IS THE SYLLOGISTIC A LOGIC?

Much of the last fifty years of scholarship on Aristotle's syllogistic suggests a conceptual framework under which the syllogistic is a logic, a system of inferential reasoning, only if it is not a theory or formal ontology, a system concerned with general features of the world. In this paper, I will argue that this a misleading interpretative framework. The syllogistic is something *sui generis*: by our lights, it is neither clearly a logic, nor clearly a theory, but rather exhibits certain characteristic marks of logics and certain characteristic marks of theories. And indeed, the possession of certain logical characteristics does not preclude a system from having certain other characteristics which we associate with theories. In what follows, I will present a debate between a theoretical and a logical interpretation of the syllogistic. The debate *centers* on the interpretation of syllogisms as either implications or inferences. But the *significance* of this question has been taken to concern the nature and subject-matter of the syllogistic, and how it ought to be represented by modern techniques. For one might think that, if syllogisms are implications, propositions with conditional form, then the syllogistic, in so far as it is a systematic taxonomy of syllogisms, is a theory or a body of knowledge concerned with general features of the world. Furthermore, if the syllogistic is a theory, then it ought to be represented by an axiomatic system, a system deriving propositional theorems from axioms. On the other hand, if syllogisms are inferences, then the syllogistic is a logic, a system of inferential reasoning. And furthermore, it ought to be represented as a natural deduction system, a system deriving valid arguments by means of intuitively valid

inferences. I will argue that one can disentangle these questions—are syllogisms inferences or implications, is the syllogistic a logic or a theory, is the syllogistic a body of worldly knowledge or a system of inferential reasoning, and ought we to represent the syllogistic as a natural deduction system or an axiomatic system—and that we must if we are to have a historically accurate understanding of Aristotle.

The paper has four parts. I will begin by arguing that the syllogistic exhibits one mark of contemporary logics: syllogisms are inferences and not implications. The debate on this question has focused on the interpretation of indirect proof. I will argue that this evidence is neutral on the question. Instead, I will offer new considerations in favour of the interpretation of syllogisms as inferences (§1). I will next argue that the syllogistic exhibits one mark of theories: it employs a distinct underlying logic so to derive derivative structures from primitive structures. So the syllogistic exhibits some of the marks we now find characteristic of logics and some of the marks we now find characteristic of theories. For this reason, the syllogistic is, by our lights, neither a paradigmatic logic nor a paradigmatic theory. I will also discuss in this section whether the syllogistic is better represented as a natural deduction system or an axiomatic system (§2).

I will then turn from these technical observations to the nature and subject-matter of the syllogistic. I will argue that the move from the denial that syllogisms are implications to the denial that the syllogistic concerns worldly features relies on an anachronistic conception of logic. To get a historically accurate picture, then, we need to distinguish between two construals of logic. Briefly put, according to the first construal, a logical truth obtains solely in virtue of its form and so independently of the way the world

is. Call this the view that logic is Formal. According to the second, a logical truth obtains in virtue of highly general features of the world. Call this the view that logic is General. I will argue that Aristotle holds that the syllogistic is General (§3). Next I will discuss the views in the philosophy of language and metaphysics which underlie Aristotle's philosophy of logic. In particular, I will argue that Aristotle provides an account of syllogisms by appeal to a fragment of a mereology. In light of these views, Aristotle would deny that the syllogistic is Formal. For these reasons, the syllogistic is both a systematic representation of inferential reasoning and concerned with general features of the world (§4).

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I will begin by reminding readers of the broad outlines of the syllogistic. *Syllogisms* or *moods* are three member sequences of categorical propositions. The assertoric categorical propositions have the forms: B belongs to every A; B belongs to no A; B belongs to some A; and B does not belong to some A. The syllogisms are classified into three figures, which have the following format. The first two members of the sequence contain the two terms of the third member respectively and a common or middle term: in the first figure, the middle term is in the predicate position of the first member and in the subject position of the second member; in the second and third figures, the middle is the predicate or the subject, respectively, of both of the first two members. So, for example, one of the syllogisms of the first figure, called by its medieval mnemonic, 'Barbara', has this form:

(Barbara)   A belongs to every B;

                B belongs to every C;

                A belongs to every C.

The syllogistic is in part a two-tier classification of syllogisms. In chapters A4-7 of the *Prior Analytics*, Aristotle considers various combinations for these three figures and shows which are acceptable and which unacceptable. The acceptable moods of the first figure are taken to be evidentially acceptable; the acceptability of the acceptable moods of the higher-order figures is established by showing that these moods stand in a certain relation to one of the moods of the first figure—often, that of convertibility. That is to say, Aristotle takes such syllogisms as (one of the first figure moods) Celarent:

        A belongs to no B; B belongs to all C; so A belongs to no C

as obviously acceptable. He then establishes the acceptability of such syllogisms as Cesare

        M belongs to no N; M belongs to all O; so N belongs to no O

by converting the first member to

        N belongs to no M

by means of the conversion rule *e-conversion* and then appealing to Celarent.

        Another method to establish the acceptability of higher-order syllogisms is exposition. Take the first two members of Darapti

        A belongs to every B;

        C belongs to every B.

Now set out some particular B, say b. Then we may infer from the first member

        A belongs to b

and from the second member

C belongs to b.

So it follows that A belongs of something to which C also belongs; hence

A belongs to some C.[1]

The third and final method is indirect proof, which I will discuss momentarily. Finally, the unacceptability of the unacceptable sequences is typically established by counter-instance, which I discuss in §3. So the syllogistic is a structured classification of syllogisms: certain syllogisms are taken to be fundamental and others are shown to be derivative.

