



Bocheński's model of the development of logic

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Accepted: 29 August 2021 / Published online: 25 October 2021
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Abstract

According to Bocheński's description of the history of formal logic, there clearly is some objective development, though far from being cumulative or linear. The history of logic throughout the world consists of three relatively short pinnacles preceded by also short periods of awakening and followed by periods of extensive commentary running into long periods of standstill and decadence, when nearly all achievements are consigned to oblivion.

Keywords Logic · History · Development · Bocheński

Józef Maria Bocheński's oeuvre in the field of the history of logic amounts to 25 works (making together 1935 pages in print, as counted by Bocheński himself, cf. Bocheński, 1994) published between 1935 and 1962 (with the exception of one book review published later) and includes, among others, some truly epoch-making texts. His activity as a historian of logic may be divided into two main periods: in Rome (1934–1939) and in Fribourg (1945–1955), separated by his military service during World War II. During the Roman period, which according to Bocheński was his most creative and flourishing research time, he published 11 works in the history of logic amounting to 401 pages. Of Bocheński's works on the history of logic, the following two are pivotal for understanding his model of the development of logic:

- *Notiones historiae logicae formalis* (1936),
- *Formale Logik* (1956).

Two decades separate these works, the first one being an early work of the Roman period, written in Latin, outlining the general idea of the development of logic with practically no substantiation, and the other his famous comprehensive, source-based classic. Therefore, *Notiones* (1936) should be considered the seminal work in the field of the history of logic worldwide, the first such account ever, and *Formale*

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Logik (1956) the first complete monograph, closing the process of the birth of the history of logic as a mature branch of science.

Bocheński is best known for his enormous and pioneering source queries in the field of the history of logic. However, at the end of his life, Bocheński insisted that he also invented and substantiated a model, a permanent, constant pattern or a structure exemplified by the development of logic. The model is the focus of this paper.

Bocheński's view on the state of the history of logic in the 1930s

Bocheński's model of the history of logic pertained directly to the three most influential—as he saw them—philosophical currents of the interwar twentieth century: modern philosophy, neo-scholasticism and mathematical logic with analytic philosophy. For different reasons, representatives of those currents systematically misunderstood the history of logic.

The period of modern philosophy begins in the middle of the fifteenth century and ends at the turn of the nineteenth and twentieth centuries, contrasting with the Middle Ages on one side and with contemporary philosophy on the other. Hence, the terms “modern” and “contemporary” (*moderne Philosophie* and *Philosophie der Gegenwart* in German), as coined by Bocheński, are to be carefully distinguished. This is related to Bocheński's view that the beginning of the twentieth century marks a profound breakthrough in philosophy, doing away with the direct past and involving some kind of return to scholasticism (Bocheński, 1947, 1993). In modern philosophy, logic was either openly neglected or turned into a naive psychology of cognition.

In 1787, in the second edition of his famous *Critique of Pure Reason*, Immanuel Kant presented the view that where logic is concerned, Aristotle had discovered everything and hence no further development would be either required or even possible (Kant, 1929, p. 17–18).

In the mid-nineteenth century, Carl Prantl published a huge, four-volume history of logic under the title *Geschichte der Logik im Abendlande* (Prantl 1855–1870). It was guided by Kant's thesis that no progress is possible in logic, and all achievements were interpreted either as a repetition of Aristotle or as a mere novelty of exposition, or as a corruption. Prantl's composition was commonly accepted even in the 1930s.

The attempts, that started around the time of the Congress of Vienna in 1815, to renew scholasticism in the Catholic Church are known as neo-scholasticism. However, as remembered by Bocheński, the representatives of neo-scholasticism practically endorsed the modern attitude towards logic. They knew neither mathematical nor even proper medieval logic. In the field of logic, neo-scholasticism was mostly a part of modern philosophy (Bocheński, 1994, p. 93).

In the 1930s, mathematical logic was at its acme. It was flourishing among foundationally oriented mathematicians and some of the early analytic philosophers. However, the vast majority of the logicians of the period were hardly aware of the history of their own research.

