (*pragma*; plural *pragmata*), the state of affairs signified by the *lekton*, which becomes true or false. The utterances which are complete (*i.e.* having subject and verb), the *ἀξιώματα* (singular *axiomata*; *ἀξίωμα*), are true or false. Only a consideration of Stoic logic based upon an appreciation of the relation between the *lekton*, the *pragmata*, and the *axiomata* can fully appreciate and comprehend the nature of Stoic logic.⁴

⁴And, coincidentally, why, through the influence of St. Augustine and his Stoic-inspired *Dialectica*, the early medieval logicians focused their attention so heavily, and indeed almost exclusively, upon what we would today call semantics and philosophy of language.

Augustine's *Dialectica* can be said to form a crucial link between the Stoic philosophy of logic and grammar and the medieval scholastic philosophy of logic and language. Augustine follows the Stoics in calling logic "dialectic"; see, for example, Cicero, *Topics* XII.53. The Stoics of the third century B.C. contributed to and were the principal practitioners of truth-functional logic. Philo of Megara provided truth-functional definition of logical connectives leading to paradox of material implication (*ex falso quodlibet sequitur*) and he was originator of Philonian implication, which is the definition to *material implication* that we use today in symbolic

Among the principal Stoic philosophers considered by O'Toole and Jennings, are Zeno of Citium (333-261 B.C.), the founder; the Megarian dialectician Euclides of Megara, whose pupil Diodorus influenced Zeno, evidently in his debate with Plato concerning the conditions by which the consequent of a conditional *axiomata* follows from the antecedent (p. 407); Cleanthes (Kleanthes of Assos; 3rd cent. B.C.), Zeno's successor; and Chrysippus of Soli (282-206 B.C.), the leading Stoic logician of the ancient world. Most of this essay is taken up with an account of Stoic semantic concerns, and proceeds to consideration of the ontological entities, or *pragmata* which *lektōns* signify.

A major focus are *axiomata* which are conditional. These are constructed of two *axiomata* bound together by the connective 'if' ($\epsilon\iota$). This is one of the most crucial aspects of Stoic logic; for as is well known, one of the critical differences between the Stoic syllogism and Aristotle's hypothetical syllogisms, and a matter in antiquity of much heated debate between the Peripatetic followers of Aristotle's term logic and the Stoic logicians' propositional logic, hinges upon the difference between Philonian and Diodoran implication. Diodorus Cronos (d. 307 B.C.) defined a conditional as *sound* (or true) if it is capable of having a true antecedent and a false consequent; Philo (Philon of Megara; *fl. ca.* 300 B.C.) defined a conditional as *sound* (or true) whenever it is not the case that the antecedent is true and the consequent false. The Stoic logicians were then particularly exercised by what has come down to us in the Latin phrase: "*ex falso sequitur quodlibet.*"⁵ The Skeptic philosopher Sextus Empiricus (*fl. ca.* 200 A.D.) rejected both Philonian and Diodoran implication; but he also rejected as well the entire Stoic undertaking (p. 479).⁶

logic; he also considered a square of opposition for modal logic. The Stoic logic, particularly the Stoic concepts of *logos endiathetos* and *logos prophorikos*, play an important role in Augustine's tract, and a understanding of these concepts and the Stoic notion of *lektōn* (the "sayable") is central to a clear understanding of the Augustinian *Dialectica*. (The first modern discussion of the Stoic logic of Cicero was undertaken by Adam Burski [Burski 1604]; the only complete general discussion of Stoic logic is Benson Mates' [Mates 1953].

Augustine's *De Dialectica* was first cited, as far as we know, by John of Salisbury d. 1180), who opens chapter IV of his *Metalogicon* (1159) with a reference to Augustine's definition of dialectics as the "science of arguing well," that is, by citing the opening words of *De Dialectica*, "*Dialectica est bene disputandi scientia.*" Augustine's *De Dialectica* was frequently used as a liberal arts textbook.

⁵See also [Mates 1949a] on Diodoran implication and [Hurst 1935] on implication in the 4th century B.C.

⁶See also [Mates 1949b] on Sextus Empiricus on Stoic logic and [White 1986] on Empiricus's treatment of the conditional.