I have presented the syllogistic in interpretatively neutral terms of the acceptability of sequences. The interpretation and representation of these sequences, their acceptability and the resulting structure of the syllogistic is a bellwether of the logical concerns of the interpreter's time. For the representation of the syllogistic as a modern logical system has taken over the last fifty years one of at least two approaches. And this matches two periods under which the dominant paradigm for a logical system was an axiomatic theory of logical truths and a natural deduction system of inferential reasoning, respectively. In the 50's and 60's, Łukasiewicz and Patzig took syllogistic forms to be true generalized conditionals and so instances of these forms, implications.[2] I will turn to the critical attention this view received in a minute. But first I will note the apparent *consequences* of the position for the interpretation of the syllogistic. For, if syllogisms are implications, propositions with factual content, then it seems that the syllogistic, insofar as it is partly a systematic taxonomy of syllogisms, concerns worldly or extra-logical facts. A natural corollary is that the syllogistic is, for this reason, a formal ontology or a

system of general facts. And furthermore, the most natural modern representation of the syllogistic would be then as an axiomatic system.

In the early 70's, by contrast, Corcoran (1974b) and Smiley (1973) independently argued that syllogistic forms are valid inference rules and instances of these forms, deductions. If particular syllogisms are inferences, arguments proceeding from premises to a conclusion, then it seems that the syllogistic is a logic or system of inferential reasoning. The most natural modern representation of the syllogistic then would be as a natural deduction system. And a natural corollary—natural by our lights, at least—is that syllogisms are valid independently of the features of the world.

The interpretation of the particular syllogistic sequences, as implications or inferences, then, has significance for the interpretation of the two-tier structure of the syllogistic. The contrast here is partly between the derivation of theorems and the derivation of arguments. Theorems are established as true by deriving them from other propositions, axioms or theorems, whose truth has already been established or, in the case of axioms, accepted without derivation. Arguments, on the other hand, are established as valid by assuming the truth of the premises and deriving the conclusion using accepted rules of inference. And so Łukasiewicz, in representing the syllogistic as an axiomatic system, treats the particular first figure moods as axioms and the higher-order moods as derived theorems. By contrast, Corcoran and Smiley, in representing the syllogistic as a natural deduction system, treat the first figure moods and conversion rules as intuitively valid inference rules. The second and third figure moods are deductions with more than two premises providing step-wise derivation of a conclusion; the methods of showing the acceptability of these syllogisms establishes their validity.

To summarize, Łukasiewicz held all of the following:

1) Syllogistic forms are true universalized conditionals and instantiations of these forms are implications.

2) The syllogistic is a theory.

3) The syllogistic concerns worldly features.

In particular, Łukasiewicz represents the syllogistic as an axiomatic system: moods of the first figure are axioms; moods of the higher-order figures are derived theorems. And Łukasiewicz takes the syllogistic to concern facts; specifically, such relations among classes as inclusion, exclusion, overlap and non-inclusion. In what follows, for ease of exposition, I will take syllogisms to be either inferences or implications—that is, instances of inference rules or instantiations of true universalized conditionals. Although the debate centers on the truth or falsity of (1), the significance of the debate might be taken to concern the truth or falsity of (3). That is to say, the move which might be drawn from the debate is that from the falsity of (1) to the denial of (3).

One of the aims of this paper is to argue that this move—from the falsity of (1) to the denial of (3), for example—rests on an anachronistic conception of logic. I will argue that (1) is indeed false but that the falsity of (1) does not unequivocally entail the falsity of (2) and (3). Indeed, the syllogistic, although a systematic representation of inferential reasoning, exhibits what is, by our lights, a mark of theories. Furthermore, although Łukasiewicz is mistaken both to view the syllogistic as concerned with facts and to view the syllogistic as concerned with class-theoretic notions, there is good evidence that (3) is true. But it will be useful to first consider the question: are syllogisms inferences or implications? So in the rest of this section, I will rehearse the evidence cited in support of, and criticism levied against, (1), the claim that syllogisms are implications.

Łukasiewicz (1957: 1-3, 20-30) and Patzig (1968: 3-4) defend the claim in part by noting that Aristotle generally presents syllogisms in conditional form. For example, Barbara is stated as: "if A is said of every B and B of every C, then it is necessary for A to be predicated of every C." This suggests that syllogisms are not inferences but implications.

Recent scholarship has focused on the evidence of indirect proof, one method of perfection.[3] For example, the indirect proof of Baroco, from 27a36-b1, is:

> if M belongs to every N but does not belong to some X, it is necessary for N not to belong to some X. (For if it belongs to every X and M is also predicated of every N, then it is necessary for M to belong to every X; but it was assumed not to belong to some.)[4]

It is controversial how to describe what happens in Aristotle's indirect proofs. But according to one plausible reading, the above passage assumes the premises of Baroco and shows that its conclusion follows by assuming the negation of one of its premises and using Barbara to derive a contradiction. Łukasiewicz noted that an indirect proof of a conditional must take as its hypothetical assumption not the negation of the conclusion, as Aristotle does in converting Baroco, but the negation of the conditional. So either (1) is false, under the plausible assumption that the only propositions syllogisms could be are conditionals, or we must ascribe a serious error to Aristotle. Łukasiewicz (1957: 58) opts for the second disjunct, writing that "Aristotle does not understand the nature of hypothetical arguments." This allowed Łukasiewicz to continue to endorse (1).

It is more tempting to use the evidence as an argument against (1). For suppose that you were persuaded by the evidence from indirect proof to hold the disjunctive conclusion that either (1) is false or Aristotle makes a blunder. Nonetheless, you adhere to some such hermeneutic principle as: ascribe errors to Aristotle only as a last resort. So against Łukasiewicz, you opt for the first disjunct, arguing that (1) is false from this

evidence. This is surely the more attractive line, if indeed we're forced to make this decision between the two disjuncts.

However, the evidence from indirect proof fails to support the disjunctive conclusion and so makes for a poor argument for either disjunct. Łukasiewicz is right to note that, if syllogisms are implications, propositions with conditional form, then an indirect proof of a syllogism would begin by assuming the negation of that syllogism. But the negation of a conditional, of course, can be expressed as a conjunction where the antecedent obtains and the consequent fails to obtain. And this is just what happens in the proof of Baroco. Admittedly, the indirect proof does not explicitly make the first move of assuming the negation of the conditional—along the lines of saying: "Suppose it's not the case that if M belongs to all N, but not to some X, it's necessary that N should not belong to some X." But still, it is open for us to hold that the proof of Baroco starts *in medias res*, by explicitly assuming the truth of the two conjuncts of the antecedent and the falsity of the consequent under the tacit assumption of the negation of the conditional. That is, the absence of an explicit assumption of the negation of the conditional only shows that the passage is crabbed, not that either syllogisms are not implications or Aristotle was confused about the nature of indirect proofs. So the evidence from indirect proof is inconclusive support for the denial of (1).