Bocheński was lucky to collaborate with Jan Łukasiewicz, and also with Heinrich Scholz and Jan Salamucha, rare examples of logicians aware of the existence of the history of formal logic. Bocheński (1936) mentions *Geschichte der Logik* (1931) by Scholz and *Zur Geschichte der Aussagenlogik* (1935) by Łukasiewicz as the only two proper works on the history of logic at the time. Later he lists also Charles Sanders Peirce as a forerunner of the history of logic (Bocheński, 1956). The works by those logicians appear to be Bocheński's real sources of inspiration.

Bocheński's pessimistic evaluation of the modern period is, perhaps, exaggerated. Some logical research did exist both in the modern and in the scholastic circles, especially until the eighteenth century. However, the reduction and weakness of formal logic in the time in question, and especially in the nineteenth century, is undeniable. Multiple rediscoveries of forgotten parts of logic, such as De Morgan's laws, are simply a matter of fact. Bocheński is here a witness to the interwar period, not a mere historian, and his evaluation of that state of logical research and education, even if one-sided, helps to understand the motivations underlying his huge source-based research.

The general pattern of the history of logic

According to Bocheński, it could be said roughly that in the 1930s the representatives of modern philosophy and neo-scholasticism misunderstood the history of logic for they did not know logic, whereas the representatives of mathematical logic and analytic philosophy misunderstood the history of logic for they were ignorant of history. It was to those misunderstandings that Bocheński directed his model of the development of logic. It may be summarized as the conjunction of the following claims:

- in logic there is a development, (1a)
- the development of logic is neither cumulative nor linear, (1b)
- short highly creative intervals of logic are divided by long periods of decadence (1c)

Theses (1) may be called a model of the development of logic in the sense that they serve as a general outline to be filled in and substantiated by relevant historical records. It is worth mentioning that, according to Bocheński (1956), it is not only the history of logic which is designed in accordance with theses (1), but the history of knowledge and of the entire culture. That claim, however, is not the subject here.

In the opening passages of *Formale Logik*, where theses (1) serve as the general model and the book's design, Bocheński declares, firstly, that theses (1) are presented for the first time ever and, secondly, that theses (1) are not accepted as synthetic a priori propositions but simply derived from the historical record, the sources collected and presented in the book (Bocheński, 1956, pp. 12–13). Without deprecating Bocheński's achievements, it should be affirmed that neither of those two declarations is perfectly accurate.

Thesis (1a) had been fully expounded, but not substantiated, in Bocheński's early work *Notiones historiae logicae formalis* (1936). Bocheński recalls that at the beginning of his academic career he considered it his personal mission to convince the world that Kant had been wrong, logic had an impressive history, and especially had flourished in the Middle Ages. And he openly admits his own dependence on Łukasiewicz (Bocheński, 1994). It is therefore certain that Bocheński received thesis (1a) from Łukasiewicz and Scholz. Thesis (1b) is more likely to be Bocheński's own invention, connected to his early philosophical view that modern philosophy as a whole is without value and a dead end (Bocheński, 1994) as well as to his neo-scholastic education as a Catholic clergyman. But it also is more than implied already in *Notiones* (Bocheński, 1936) and, hence, much earlier than Bocheński's inquiry into sources. Thesis (1c) appears to be later, a truly empirical result of Bocheński's source-based research, and is definitely his original contribution to understanding the history of logic.

Over the course of the 20 years between *Notiones* (1936) and *Formale Logik* (1956), Bocheński substantiated theses (1) by enormous source-based research, including numerous search queries throughout Europe (Bocheński, 1994).

It seems certain that that huge enterprise was from the very beginning guided by hypotheses (1a) and (1b). The general model or blueprint of the history of logic was ready to use at the very beginning, as early as 1936, and followed by two decades of the source-based research aimed to substantiate the model. Bocheński's method did not consist in simple gathering facts but was much more similar to Karl Raimund Popper's idea of conjectures and refutations.