Related to the question of the definition of implication is the question of the choice between inclusive and exclusive disjunction, a question that arose for the Stoic logicians and was a matter of debate for leading logicians of the nineteenth century.⁷ Stoic disjunction, O'Toole

⁷Boole used exclusive disjunction, whereas Jevons argued for inclusive disjunction. One of the most salient and long-lasting of Jevons's alterations to Boole's system was the replacement of Boole's exclusive disjunction with inclusive disjunction as a fundamental propositional connective.

In a review of Jevons's [Jevons 1890] *Pure Logic and Other Minor Works*, edited by Robert Adamson, Charles Peirce [1881] noted regarding Jevons' "modification of Boole's use of the symbol + in logic" that Boole read logical addition as exclusive disjunction (see *The Mathematical Analysis of Logic* [Boole 1847, 52], and *The Laws of Thought* [Boole 1854, 33, 48, 55-56, 119]), whereas Jevons expanded it to inclusive disjunction (see "Pure Logic", §64 for the definition and §§177-183 for the justification and criticism of Boole's use of exclusive disjunction. Jevons joined Richard Whately, Henry Mansel, and John Stuart Mill on this matter, against Boole and William Hamilton. All of Chapter XXI of the second edition of Jevons's [Jevons 1884] *Studies and Exercises in Deductive Logic* (London: Macmillan & Co., 1884, 2nd ed) is devoted to an exposition of disjunction. Jevons initially employed the sign " $\cdot|$ " to distinguish his use of disjunction from Boole's use of "+". Jevons followed De Morgan, who wrote (see [De Morgan, 1966, 188]): "The disjunctive particle, *or*, expresses aggregation: 'either *A* or *B*' means 'in the class (*A, B*),' and (see [De Morgan 1966, 309]): "The disjunctive forms may now follow: *either* meaning *either or both* the true contrary of *neither*." Farther on in his review, Peirce noted, in referring to Venn's [Venn 1876] article "Boole's Logical System" and the preference for exclusive over inclusive disjunction, that "Mr. Venn is alone in his dissent." In "Boole's Logical System", *e.g.*, Venn [Venn 1876, 489-490] wrote:

The other point refers to the proper method of expressing alternatives. This question is complicated by the introduction of the purely literary or grammatical discussion of a matter of usage, *viz.*, whether the word "or" does or does not imply that the disjunctives are mutually exclusive. Boole unfortunately committed himself to an opinion as to which signification should be preferred "in strictness of meaning," a somewhat hopeless attempt—for the final appeal of usage is rather against his opinion that the popular forms of disjunction are mostly mutually exclusive. The really important thing however is to improve upon popular vagueness, by keeping prominently before the mind the fact that there is this ambiguity. This is just one of the things that symbolic language can and should do, and Boole's expressions have the merit of great clearness and precision here. Sometimes what we mean is "A or B or, it may be, both;" sometimes "A or B but not both." These are surely such distinctive meanings that it is a real blemish in common language to merge them together, for we certainly ought to know, in any given case, which of the two we have in mind. This Boole indicates by always using $a(1 - b) + b(1 - a)$ for the exclusive

and Jennings note (pp. 398-399), is not, as is sometimes assumed, the modern exclusive disjunction. For that reason, these same modern writers conclude, equally falsely according to O'Toole and Jennings (p. 399), that it cannot be modern inclusive disjunction, since inclusive disjunction "will not support" both the fourth and fifth Stoic syllogisms, whereas exclusive disjunction will. But O'Toole and Jennings assert (p. 399) that the Greek notion of disjunction (*διεξευγμένον*) is *not* after all, the modern inclusive disjunction, since the Greek texts indicate that a Stoic disjunction would be true whenever exactly one of its disjuncts is true, regardless of the number of disjuncts (or clauses) comprising it, whereas modern inclusive disjunction is true provided any number of its disjuncts are true.