The question whether syllogisms are implications or inferences has centered on the questions whether they in fact are expressed by conditional expressions, and whether they ought to be so expressed. But the question whether syllogisms are presented as conditionals or not is germane to the question whether they are propositions only under the assumption that conditional grammatical constructions in Aristotle refer to

propositions. I believe that this assumption is mistaken. For there is evidence that

Aristotle would deny that conditionals express truth-evaluable propositions. One point of

evidence is the omission of implications from Aristotle's discussions of propositions. It is

Aristotle's view that all propositions are categorical—that is, one of universal

affirmations, universal negations, particular affirmations or particular negations. Aristotle

mentions a third quantity, indeterminate propositions, at 24a17 and elsewhere but these

are not obviously a class of propositions distinct from universal and particular

propositions. Rather, Aristotle may be pointing out that some object language sentences

are ambiguous with respect to their quantity and need to be disambiguated as either a

particular or a universal proposition. So Aristotle holds that there are only four kinds of

propositions. As such, he seems to hold that the premises of propositional logic—

conjunctions, disjunctions, and so on—do not express single propositions. And, of

course, the syllogistic does not include such inferences as conjunction introduction or

disjunction elimination. Aristotle does discuss hypothetical syllogisms. But it is now well

established that such syllogisms employ ordinary syllogisms under an assumption, so to

show what follows from that assumption. An hypothetical syllogism is not an argument

with conditional premises, such as *modus ponens* or *modus tollens*.[5]

The omission of implications from Aristotle's discussions of propositions

provides some evidence that conditionals do not express truth-evaluable propositions.

The best evidence, however, is in Aristotle's discussion of truth and falsity. Aristotle

associates truth and falsity with notions of combination and separation. For example, at

Categories 10, 13b10-11, Aristotle writes: "Nothing, in fact, that is said without

combination is either true or false." A necessary condition for a linguistic expression to

be a complete sentence, and so capable of expressing a truth or falsehood, is complexity.

Compare *Categories* 2, 1a16-19, where Aristotle writes:

> Of things that are said, some involve combination while others are said without combination. Examples of those involving combination are 'man runs', 'man wins' and of those without combination 'man', 'ox', 'runs', 'wins'.[6]

Aristotle classifies utterances into those involving *symplokês* or interweaving, and those which do not. From the examples it is clear that Aristotle means to distinguish terms from complete sentences.

In these passages, Aristotle is pointing out that terms alone do not express truths or falsehoods, and so the referents of terms are not truth bearers. As such, this may be just a claim about the composition of the surface structure: well formed sentences, in order to express truths or falsehoods, are composed of terms. However, Aristotle does not merely make a claim concerning the surface structure of natural language sentences. The thoughts expressed by sentences are also complex. See, for example, *De Interpretatione* 1, 16a9-18:

> Just as some thoughts in the soul are neither true nor false while some are necessarily one or the other, so also with spoken sounds. For falsity and truth have to do with combination and separation. Thus names and verbs by themselves—for instance 'man' or 'white' when nothing further is added—are like the thoughts that are without combination and separation; for so far they are neither true nor false.

A sentence is composed of terms; a thought, of the significations of these terms; and a *pragma*, of the extra-mental objects which these significations resemble. But Aristotle cannot mean by combination here merely the composition of a sentence, a thought or a *pragma*. For the association of falsity with separation is unintelligible on this reading, since thoughts which fail to resemble the facts are composed of the significations of the terms, no less than thoughts which succeed in resembling the facts. Moreover, Aristotle

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recognizes that there are well-formed sentences which are not assertions and so express neither true thoughts nor false: at 17a4, he gives the example of a prayer. These sentences are composed of the same sentential components as assertions but, differing in linguistic force, arguably do not involve the relevant notion of combination and separation. So it cannot be linguistic items that are combined and separated. Rather, it is the constituents of the conditions, under which a thought is true, that bear relations of combination and separation.

I have incurred an obligation I will discharge in §4, when I defend an interpretation of this separation and combination terminology. But for now it will suffice to note that a conditional expression does not combine terms in the relevant sense of combination. For I will argue that combination is mereological containment of the referent of the subject term within the referent of the predicate term. It is not plausible to view a conditional expression as relating the antecedent and the consequent in this way. For this reason, Aristotle would deny that conditionals express truth-evaluable propositions. And so syllogisms, even if expressed by conditionals, are not implications.

There is good reason to think that, for Aristotle, conditionals do not express a truth evaluable proposition or a putative fact. Indeed, it would be natural in some contexts to express inferences as conditionals where, if the premises hold, then the conclusion follows.[7] So it is open to us to ascribe to Aristotle the view that conditional express a license to take a step in an inference, a move from the antecedent to the consequent, which may be accepted or denied. Although these considerations fall short of conclusively establishing that syllogisms are not implications, they do weigh in favour of the interpretation that syllogisms are inferences.

I turn to (2), the claim that the syllogistic is a theory. A natural corollary to (2) is the claim that the syllogistic is best represented as an axiomatic system. I have contrasted axiomatic and natural deduction systems. The contrast here, recall, is partly between the derivation of theorems and the derivation of deductions. Theorems are established as true by deriving them from other propositions, axioms or theorems, whose truth has already been established or, in the case of axioms, accepted without derivation. Deductions, on the other hand, are established as valid by assuming the truth of the premises and deriving the conclusion using accepted rules of inference. Since syllogisms are inferences and not implications, the syllogistic is not a theory in this sense. And so the syllogistic would be poorly represented by an axiomatic system, at least on this count.