Hence, originally, Bocheński and Prantl differ not in method but in hypothesis. They both accept a hypothesis at the starting point and attempt to substantiate the hypothesis by their source-based research. In Prantl's case, the hypothesis equals to Kant's above-mentioned stance, and in Bocheński's case, it amounts to theses (1a) and (1b). Bocheński admits that Prantl had access to a huge amount of sources but was gathering and evaluating those sources from a wrong point of view. The wrong point of view stems from the ignorance of what logic is, what it consists in (Bocheński, 1956, p. 8–10). The difference consists in that Bocheński's hypothesis was true or closer to true, whereas Prantl's was false or at least much less close to true, and also in that Bocheński was much more ready to condition his guiding theses to the outcomes of his source-based inquiry, whereas Prantl was more faithful to the hypotheses than to the sources.

Thesis (1a)

As has been already stated, thesis (1a) appears in the very opening statements of *Notiones* (Bocheński, 1936) literally. Bocheński undoubtedly believed it before he had begun any source research in the history of logic. Hence, Bocheński's source search inquiry over the course of two decades was guided by thesis (1a) rather than the other way around. It is far from calling thesis (1a) an a priori belief. However, it seems fair to say that thesis (1a) was originally grounded in some residual knowledge owed to the general classical education.

Bocheński's original hypothesis, which is thesis (1a), is not to be understood as a mere negation of Kant and Prantl's thesis of the perfection of Aristotle's logic. It is not just about rejecting the long-standing ideal but also about adopting a new one.

Like Scholz and Łukasiewicz, Bocheński accepted the view that the mathematical logic of the 1930s was exemplary (Bocheński, 1994). None of them would likely call mathematical logic of their times final, but they all would certainly call it the pattern or paragon of logic. Hence, deviating from the pattern would be called corruption. The reader should not think that I aim to undermine the view of Scholz, Łukasiewicz and Bocheński or to consider it on a par with the view of Kant and Prantl. It is only to openly admit that Bocheński's model of the history of logic is axiologically grounded and does not simply follow from source research itself. Bocheński's history of logic is the history of what mathematical logicians of the interwar period counted as logic. And it is obviously not the only possible stance. For example, it is in principle possible to study the history of what was being understood and done under the title of logic in one generation after another, including changes in the paragon of the discipline. Even Bocheński's decision to restrict the scope of logic to formal logic, excluding most of semiotics and methodology, must have influenced the general picture, for those latter areas of research were emphasized in the modern period.

Hence, the term "development" in thesis (1a) means something more than merely change. It means a change or rather changes from worse to better or conversely, progress and regress, improvement and corruption. And that seems much like Kant's and Prantl's view of the history of logic as a gradual worsening and corruption of Aristotle's perfect theory. The two models of the history of logic differ firstly over different paragons, the one being Aristotle, the other the mathematical logic of the 1930s. The other difference is that in Bocheński's model both corruption and improvement are possible, whereas Kant and Prantl, situating their paragon at the very beginning of the history, admit corruption only. Thesis (1a) might be further analysed as the conjunction of the following theses:

the mathematical logic of 1930s is the paragon of logic, (2a)

problems of 1930s logic have been investigated since antiquity, (2b)

previous accounts of logic either approximate the paragon or deviate from it (2c)

Theses (2) are probably not far from the truth, but they are not a priori obvious, for it seems clear that another view, although not necessarily correct, is possible, namely that logic is simply what people as well as logicians of a given generation consider interesting and important with respect to the theory of justification.

In the period between *Notiones* (1936) and *Formale Logik* (1956), thesis (1a), in the spirit of theses (2), did not change. On the contrary, it received strong corroboration from the sources Bocheński had analysed over the course of two decades. It may be of interest to examine the means of the corroboration.

Even if theses (1a) and (2) were not purely a priori in 1936, scholars such as Scholz, Łukasiewicz, Grabmann and Bocheński held them intuitively, based on their profound classical education and the notorious lack of elementary understanding of

logic or history, described above, among their contemporaries. Having studied theology or philosophy, they knew Aristotle, or the Stoics, or the scholastics, and realized that something resembling the logic of the 1930s had existed previously but was nearly completely forgotten. Scholz (1931) and Łukasiewicz (1935) originally appreciated that Stoic logic was valuable and independent of Aristotle, but they were largely unaware of the level logic had reached in the Middle Ages. Even Bocheński (1936) speaks of the theory of *proprietates terminorum* and commentaries to Aristotle's syllogistics as the key scholastic contribution to logic prior to the theory of *consequentiae* and without even mentioning the theory of *obligationes*.

