SCIENTIFIC ACCOUNTS OF A VANISHING LAKE:

JANEZ VALVASOR, LAKE CERKNICA

AND THE NEW PHILOSOPHY

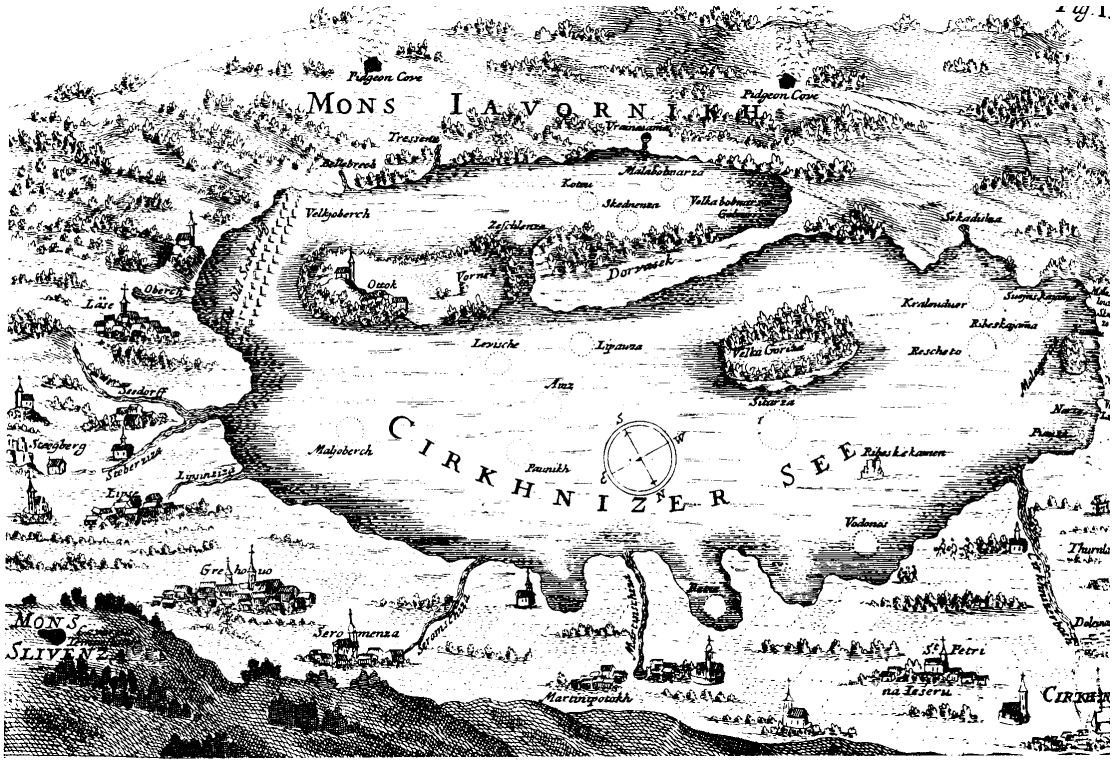

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TABLE OF CONTENTS

The image on the cover page is Janez Valvasor's 1687 map of Lake Cerknica. (Source: Valvasor (1987), 53)

ABSTRACT

Though passed off as a hybrid of science and superstition, Janez Vajkard Valvasor represents an important window into late seventeenth-century accounts of fantastic phenomena. Existing scholarship treats Valvasor's methodology of the fantastic largely through Whiggish lenses, thus obscuring both his historical context and the particulars of his methodology. This thesis seeks to address the prevailing Whiggish portrayal by situating Valvasor in the context of the early Royal Society. The justification for this approach is twofold. First, Valvasor corresponded with the Royal Society about Lake Cerknica (resulting in Valvasor becoming Slovenia's only member of the Society). And second, the methodological problems faced by Valvasor parallel those encountered by the Early Royal Society. In particular, Valvasor's account of this 'miracle of nature' that drained and filled without any superficial inlets or significant outlets mirrors the credibility problems faced by early contributors to the *Philosophical Transactions*.

To better situate Valvasor in his historical context and understand his methodology of the fantastic, I make use of recent historiographical approaches of Jim Bennett and Steven Shapin. These two approaches emphasize the need to focus on the practical dimensions of securing reliable natural knowledge. Coupled with a survey of the early Royal Society and *Philosophical Transactions*, the two approaches remedy some of the presentist splicing jobs of existing literature, while opening the door to a more unified and nuanced understanding of Valvasor's interaction with these 'miracles of nature'.

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*

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NOTE ON SOURCES AND CONVENTIONS

With the exception of journal articles and web-pages, which are fully cited in the footnotes, references have the following format: author's surname, year of publication and page of reference, where applicable. For significantly later editions of older works, the publication year is given first for the used text, followed by 'orig.' (meaning originally) and then the original date of publication. Articles from symposiums or conferences are given as author's surname, year of the conference and page of the reference. The full title of the article and the full citation for the conference proceedings are given in the bibliography.

Translations from Slovene that are not cited with a translator are my own. Since several different translations of Valvasor's *Slava* were used, I have included not only the page number for the reference (which differs from translation to translation) but also the book and chapter number from the original German *Die Ehre dess Hertzogthums Crain* (for example, Valvasor (1969, orig. 1689), bk. 2, ch. XLVII, 66-67).

Non-standard spelling from seventeenth-century texts have been left as written, although italics have been omitted from titles of entries in the *Philosophical Transactions.* Long titles of articles are generally shortened, unless the full title carries particular interest.