However, there is also a relevant difference between an axiomatic system and a natural deduction system in terms of the logic or reasoning underlying the derivation process which establishes theorems as true or arguments as valid. In an axiomatic system, the reasoning underlying the derivation process is not explicated *within* the axiomatic system. But in a natural deduction system, the initial structures are themselves the basic inferences used in the derivation process used to prove the validity of higher order arguments. We might follow Corcoran in holding that in order for a system to be a *logic*, it must embody and so explicate the very reasoning employed in moving from initial to derivative structures. What hinges on the issue whether the syllogistic is better

represented as an axiomatic system or a natural deduction system is then, for Corcoran, the foundation of logic itself. Corcoran (1974a: 280, italics removed) writes:

> if the Łukasiewicz view [that (2) is true] is correct then Aristotle cannot be regarded as the founder of the science of logic. Indeed Aristotle would merit this title no more than Euclid, Peano, or Zermelo, regarded as founders, respectively, of axiomatic geometry, axiomatic arithmetic and axiomatic set theory. Each of these three men set down axiomatizations of bodies of information without explicitly developing the underlying logic.

I will return to this assessment momentarily.

The question whether the syllogistic *employs* or *embodies* a reasoning process has centered on the interpretation of perfection. Recall, the syllogistic is a two-tier structure relating two kinds of sequences. The acceptability of second and third figure sequences is established by showing that they stand in a suitable relation to the evidentially acceptable sequences of the first figure: Aristotle calls a fundamental syllogism *teleios*, an adjective whose root is *telos* and which means the same as 'pertaining to the last part of a process or series, to the end of a duration, or to a goal'. A derivative syllogism is called by the alpha-privative *atelês* and the process of establishing the acceptability of these syllogisms, *teleiousthai* or *epiteleisthai*. Aristotle writes at 24b22-24 (adapting Smith (1989)):

> I call a syllogism *teleios* if it stands in need of nothing else besides the things taken in order for the necessity to be evident; I call it *atelês* if it still needs either one or several additional things which are necessary because of the terms assumed, but yet were not taken by means of the premises.

The terminology of this distinction is ambiguous between two readings; the debate might be seen as a dispute over the disambiguation of this terminology. The Greek *teleios* has traditionally been translated as 'perfect'. This translation suggests that a mood of the first figure is the end result of the process of establishing the acceptability of the derivative syllogisms. Those who interpret the syllogistic as a theory, and represent it by an

axiomatic system, tend to view perfection as the *transformation* of an imperfect

syllogism into a perfect syllogism. On this interpretation, the process of perfection need

not be itself syllogistic: it may be a reasoning process employed, but not embodied, by

the syllogistic.

Smith (1989), by contrast, translates *teleios* as 'complete'. This translation

suggests that the moods of the second and third figures are incomplete. On this reading,

Aristotle's characterization of these moods with merely two premises is abbreviated.

Those who interpret the syllogistic as a logic, and so represent it by a natural deduction

system, tend to view the process of establishing the acceptability of the derivative

syllogisms as the completion of incompletely stated syllogisms. The fully stated

syllogism would contain a first figure syllogism. On this interpretation, the process of

completion may seem to be itself syllogistic: it is a reasoning process not merely

employed, but embodied, by the syllogistic.

The debate over perfection is inconclusive. On the one hand, the view that second

and third figure moods are perfected and so the process of perfection *yields* first figure

moods, is open to certain objections. As Striker (1996) notes, the view handles poorly

indirect proof. In an indirect proof of an imperfect syllogism, recall, one assumes that the

conclusion of the syllogism is false and uses a first figure mood to derive a contradiction.

It is implausible to view such a method as the transformation of the imperfect mood into

a first figure syllogism. So not every method of establishing the acceptability of the

derivative syllogisms can be viewed as a process of perfection. On the other hand, the

view that second and third figure moods are completed and so, when fully stated, *contain*

first figure moods, is I believe also open to certain objections. Certain second and third

figure syllogisms can be proven acceptable by more than one method. For example, Aristotle recognizes at 28b20-21 that Bocardo can be shown to be acceptable by both indirect proof and exposition. So on the view that imperfect syllogisms are deductions containing perfect syllogisms, one must say either that one and the same syllogism can have distinct sequences of deductive steps, or that distinct syllogisms can have the same initial premises and conclusion. On either option, it is misleading to identify the imperfect syllogism with any particular sequence of deductive steps. Rather, one must identify the imperfect syllogism with a class of deductions with the same initial two premises and conclusion.

However, regardless of one's interpretation of perfection, it is clear that the syllogistic relies at least in part on an alien underlying logic. Regardless of whether or not we view conversion rules as contained in second and third figure moods, the conversion rules *themselves* are not syllogisms. The definition of a syllogism at 24b18-20 as "a discourse in which, certain things having been supposed, something different from what is supposed results of necessity by their being so" appears to require that there be more than one premise. And Aristotle asserts at 40b35-36 that nothing follows necessarily from a single premise. Of course, Aristotle does not hold that repetition or conjunction elimination are invalid; rather, he is denying that these are syllogistic.

But moreover, Aristotle proves the validity of the conversion rules. And indeed, the syllogistic presupposes a background logic which itself resists representation as syllogisms. Aristotle proves e-conversion at 25a1-17 as follows:

> It is necessary for a universal privative premise of belonging to convert with respect to its terms. For instance, if no pleasure is a good, neither will any good be a pleasure…. First, then, let premise AB be universally privative. Now, if A belongs to none of the Bs, then neither will B belong to any of the As. For if it

does belong to some (for instance to C), it will not be true that A belongs to none of the Bs, since C is one of the Bs.

Aristotle establishes e-conversion by employing a reductio principle and the square of opposition (or, at least, the contradictory opposition between e- and i-propositions). He goes on to establish the other conversion rules by reductio proofs that employ the established e-conversion. As we have seen, Aristotle does not view reductio proofs as syllogisms. As such, the syllogistic exhibits a mark of contemporary theories: the employment of a primitive inference rule—here, a reductio rule—that is itself non-syllogistic.