In *Formale Logik* (1956), theses (1a) and (2) appear to be seriously substantiated by the sources. I think Bocheński's justification of those theses could be summarized in the three following theses (3), (4) and (5). Firstly, Bocheński established that, on the one hand,

there exists a profound and systematic affinity among the logical texts of Aristotle, (3)
the Megarian, Stoic, scholastic, and mathematical logicians

It consists—to a degree—in speaking similar languages, posing similar questions, using similar methods of solving problems and even delivering similar answers (Bocheński, 1956, p. 3–5, 17–19). It is likely, therefore, that a logician from one of the groups listed in thesis (3) could understand works from representatives of other groups and find them interesting and in line with his own research. On the other hand,

the content of logical texts mentioned in thesis (3) is distinct from and alien to (4)
the content others deal with under the title of logic

to the effect that they could hardly even be regarded as varieties of the same branch of knowledge. That is particularly true with respect to logic in the sense of modern philosophy (Bocheński, 1956, p. 297–301; 1994, p. 313). Bocheński emphasized that mathematical logic is no successor whatsoever of the currents of the Renaissance or Enlightenment logic. On the contrary, it stands in opposition to those currents and is a successor of the currents mentioned in thesis (3). Finally, Bocheński observed that.

the changes from logic in the sense of thesis (3) to another current called logic (5)
always encompass a transition period of decline in the quality of logical
research in the sense of thesis (3) ending in abandonment

Thesis (5) opens the door to the axiological import of theses (2), viz., evaluating some logical traditions as primary and others as decadent. Bocheński demonstrated that decadent periods do not originate in learned refutation of their predecessors but rather in gradual or quick loss of skills or interest, in due course both, leading to—at least in the modern period—the complete oblivion of logic. What is refuted or ridiculed after that transition period is a caricature of logic, criticized from positions of ignorance (Bocheński, 1956, p. 154–155, 297–300).

Theses (3), (4) and (5) combined show that there is a history of logic in the sense of the mathematical logicians of the 1930s, a single field of study shared by Aristotle, the Megarians, the Stoics, the Schoolmen and the mathematical logicians; that the history, however, is not continuous; and finally, that the disruptive periods are not simply different but vitally inferior.

It should be admitted that the source-based and analytic work Bocheński carried out over the course of the two decades between *Notiones* and *Formal Logic* was enormous. Theses (2) moved from being vague intuitions to well-substantiated theorems. Even today, it requires only minor corrections. In particular, simply to identify the paragon of logic with the logic of the 1930s does not appear to be the best option, as it too has its weaknesses, outstanding questions and room for further development. Perhaps thesis (2a) of Scholz, Łukasiewicz and Bocheński could be exchanged for a slightly less time-dependent version of it:

There exists a paragon of proper logical knowledge, exemplified and shared (2a*) among others by the mathematical logic of the 1930s

For it seems better to accept that there exists an ideal of proper logical knowledge without excluding the possibility of the ideal being even better exemplified than in the case of the logic of the 1930s. However, the main lines of theses (2), as substantiated by Bocheński's source research and analysis, presented in *Formale Logik*, remain valid.

Thesis (1b)

The axiological understanding of thesis (1a) in the spirit of theses (2), substantiated by means of theses (3), (4) and (5), opens the door to the proper understanding of thesis (1b). Bocheński's commentaries (1937, 1949, 1994) show that thesis (1b) was for him personally, throughout his lifetime, the most important component of his model of the development of logic (and culture). This had to do with his philosophy of life and his fundamental outlook first as young academic, then a budding talent, who became a top historian of logic, and into retirement. It had to do also with his philosophy of history and philosophy of culture, especially in regard to the relations between the Middle Ages and the modern and the contemporary times. As it has been said already, Bocheński believed that the twentieth century was a proper continuation of the Middle Ages, and that those two periods stood in equally firm mutual contradiction to the modern culture of the sixteenth to nineteenth centuries. Bocheński considered it his personal mission to convince the academic world that, from the contemporary point of view, the medieval culture was vital whereas modern was valueless (he often described modernity as the true dark ages). The idea of non-linearity and non-cumulativeness was important, for it allowed Bocheński, firstly, to divide the Middle Ages into two periods: one that had lost the ancient cultural inheritance and the other that restored and even developed the inheritance in the West; and secondly, to describe the period from

the sixteenth to the nineteenth century as a time of corruption rather than progress. That does not necessarily mean that thesis (1b) was false or ideological; on the contrary, it was mainly justified. It only means that the point was personally important for Bocheński, that it was more than mere theory for him.