The penultimate essay is on "Arabic logic", by Tony Street (pp. 523-596), and it covers the Peripatetic or Aristotelian tradition, produced in Arabic for the period from 750 to 1350. But Street concentrates in particular on works produced between 900 and 1300, confessing (p. 526) that the reason for this chronological limitation is in substantial part determined by the fact that: "my knowledge of Arabic logic texts written after 1350 is even sketchier than my knowledge of the texts written before 1350." Thus we are led to wonder how strong really is the author's knowledge of Arabic work in logic even for the period 900 to 1300, and whether Gabbay and Woods could not have found a more

sense, and $a + b(1 - a)$ for the non-exclusive. There is no harm, however, as he points out, in using $a + b$, in case we happen to know that a and b have nothing in common, for in that case $ab = 0$, and the three expressions therefore are of course identical.) Jevons, on the other hand, adopts a symbolic form of his own, as a sort of indifferent form of alternative, that is one which declines to commit itself to either of the above-mentioned meanings.* ...

*This [Venn adds in his footnote] is not a necessity of his notation, for (as he has pointed out) these two classes of alternatives could readily be expressed and distinguished by means of his symbols.

This applies principally to the first edition of Venn's [Venn 1881] *Symbolic Logic*. In the second, revised edition of *Symbolic Logic*, Venn [Venn 1894, 46] says, however:

Boole [...made ...] all his alternatives mutually exclusive, and in the first [1881] edition of this work I followed his plan. I shall now adopt the other, or non-exclusive notation:—partly, I must admit, because the voting has gone this way, and in a matter of procedure there are reasons for not standing out against such a verdict; but more from a fuller recognition of the practical advantages of such a notation.

knowledgeable person to produce a study of Arabic logic. Street endorses Rescher's approach to the history of Arabic logic, of considering logic within the broader context of Arabic philosophy, over Madkour's [Madkour 1938], which sought to view the history of logic in isolation from the history of philosophy. Street justifies this procedure on the ground that the philosophical "school" to which a scholar belonged determined his choice of topics and his approach to logic, and therefore the logical "school" to which he belonged. This is not a general endorsement of Rescher's history, however, since Rescher, Street argues, defined "school" too strictly, as if in "western" terms; moreover, Rescher's periodization, according to Street, is too artificial, failing even to coincide with the chronology of the political framework of Middle Eastern history. Street therefore modifies and expands Rescher's account, taking it as a general framework for his own treatment, but filling in some of the gaps in Rescher's account, by discussing some of the Arabic scholars whose writings in logic were significant, but omitted from Rescher's history.

Street includes a discussion of the translation of Aristotelian logic texts into Syriac and thence into Arabic (pp. 592-533). The final essay, by Charles Burnett, takes up this story by providing a brief account by of the history of "The Translation of Arabic Works on Logic into Latin in the Middle Ages and the Renaissance" (pp. 597-606).⁸

O'Toole and Jennings (p. 398), citing Łukasiewicz's [Łukasiewicz 1967, 67] criticism of Prantl's history, which, although "indispensable...as a collection of sources and materials,...has scarcely any value as an historical presentation of logical problems and theories," so that "the history of logic must be written anew, and by an historian who has fully mastered mathematical logic," nevertheless warn against "whiggism" or internal history, that is, against what the authors call the "convergence theory of history", and that

...the historian of logic possessing this requisite mastery
of mathematical logic may allow his or her familiarity

⁸The reader who would like a more detailed treatment of the history of the preservation and transmission of ancient logic to the Renaissance is advised, by this reviewer, to consult [Laughlin 1995], which, though limited to texts belonging to Aristotle's *Organon*, gives a better over-all sense of these developments, while the brief accounts by Street and Burnett can be used as a supplement to Laughlin's study, relating specifically to translations from Greek into Arabic, and as a minor survey of logic treatises other than those of Aristotle being transmitted to western Europe via translations into Latin (and Greek).

with the discipline to obscure, or even distort, the historical enterprise. When viewing the past from the perspective of contemporary doctrines, it is sometimes all too easy to succumb to the appeal of a ‘convergence’ theory of history, and to assume that one’s predecessors, if only they had got it right, would have come to the same place we now occupy. At any rate, there seems to have been a tendency toward such a view among several modern commentators....

Unfortunately, this warning went largely unheeded by the authors of these essays.

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