Little hinges on the interpretation of perfection, either, for the representation of the syllogistic as some natural deduction system or other. For, even if perfection is a transformation with a perfect syllogism as the result of the process, we may nonetheless represent the syllogistic as a natural deduction system. Both Smiley and Corcoran represented the syllogistic as a Fitch-style natural deduction system. Such systems establish that an argument is valid by employing a step-wise derivation from the premises of the argument to its conclusion. Each step of the derivation is a proposition. In a Gentzen-style natural deduction system or sequent calculus, by contrast, an argument is established as valid by a step-wise derivation of the argument itself. Each step of the derivation is an argument. The interpretation of perfection as the transformation of an imperfect syllogism into a perfect syllogism suggests the representation of the syllogistic as a sequent calculus.

For the reasons canvassed above, the representation of the syllogistic as a sequent calculus would be partial: the representation is not implausible as a representation of conversion but a sequent calculus is ill-suited to represent indirect proof. Indeed,

although the syllogistic is systematic in so far as it attempts an exhaustive classification of arguments satisfying certain restrictions, it is not by intention a system. Aristotle uses a variety of methods for establishing validity and invalidity, without a concern for proving the consistency of these methods. Some, but not all, perfection techniques resemble a sequent calculus, but I doubt that any representation of the whole syllogistic as a modern system will be entirely satisfactory.

So the syllogistic exhibits what is, by our lights, a mark of paradigmatic theories. Let me return to Corcoran's assessment that, if the syllogistic presupposes an underlying logic, then we ought not call Aristotle the founder of logic. This strikes me as too strong a claim. For although the syllogistic is not fully a logic in Corcoran's sense, it is reasonable to call Aristotle the founder of logic. He provides the first systematic study of inferential reasoning. Moreover, although the syllogistic employs itself a non-syllogistic underlying reasoning process, Aristotle shows a logician's interest in this underlying reasoning. Unlike Euclid, Peano and Zermelo, Aristotle is concerned to *defend* much of this reasoning: as we have seen, he proves the validity of the conversion rules. Finally, the assessment that, if the syllogistic presupposes an underlying reasoning process, then we ought not call Aristotle the founder of logic, presupposes a certain conception of logic. I will next argue that this conception is not Aristotle's. Before proceeding, however, let me make a disclaimer. The informed reader will recognize my debt to Corcoran, Smiley, Smith, Scanlan and others. The current paper might be read as arguing for the extent to which the achievement of these authors—achievements which include the correct identification of syllogisms as inferences, and the representation of conversion as a

natural deduction system—is consistent with what is, I believe, a more historically accurate characterization of Aristotle's own conception of logic.

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I have argued that the syllogistic exhibits what are, by our lights, marks of both logics and theories. I turn now to (3), the claim that the syllogistic concerns worldly features. Although I will argue that Łukasiewicz misidentifies the subject-matter of the syllogistic, I believe that he was correct to claim that the syllogistic concerns worldly features. In this section, I will discuss the inference from the falsity of (1) and (2) to the denial of (3). I will argue that this inference is valid under only one of two distinct conceptions of the nature of logic. In the following section, I will argue that this conception is not Aristotle's.

Logic is a topic-neutral study of consequence. That is to say, logic is a study of what it is for a conclusion to follow from premises; and the way in which this study is conducted is topic-neutral in—roughly—the following sense. The syllogism, 'All Greeks are men; all men are mortal; so all Greeks are mortal' is a valid inference but its validity does not depend on the meaning of the non-logical words, 'Greek', 'men' or 'mortal'. The inference would be licensed regardless of what these words meant. The inference from 'John is a bachelor' to 'John is unmarried', on the other hand, is also a permissible inference but its permissibility depends on the meanings of the non-logical words. If 'bachelor' meant Canadian, then the conclusion would not follow from the premise.

But topic-neutrality, so characterized, can be read in one of two distinct ways. Under one conception, logic is characterized by its indifference to all worldly facts or its abstraction from all semantic content whatsoever. Under this conception, the above syllogism is valid regardless of any worldly facts whatsoever: whether Greeks are men, whether men are mortal, and so on. This conception is often drawn on in contemporary characterizations of logic; it underlies, for example, Ernest Nagel's (1956: 66) claim that logical laws are empty: they tell us nothing about the world. And the conception underlies the view Quine (1970: 95) ascribes to Carnap: that "it is language that makes logical truths true—purely language, and nothing to do with the nature of the world." The thesis that logical truths hold in abstraction from all facts naturally leads to a corollary concerning *that in virtue of which* a logical truth holds: namely, that logical truths hold solely in virtue of their form. For it is difficult to imagine what else it may be in virtue of which a logical truth holds, if not its form, under the conception of logic as indifferent to worldly facts. Call this then the Formal conception of logic.

According to another conception of topic-neutrality, to claim that logic is topic-neutral is not to characterize logic by its abstraction from all content whatsoever but rather to characterize logic by its abstraction from the *specific* identities of things. Under this conception, the syllogism is valid regardless of the specific identities of the referents of 'Greek', 'man' and so on. Such a conception of logic, unlike the Formal conception, is compatible with the claim that logical truths hold in virtue of highly *general* features of the world. So call this the General conception of logic. Such a conception underlies Russell's (1919: 169) oft-cited claim that "logic is concerned with the real world just as truly as zoology, though with its more abstract and general features."

We can now contrast two conceptions of the topic-neutrality of logic:

Formal Conception: logical truths and validities obtain independently of their semantic content;

General Conception: logical truths and validities obtain independently of the particular identities of things.

The notion of topic-neutrality has become associated with the notion of independence from worldly facts. Despite the success of Quine's arguments against this view of formal logic, and despite the stature of Quine, philosophers and historians of logic today are still liable to view logic under the Formal Conception.

Consider the move from the falsity of (1) to the denial of (3); put contrapositively, the entailment is, if (3) then (1). This move is valid under the Formal construal of logic. For under this construal of logic, the claim that the syllogistic concerns worldly features entails that syllogisms are not inferences and the syllogistic, not a logic. But, under the General construal of logic, (3) doesn't necessarily entail (1). For it is consistent to hold, under the General construal, that there is a sense in which the syllogistic concerns worldly features yet that syllogisms are nonetheless inferences.