Even if not openly stated like (1a), thesis (1b) also can be quite easily reconstructed based on the content of the early work (Bocheński, 1936). In *Notiones*, Bocheński lists five periods of the history of logic (Bocheński, 1936, p. 111), namely:

- periodus antiqua graeca (from the fourth century before Christ to the 3rd after Christ), (6a)
- periodus decadentiae antiquae (from the 3rd to the eleventh century), (6b)
- periodus scholastica (from the 12th to fifteenth century), (6c)
- periodus decadentiae modernae (from the 16th to the mid-nineteenth century), (6d)
- periodus recentissima (beginning in the mid-nineteenth century) (6e)

The names of the periods suggest thesis (1b). Periods (6b) and (6d), called openly decadent (*periodus decadentiae*), separate three other periods from one another that apparently are not so decadent: Greek (6a), scholastic (6c) and contemporary (6e). The descriptions of the listed periods confirm fully that suggestion (Bocheński, 1936, p. 111–116). The list is repeated in *Formale Logik* (1956) with the borders between two periods, (6a) and (6b), moved from the third to the sixth century. It is then quite obvious that the history of logic is being described here in much more sinusoidal than linear terms. Thesis (1b) had been clearly stated already in *Notiones* and then justified in the works to be published.

In his numerous works in the field of the history of logic, Bocheński often speaks of huge parts of the logical knowledge being lost or forgotten in periods of decadence. It is the core argument for thesis (5), substantiating thesis (1a): as logical research was sometimes better and sometimes worse, it is possible to claim that there is a development in the history of logic. According to thesis (1b), from time to time the development is reversed.

On the one hand, the non-linear and non-cumulative character of the development of logic also signifies something more, namely—as in thesis (1a)—the evaluation not only of the logical knowledge and skills, but also of logical objectives, problems, methods and solutions put forward at different times. From such a point of view, for example, Mill's logical works should be evaluated as inferior compared with those by Albert of Saxony, because they deviate from the set paragon of logical research, even if it were to turn out that Mill was perfectly cognizant of Albert's works but concerned himself with different questions. Hence, in Bocheński's model, not only the logicians but logic itself changes from worse to better or conversely. The lack of linearity and cumulativeness means that those changes are not irreversible.

On the other hand, non-linearity and non-cumulativeness signify something less. It is not that the history of logic has known no linearity or cumulativeness. What is denied is a thesis stemming from the Enlightenment about the existence of a single, monotonic line of progress running through history: the later the

generation of logicians, the broader or more sophisticated is their logical knowledge (at least in the sense of weak ordering: not less broad and not less sophisticated). Bocheński emphasized that, compared with medieval logic, modern logic was inferior. However, weaker kinds of linearity are not only excluded by thesis (1b) but also explicitly mentioned in Bocheński's works. Two kinds of weakened linearity should be mentioned here. Although Bocheński does not name them, they can be referred to as *local* and *intervarietal* linearity, cumulativeness, or progress in general.

Firstly, local linearity and cumulativeness quite clearly exist within periods of the history of logic. In *Notiones*, Bocheński mentions them and in *Formale Logik* offers broad demonstrations. For example, it may be clearly observed that in the Middle Ages there is a linear and cumulative progress in logic in the period from Peter Abelard to John Buridan. Logicians of later generations do study, understand, discuss and sometimes improve works of their predecessors in such areas as syllogistic, theories of consequentiæ, proprietates terminorum, modalities, obligationes, antinomies, and the like. This is also certainly true with respect to mathematical logic from George Boole and Augustus De Morgan, through Gottlob Frege, and then Alfred Tarski and Kurt Gödel. Such progress may be observed within Greek logic; however, the poverty of sources makes proper demonstration difficult.

The locality of progress means limitation in time as well as in space. For example, Greek logic was restricted to the Mediterranean basin, including for a short period the Muslim Middle East, and the scholastic logic to the part of Europe influenced by the university policies of the Church of Rome (Bocheński, 1956, p. 13). Prantl (1855–1870) speaks even of German universities in the last decades of the Middle Ages as having two separate faculties of philosophy each: one studying advanced logic and the other rejecting it. The contemporary period of the history of logic may seem world-wide, and yet it is still possible to find circles devoted to scholastic logic that do not recognize mathematical logic.

The point is mentioned in *Notiones* (Bocheński, 1936, p. 116), but becomes far more central in *Formale Logik*, where Bocheński coined the term “variety of logic” (*Gestalt der Logik*): local progress exists within a variety of logics. In *Formale Logik*, the point is thoroughly demonstrated and even one of central ideas of the book. Bocheński always lists four varieties of logic: Greek, scholastic, Indian and mathematical (Bocheński, 1956, p. 15–17).

It should be noted marginally that the sources have made it rather clear now that there actually was no Indian logic in the strict sense. It was rather a kind of advanced epistemology and philosophy of language, not formal logic. Bocheński decided to retain in *Formale Logik* the opposite view, put forward in *Notiones*, even though it was not properly corroborated.

Secondly, in his studies, Bocheński outlined another kind of linear or at least possibly linear-like progress in the history of logic, one that is more mysterious. Bocheński speaks of something like linear progress when comparing the three varieties constituting the logic of the West: Greek, scholastic and mathematical. This is not even mentioned in *Notiones*. In *Formale Logik*, however, it is claimed that the scholastic logic as a whole may be considered a progress compared with the Greek logic as a whole, and the same holds for the mathematical variety as a whole

compared with the scholastic one. The idea is not as thoroughly elaborated as that of local progress, but it could be reconstructed as follows. In the course of his research into sources, Bocheński appears to have observed that at some stage (never at the very beginning) of a later variety of the Western logic the entire legacy of the earlier varieties is recovered and in a sense becomes a proper part of the achievements of the later one. On the one hand, the legacy of the previous varieties is rediscovered as interest in logical problems grows, but on the other hand, there is something in the method itself that allows logicians to discover questions and answers much like those of their predecessors, even without being aware of those predecessors. This objective unity is the subject of thesis (3). It also allows speaking of some objective progress among varieties of the Western logic as a whole. Such progress could be called *intervarietal*.

However, Bocheński insists that intervarietaal progress does not mean reception and further development of the former variety. On the contrary, a new variety of logic is being created out of nothing or nearly nothing left of the former one (Bocheński, 1956, p. 14–15).

The non-linear and non-cumulative development of logic, as presented in *Formale Logik*, may be thought of as a curved line similar to a segment of the three periods of a sinusoid. In the curve, there are three maxima divided by two minima. The minima are to be identified, of course, as the periods of decadence (6b) and (6d), whereas the maxima represent the peaks of the three acmes of logics: Greek (6a), scholastic (6c) and mathematical (6e) in turn. The concept of locally linear progress applies to the growing amplitude between the beginning of a period and its maximum. The intervarietaal progress may be pictured by assuming that the amplitude grows with periods, i.e. the maximum of a later period is greater than the maximum of an earlier one.

Thesis (1c)

The final point of Bocheński's picture of the history of logic is a more detailed description of the structure of the creative periods logic: Greek (6a), scholastic (6c) and mathematical (6e). Bocheński shows that those periods are not uniform and contain stages of different length, character and value. Bocheński stated the thesis several times with minor differences with the most elaborate statement in *Formale Logik* (Bocheński, 1956, p. 14–15). Putting the periods of decadence to one side, the remaining periods of creative research in logic share—according to thesis (1c)—a similar interesting structure of three stages or subperiods:

the periods of lively logical research consist of three stages each: awakening, (7) explosion and systematization

The stage of awakening refers to a sudden and even difficult to explain origin of interest in logical research even exceeding research itself. Forgotten for centuries (or not existing at all in the case of the Greek logic), often ridiculed logical questions

suddenly become interesting to leading scholars and numerous groups of students. The stage of explosion lasts a very short time, from 50 years to circa a century, and involves an extremely intense development of logical ideas, theories and methods. Its transience and intensity make explosion an excellent metaphor for the stage. Whereas awakening and especially explosion are the times of artists, systematization is the time of professionals. Hardly any new problems or fresh ideas appear at that stage, but it is a very productive period in the sense that well-trained experts or specialists, much like skilled craftsmen working methodically, in accordance with the variety of logic in question and in a well-organized manner, deliver more and more advanced scientific outcomes. The stage of systematization ends, however, with stagnation and leads to another, usually long-lasting, period of decadence. It is also possible for systematization to transit smoothly into decadence without visible divisions.