Aristotle would both hold that logic is General and deny that logic is Formal. In the rest of this section, I will argue that Aristotle holds that logic is at least General. There's good reason to think that Aristotle believes that an argument is valid only if every argument in the same form is valid. This claim is only tacit in the *Prior Analytics* but it plays two roles there, as Corcoran (1974) noted. First, to establish validity of all arguments in the same form as a given argument, he establishes the validity of an *arbitrary* argument in the same form—that is to say, leaving its content words

unspecified. As we've seen, he uses letters for the terms when stating syllogisms and when proving the higher-order syllogisms valid by conversion.

Second, Aristotle establishes the invalidity of a syllogistic form by a method of "contrasted instances," as Ross (1949: 302) puts it. Consider the following explanation of this method, at 26a2-9 (adapting the Smith (1989) translation):

> If the first extreme [i.e. the major term] belongs[8] to every one of the middle and the middle belongs to none of the last [i.e. the minor term], there will not be a syllogism of the extremes, for nothing necessary results in virtue of these things being so. For it is possible for the first extreme to belong to all as well as to none of the last. Consequently, neither a particular nor a universal conclusion becomes necessary; and since nothing is necessary because of these, there will not be a syllogism. Terms for belonging to every are animal, man, horse; for belonging to none, animal, man, stone.

Here Aristotle shows that there is no deduction with the premises

A belongs to every B; and

B belongs to no C.

To show that nothing follows of necessity from these premises, Aristotle shows that different assignments of referents to the terms yields different propositions containing the extreme terms. For one assignment of referents to the terms

A: animal

B: man

C: horse

has the result that the alleged premises are true and a proposition where the extreme terms form a universal affirmation—namely, 'animal belongs to all horses'—is also true. But another assignment of referents to the terms

A: animal

B: man

C: stone

has the result that the alleged premises are true and a proposition where the extreme terms form a universal negation—namely, 'animal belongs to no stone'—is also true. The former situation shows that no universal negation follows of necessity; the latter situation shows that no universal affirmation follows of necessity.

These considerations support the ascription to Aristotle of the General conception of logic.[9] But they do not go so far as to support the ascription to Aristotle of the Formal conception. That is, although arguments in the same form are either all valid or all invalid, this does not show that the way the world is a matter of indifference to the question of an argument's validity. And, especially in light of the fact that the Formal conception of logic is a currently controversial thesis, we need to proceed carefully. Aristotle nowhere expresses the Formal conception of logic. His methods do not require it. And it is a substantial and currently controversial thesis. So we have as yet seen no reason to ascribe to Aristotle anything stronger than the General conception. To find whether Aristotle would hold or deny that logic is Formal, we need to dig deeper into Aristotle's views on consequence.

4

Aristotle introduces the first figure syllogisms, Barbara and Celarent, at 25b32-26a2 as follows:

> (i) Whenever, then, three terms are so related to each other that the last is in the middle as a whole and the middle is either in or not in the first as the whole, it is necessary for there to be a complete (*teleios*) deduction of the extremes. ((ii) I call that the *middle* which both is itself in another and has another in it—this is also middle in position—and call both that which is itself in another and that which

has another in it the *extremes*.) (iii) For if A is predicated of every B and B of every C, it is necessary for A to be predicated of every C ((iv) for it was stated earlier what we mean by 'of every'). (v) Similarly, if A is predicated of no B and B of every C, it is necessary that A will belong to no C.

Barbara is stated in (iii). The relation of mereological containment is transitive: if, for example, B is wholly in A and C is wholly in B, then C is wholly in A. It is clear that, in section (i) of the passage, Aristotle is appealing to the transitivity of mereological containment to introduce Barbara and defend its status as a perfect syllogism. Section (v) of the above passage suggests that Celarent is defended in a like manner—that is to say, by appeal to the mereological principle that if one thing A is wholly excluded from another, B, and B is wholly in a third thing, C, then A is wholly excluded from C. So it is *prima facie* plausible to ascribe to Aristotle the view that certain syllogisms are valid in virtue of certain mereological relations.

The appeal to mereological relations, in an account of that in virtue of which certain syllogisms are valid, is defended —'for' in (iv)—by reference to a previously stated interpretation of universal affirmative propositions. I take the referent of 'what has been said earlier' in section (iv) to be 24b26-8. Aristotle provides an interpretation of categorical propositions early on in the *Prior Analytics* (24b26-8), writing that "'one thing is wholly in another' means the same as 'one thing is predicated universally of another'."[10] Although Aristotle only provides a semantics for universal affirmations here, the extension to universal negations and particular propositions ought to be clear. Aristotle thus implies mereological truth conditions for all of the categorical propositions. So, just as 'A belongs to every B' is true iff B is mereologically included in A, so too 'A belongs to no B' is true iff B is mereologically excluded from A. 'A belongs to some B'

is true iff A and B mereologically overlap—that is to say, iff a part of B is a part of A. And 'A does not belong to every B' is true iff A is not mereologically included in B.

The part-whole talk might suggest to the reader that Aristotle views predication in terms of set-theory: under this interpretation, the terms range over sets; the categorical propositions express such set-theoretic notions as inclusion, exclusion, overlap and non-inclusion. Indeed, Aristotle's discussion of predication in mereological terms has struck some as a confused conflation of mereology, the metaphysics of properties and set theory.[11] The difficulty of interpretation here is partly that Aristotle is employing mereological notions which are foreign to us. Among various senses of 'whole', Aristotle distinguishes between what became known as quantitative wholes and integral wholes at *Metaphysics* 5.26 (1023b26-33):

> We call a whole … that which so contains the things it contains that they form a certain unity; and this in two senses—either as each part being one, or as a unity made up out of the parts. For what is universal and what is said wholly, since it is a certain whole, is universal in the sense that it contains many things by being predicated of each and by being all those and each of them one, as for instance man, horse, god are one because they are all living things. But the continuous and limited is also a whole, whenever there is a certain unity from the many.