Thesis (1c) is the most empirical, so to speak, of theses (1). It never appears in the works of Scholz or Łukasiewicz, and it is completely foreign to *Notiones* (1936). It is even a serious revision of the picture drawn in the 1930s, for in *Notiones* it is implied—if not openly stated—that locally linear progress in logical knowledge lasts more or less throughout each creative period. For example, Bocheński describes the scholastic logic as if it was a uniform progression starting with the reception in the West of the *Corpus Aristotelicum* and lasting until William of Ockham and Vincent Ferrer. It must have been the two decades of prolific source studies between 1936 and 1956 that brought Bocheński to change his mind. Hence, thesis (1c) is not only the most empirical, but largely also Bocheński's own contribution to the model of the history of logic.

In *Formale Logik*, we find a more accurate periodization introduced by dividing periods (6) into subperiods or stages. The period (6a) of Greek logic has been further divided into three stages: (a) from the beginning to Aristotle's *Topics*, (b) from the mid-fourth to the end of the third century BC, and (c) to the death of Boethius in the sixth century after Christ. The first stage is clearly the awakening, the second one is the explosion with Aristotle, the Megarians and the Stoics, and the third is the systematization, the stage of the Commentators (Bocheński, 1956, p. 32–33).

Due to constant lack of knowledge about the Middle Ages, period (6c) of the scholastic logic has been further divided only provisionally into centuries. And yet, the collection of sources Bocheński gathered suffices to distinguish the time of creation from Abelard to Buridan and the following time of elaboration, the former clearly containing both the awakening and explosion (Bocheński, 1956, p. 170–171).

Regarding the mathematical variety of logic, Bocheński, having referred to some prehistory, including Gottfried Wilhelm Leibniz, speaks of three stages: (a) the Boolean stage (the second half of the nineteenth century), (b) the Fregean period (from *Begriffsschrift* to *Principia Mathematica*) and (c) the period of metalogic and non-classical logics. The Boolean stage constitutes the awakening, whereas the remaining stages are the explosion. When he published *Formale Logik*, Bocheński believed that the last stage was still current (Bocheński, 1956, p. 314–315).

It is fair to say that thesis (1c) has been formulated on an empirical basis by systematizing the sources and justified constructively by sub-periodizations of periods

(6a), (6c) and (6e). It is foreign not only to Bocheński's predecessors and his own *Notiones*, but also in the vital independent account of the history of logic by William and Martha Kneale (1962). The Kneales obviously share thesis (1a) and—less obviously, less consciously and in a less radical and missionary way than Bocheński—thesis (1b). Their main periods of the history of logic also more or less resemble those of Bocheński. However, despite the Kneales' excellent expertise in the sources, they did not put forward thesis (1c). It should be therefore treated as Bocheński's personal contribution to understanding the development of logic.

Bocheński's picture resembles in some respects Thomas Kuhn's famous description of scientific revolutions. The stages of awakening and explosion may be regarded as revolution and prescience, and the stage of systematization as a time of normal science, with professional logicians "solving puzzles" in accordance with their paradigm. Bocheński's varieties of logic would be similar to Kuhn's paradigms. Whether this is just a superficial analogy or there exists some structural similarity between those two models of scientific development requires further study. However, two important differences are conspicuous. Firstly, in Kuhn's description, paradigm shifts resemble a war between communities of researchers, whereas Bocheński speaks of logic being abandoned and even completely forgotten, but then for some reason re-emerging centuries later. Secondly, and even more importantly, according to Kuhn, paradigms are mutually incommensurable, but Bocheński points out a kind of intervarietal unity, development and even linearity in the history of logic. Hence, although the concept of intervarietal unity and relations between varieties of logic require further analysis, it seems nearly certain that the varieties of logic in Bocheński's sense are quite commensurate. Even the controversial Indian variety according to Bocheński's description appears to be commensurate with the Western varieties. Therefore, if there were Kuhnian paradigms in the history of logic, they would rather be the formal logic of the Greeks, the Schoolmen and the mathematicians on the one side, and the logic of the modern philosophers on the other.