Aristotle draws the contrast between quantitative and integral wholes by appealing to two distinct kinds of constitution relations. A quantitative whole is homoiomerous: the sum of animals, for example, is composed of parts each of which is itself an animal. An integral whole, by contrast, is heteromerous. A house, for example, is not a quantitative whole: its parts—the roof or the door, say—are not themselves houses; and not all of what can be said of a house—that its final cause is to provide shelter, say—can be said of the parts of a house. So, for example, associated with the species humanity is a sum composed of individual humans. Any typical individual human has, of course, such parts as hands and

feet. But these are integral parts of the individual, not quantitative parts. And so the hands and feet of the individual human are not themselves parts of the sum associated with the species.

I do not expect that these comments will entirely dispel for the reader the foreignness of Aristotle's mereological views. I cannot discuss in detail the relevant metaphysics. However, it suffices for my present purposes to bring out that Aristotle appeals to a notion that he *characterizes* as mereological, so to formulate the conditions under which ordinary predications express true thoughts. I will next show that this relation is *genuinely* mereological. It will be important to establish this, as then the claim that certain syllogisms are valid in virtue of part-whole relations is inconsistent with the Formal Conception of logic. For the claim entails that their validity is not entirely independent of semantic content but is instead dependent on a mereology.

According to our best available theories of parts and wholes, any legitimate part relation is a preorder—that is to say, a relation that is at least reflexive and transitive.[12] So everything is a part of itself; and any part of a part of a thing is itself part of that thing. If we allow 'Pxy' to stand for 'x is a part of y', then we have the following axiom schemata:

(P1) Pxx (Reflexivity)

(P2) $Pxy \land Pyz \supset Pxz$ (Transitivity)

These could be expressed as axioms were the variables bound by the appropriate quantifiers, but I will leave these omitted for ease of presentation. (P1)-(P2) characterizes a relation broader than any part relation. A reflexive and transitive relation need not be a part relation: for example, the less-than-or-equal-to relation is a preorder on the real numbers. For a system to be a mereology, we need to expand the axiom set. One common

strategy for expansion is to introduce a supplementation principle. A commonly held

intuition is that whenever an object has a proper part, it has more than one proper part.

That is to say, there is always a mereological difference between a whole and a proper

part. Let us call this difference a *remainder*. The necessity of a remainder doesn't follow

from (P1)-(P2) alone. For example, consider a model of (P1)-(P2) with just two objects,

one part-related to the other but not vice versa. To express the view that, when there is

some proper part of a whole, there is always a distinct part of the same whole, it will be

useful to define the notions of overlap and proper part. One mereological sum overlaps

another just in case there is a shared part, i.e.

$$Oxy =_{df} \exists z \ (Pzx \wedge Pzy)$$

A proper part is a part which is non-identical with its whole, i.e.

$$PPxy =_{df} Pxy \wedge \neg(x =_{id} y)$$

Then the intuition that a proper part implies a remainder can be expressed by the axiom

schema:

$$\text{(P3) } PPxy \supset \exists z \ (PPzy \wedge \neg Ozx) \text{ (Weak Supplementation)}$$

Simons (1987), for example, holds that any system that can be truly called a mereology

must conform to at least (P1)-(P3).

Since Aristotle characterizes the relation holding between a quantitative part and a

whole as mereological, he is *prima facie* committed at least to the reflexivity, transitivity

and weak supplementation of the relation. Moreover, as I will now argue, we have the

textual evidence to establish that the quantitative part relation is reflexive, transitive and

weakly supplementary. This supports Aristotle's characterization of the quantitative part

relation as mereological. We have seen from 25b32-26a2 that Aristotle holds that

quantitative inclusion is transitive. The quantitative part relation is also reflexive. Recall,

Aristotle claims at 24b26-28 that one thing being wholly in another is equivalent to one

thing being predicated universally of another. Aristotle draws a result: "And so we say

'one thing is predicated universally of another' whenever none of the subject can be taken

of which the other cannot be said." (24b28-30) It is easy to see that the implication, if

none of the B's can be taken of which A cannot be said, then A belongs to all B, is true

under any substitution for the schematic letters whatsoever only if the relation of

belonging to all is reflexive. Since Aristotle believes that the implication follows from the

association of universal predication with the quantitative part relation, this passage gives

us reason to hold that this relation is reflexive.

Aristotle claims that a universal term is predicated of many subjects at *De*

Interpretatione 7 (17a39-b1):

> I call a universal that which is by its nature predicated of many things, and
> individual that which is not; man, for instance, is a universal, Callias an
> individual.

So Aristotle is committed to Weak Supplementation. When there is some quantitative

proper part of a whole, there is always a distinct part of the same whole. Since a universal

is predicable of several subjects, when there is some quantitative proper part of a whole,

there is typically a distinct part of the same whole. The characterization of the

quantitative part relation as a weakly supplementary preorder is the weakest and least

contentious ascription to Aristotle. Whatever else the quantitative part relation may be, it

is a weakly supplementary preorder if it is a genuine mereological relation at all.

Furthermore, these weak commitments suffice for our present purposes.

Let me note that I have discharged the obligation that I incurred in §1. There,

recall, I promised to show that Aristotle's association of truth and falsity with certain

notions of combination and separation makes it unlikely that he holds that conditionals express implications. The mereological interpretation of categorical propositions provides a plausible reading of Aristotle's talk of truth and falsity as concerning combination and separation. Consider, for example, the categorical proposition 'Mortality belongs to all humans'. This proposition expresses a true thought just in case the referents of the terms are suitably combined: namely, if the mereological sum of humans is a part of the mereological sum of mortals. The proposition is false if the referents are suitably separated: that is, if a part of the sum of humans is not a part of the sum of mortals. It should be clear to the reader that, if combination is mereological containment of the referent of the subject term within the referent of the predicate term, then it is not plausible to view a conditional expression as relating the antecedent and the consequent in this way. For this reason, Aristotle would deny that conditionals express truth-evaluable propositions. And so syllogisms, even though often expressed by conditionals, are not implications.