Conclusion

In its main points, Bocheński's model of the development of logic stands the test of time in an impressive way. As has been said, in 1956 it was neither completely new nor wholly empirical. Bocheński received thesis (1a) from Łukasiewicz and Scholz, admitting it intuitively together with thesis (1b) as early as 1936. Thesis (1b) should be attributed to Bocheński. There may have previously existed a vague sense of the thesis, but it seems likely that Bocheński was one of the first to have formulated it clearly. And even if others, such as the Kneales, were aware of thesis (1b), it was Bocheński who constantly emphasized it, making the thesis the key to understanding the history of logic. Thesis (1c) is entirely Bocheński's own invention. Therefore, the general and uniform outline of the development of logic consisting of theses (1) considered together as a whole should be counted as Bocheński's construction. And although he accepted theses (1a) and (1b) prior to beginning his empirical research, he did substantiate them for the first time ever by virtue of his monumental

source-based research. Decades of further scientific inquiry in the field of the history of logic have not discredited the main lines of Bocheński's outlook. However, as always, there seem to be some points which could and should be improved in the light of numerous more recent studies in the field, which, of course, cannot be discussed here.

Firstly, the description of the postulated paragon of logic certainly requires further elaboration. In the 1930s, Bocheński together with Scholz, Łukasiewicz, Salamucha and others could legitimately think of the newly created mathematical logic as exemplary. On the one hand, however, it was still being created, and on the other, the optimism attending the rapid development of logic in the circumstances of the 1930s made them suspicious and unfavourable to any attempts to introduce philosophy into logic. Łukasiewicz's famous thesis of the philosophical neutrality of logic was considered a milestone. With the passage of time, it became ever clearer that something like thesis (2a*) should be adopted, and that some kind of philosophically committed description of logical theory and its virtues is needed. It is needed if the history of logic is to contain the axiological input Bocheński made so important. It should be made clear what the criteria are with which to evaluate periods, works and theories of logic as either creative or decadent.

Secondly, and perhaps most importantly, the history of logic calls for a proper periodization. Bocheński, like other authorities, simply adopted the periodization of the history of philosophy or even of general history with minor adjustments. This inevitably leads to artificial periodization, as the history of logic is sufficiently independent to permit specific periodization. For example, in the history of logic there is no boundary between Antiquity and the Middle Ages. Dark ages in logic began with the rise, not the collapse, of the Roman Empire. Consequently, the Megarians belong to one stage of explosion together with Aristotle, not with the Stoics who were the first, highly skilled generation of systematizers. Many such problems arise when we adopt periodization foreign to logic. Nearly a century after its origin, the history of logic deserves a proper periodization of its own.

And thirdly, causal analysis of the movement between periods and stages is required. Despite decades of inquiry, hundreds of valuable source-based and interpretative contributions, and even the existence of scientific journals dedicated to the history of logic, we still do not know why logical studies flourished in one particular time and receded into obscurity in another. We also do not know why the process of awakening, explosion and systematization leads to decadence. We do not even know whether all this happens in accord with some laws of history or perhaps is a mere coincidence observed twice.

Perhaps the last question will find an answer sooner rather than later, as 1936, and even 1956, is long past. If Bocheński's model of the history of logic is correct, and especially if thesis (1c) is true, the creative period of the mathematical variety of logic is ending, and we find ourselves at the verge of new dark ages, entering a new period of decadence. Imminent verification of thesis (1c) and Bocheński's entire model would be by all means a significant progress in the history of logic. Strangely enough, a catastrophe for logic would be a success for its history.

Funding Not applicable.

Data availability Not applicable.

Code availability Not applicable.

Declarations

Conflict of interest The author states that there is no conflict of interest.

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