I will address an objection. One might hold that Aristotle's purpose in 25b32-26a2 is heuristic and the appeal to mereological relations is a mere pedagogical or illustrative aid. The objection might be fleshed out by considering an analogy with our use of Euler diagrams to teach introductory logic. Such diagrams provide a convenient decision procedure for testing certain validities: the intersection properties of circles are structurally isomorphic with the validity properties of certain arguments; and our visual and other cognitive abilities are such that we can apprehend the relevant spatial relations more easily than the abstract validities. However, it would be a neophytic error to conclude, upon being introduced to such diagrammatic representations of validities, that

logic is about certain spatial relationships. So too, the objection might continue, Aristotle appeals to mereology without intending his readers to conclude that the syllogistic is about part-whole relationships. The transitivity of containment, for example, is structurally isomorphic to Barbara and is a principle we can quickly apprehend. But the transitivity is merely a useful representation of Barbara.

In response, I do not ascribe to Aristotle the views that mereological relations are merely isomorphic to syllogisms, that the transitivity of containment merely represents Barbara, that mereology is a convenient but potentially misleading decision procedure for testing the validity of syllogisms, or that mereological inclusion merely provides an easy but non-literal way to appreciate the proposition expressed by a universal affirmation. On the contrary, as we have seen, there is good reason to take mereological relations such as inclusion to be the *intended* interpretation of the categorical propositions. The account of syllogisms in mereological terms is not implausible in the presence of Aristotle's commitments in semantics and metaphysics. In particular, given that Aristotle holds that categorical propositions express mereological relations, it is not so surprising that he holds also that inferences from a premiss set of categorical propositions to a categorical proposition as conclusion are licensed by mereological relations. Of course, Aristotle's choice of which relations to take as primitive, and so which syllogisms to take as first figure syllogisms, is sensitive to issues of elegance, accessibility and perspicuity. The syllogistic rests in part on the two mereological relations licensing Barbara and Celarent; arguably, the correctness of each is easily grasped. But to grant such considerations in the structure of the syllogistic is not to take the mereological terminology as a mere heuristic. If this is correct, then the objection lapses.

I have made two claims in this section of the paper. First, I have noted that Aristotle employs part-whole terminology in providing an account of that in virtue of which certain syllogisms are valid. And I have argued that this terminology refers to a genuinely mereological notion. That certain syllogisms are valid in virtue of mereological relations is inconsistent with the Formal Conception of logic. For it is implausible to view mereological relations as entirely free of semantic content. Rather, we have good reason to ascribe to Aristotle the General Conception of logic: certain validities obtain independently of the particular identities of things but nonetheless in virtue of highly general features of the world. This conception of logic is not entirely unlike the view endorsed by Łukasiewicz. However, where Łukasiewicz held that syllogisms are implications expressing facts, I claim merely that syllogisms are inferences which are valid in virtue of certain mereological relationships. It is in this sense that the syllogistic concerns worldly features.

I will bring the paper to a conclusion by returning to our claims (1)-(3). These are, recall:

> 1) Syllogistic forms are true universalized conditionals and instantiations of these forms are implications.
> 2) The syllogistic is a theory.
> 3) The syllogistic concerns worldly features.

I have argued that the syllogistic exhibits what are, by our lights, marks of both logics and theories. Indeed, I have argued that (1) is false and (2) is not unambiguously true. Nonetheless, we have seen evidence for ascribing to Aristotle a conception of logic under which the falsity of (1) is consistent with the truth of (3). So I have argued that one can hold that syllogisms are inferences and not implications, and even partly represent the

syllogistic as a sequent calculus, and yet hold that syllogisms are valid in virtue of

generalities, and so there is a sense in which the syllogistic concerns worldly features.

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[1] For discussion, see Smith (1982).

[2] If p and q are open sentences and Q a string of universal quantifiers, one for each free variable in (p ⊃ q), then Q(p ⊃ q) is a universalized conditional. So the syllogistic form of Barbara looks like this: For all A, B, C: if B holds of every A and C holds of every B, then C holds of every A.

[3] See Łukasiewicz (1951: 58), Austin (1952: 397-8), Corcoran (1974: 280), Smiley (1973: 137-8).

[4] Except as noted, I follow Smith's (1989) translation of the *Prior Analytics*.

[5] See Lear (1980) and Striker (1996).

[6] Translations of the *Categories* and *De Interpretatione* are from Ackrill (1963).

[7] Austin (1952), Rose (1968: 25) and Corcoran (1972: 278) all make this observation. Alexander (*in An Pr*. 373, 29-35) claims that "'if A, then B' means the same as 'B follows from A'."

[8] Reading *huparchei* with the manuscripts, as opposed to Alexander's reported *akolouthei*, adopted in the OCT.

[9] The General conception of topic-neutrality is arguably consistent with Aristotle's own use of the term 'logical' (*logikôs* and its cognates). Aristotle's meaning of such terminology is controversial. Ross (1949: 168), for example, holds that 'logical' at 1029b13 "probably always refers to linguistic inquires or considerations." Simplicius (in Phys. 440.19-441.2), on the other hand, argues that Aristotle's intention in calling a puzzle 'logical' at Phys. 3.3 (202a21-22) is that the puzzle proceeds from generalities rather than from principles peculiar and appropriate to the subject. Burnyeat (2001: 19-23) endorses and defends Simplicius' view of Aristotle's use of this terminology.

[10] Other uses of the A *en holo einai* B locution include: 25b33, 30a2, and 53a21. Use of the corresponding *hos meros* locution include: 42a10, 42a16, 49b37, 64a17, 64b12, and 69a14.

[11] See, for example, Kirwan (1993: 174) and Ackrill (1963: 76).

[12] Simons (1987) characterizes any genuine mereology as antisymmetric: if one thing is a part of another, and that other a part of the first, then the one and the other are identical. However, this characterization is now controversial. Cotnoir (forthcoming), for example, argues that extensionality entails antisymmetry, so a non-extensional mereology is not antisymmetric. The argument of the paper is neutral on the question whether the quantitative part relation is extensional or non-extensional. So I will not discuss whether the quantitative part relation is antisymmetric.