I. INTRODUCTION

Science emerged in the seventeenth century in part by focusing attention on the ordinary: balls rolling down inclined planes, apples falling from trees and mercury moving up and down a glass tube. But what of the fantastic? What of earthquakes?[1] of men growing new sets of teeth in old age?[2] of trees that come to full bloom in one night? What of disappearing lakes?[3] This thesis will deal with accounts of the fantastic in the context of the New Philosophy of the late seventeenth century. The working definition of such a 'miracle of nature' will be the one used by my main author, Janez Vajkard Valvasor. It will refer to phenomena that test the credibility of the received testimony; phenomena that a learnéd person of the late seventeenth-century might be inclined to doubt unless witnessed himself. My central questions, then, are: How did the early practitioners of the New Philosophy handle reports of the fantastic, and what significance does their treatment have for the history of science? I will seek to answer these questions in the particular case of Valvasor's seventeenth-century account of Slovenia's disappearing Lake Cerknica and surrounding phenomena.

But before turning to Valvasor's historical context and methodology of the fantastic, I will first give an overview of the principal 'miracle of nature' that engaged Valvasor's efforts. At its fullest, Lake Cerknica covers twenty-six square kilometres. It generally drains and fills once in a year, depending on precipitation, but it has sometimes drained and filled three times in a single year. What is especially unusual about Lake Cerknica is that it is surrounded by mountains, with no superficial inlets or significant outlets of water. A further, related feature is the presence of numerous caves and sinkholes in the area.

The timing and nature of the filling and draining of Lake Cerknica has traditionally been of great practical interest for the surrounding villages. In some summer months, with the lake mostly drained, farmers would gather hay from the lake floor for fodder. The primary activity around the lake, however, was fishing. In many of the caves and sinkholes, the fish are bigger than the drainage holes, thus making the lake's emptying a huge fishing event. Valvasor records how the villagers would come running when they heard the church bell signalling that the water levels were dropping.

[1] Martin Lister, 'Three Papers of Dr. Martin Lyster, the first of the Nature of Earth-quakes; more particularly of the Origine of the matter of them, from the Pyrites alone', *Philosophical Transactions, Giving Some Accompt of the Present Undertakings, Studies, and Labours, of the Ingenious in many considerable Parts of the World* [hereafter *PT*], **14** (1684), 512-21.
[2] M. Auzout, 'An Extract of a Letter written Decemb. 28. 1665 by M. Auzout to the Publisher, concerning . . . A Relation of an uncommon accident in two Aged Persons', *PT*, **1** (Oxford, 1666), 380.
[3] Valvasor (1987), 33, 73.

They would flock from all over town, without regard for what they were doing or what they were (or often were not) wearing. The behaviour of the lake was thus something both familiar and mysterious for the surrounding villages. Thus Lake Cerknica attracted both poets and stories of the supernatural, including witch gatherings, Devil-sightings and dragons. Valvasor spent a total of two years studying Lake Cerknica and interacting with the villagers.

II. VALVASOR HISTORIOGRAPHY

Recent historiography of late seventeenth-century science has tended away from what is called a Whiggish historiography, in which the scientist's work is sifted post-hoc into the scientific (i.e., that which agrees with current understanding) and the irrational (i.e., that which is no longer considered genuine science). The last few decades have seen an emphasis on the unity between the scientist's research and working context, not just between the scientist's research and the modern scientific context. For example, recent studies of Robert Boyle and Isaac Newton have underlined the integration of their experimental, religious and alchemical pursuits.[4] Tied in with this approach is the recognition that a scientist's work should be evaluated in light of the conceptions of science at the time. For example, claims that it is to Valvasor's credit that he lambasted alchemy[5] should be made with caution if, as some maintain, alchemy was a productive research paradigm in the late seventeenth century.[6]

The Whiggish approach to Valvasor has its place and can serve a useful function. For one thing, we more readily appreciate the past through its relation to the present, so discussions of Valvasor's accomplishments in light of current scientific understanding both emphasize the importance of past investigations and connect us with late seventeenth-century investigations of nature. The dangers of this approach arise when the presentist view is taken as the only one. This danger manifests itself in three ways with relation to Valvasor: a retrospective attribution of modern conceptual categories, such as 'scientific' and 'superstitious'; a focus on the *what* but not the *how* of Valvasor's investigations; and a general neglect for the academic context of Valvasor's work.

In this thesis I hope to begin moving Valvasor historiography beyond the Whiggish treatment he has received, even as recently as 1990. In the remainder of this section, I will expand on these three problems with presentist Valvasor historiography before discussing two particular views of late seventeenth-century science. I will then draw upon these two approaches, the first deriving from Jim Bennett and the second from Steven Shapin, in trying to address the distortions resulting from presentist approaches to Valvasor.

[4] See for example Hunter (1994), Principe (1998), Westfall (1980), Fauvel (1988) and Dobbs (1991)
[5] Reisp (1983), 411.
[6] Hunter (1994), Principe (1998), Westfall (1980), Fauvel (1988) and Dobbs (1991).

The first problem of Whiggish Valvasor historiography is the tendency to *post-hoc* sort his investigations into two categories of the scientific and the superstitious. This move takes for granted that modern definitions of 'scientific' and 'superstitious' are both good and applicable to Valvasor. Yet these two labels present significant historical problems. The use of both terms often tells more of the historian than of the historical subject. For one thing, superstition, like atheism,[7] is frequently used in a given historical context for polemical purposes. A related aspect of accusations of superstition is that the label derives its meaning by way of contrast with other sets of beliefs about nature. In other words, judgments of superstition are made because they violate expectations drawn from the accuser's background knowledge and beliefs. For example, the grandmotherly prescription of chicken soup to treat a cold has been considered, in the eyes of the most Western medical practitioners, something of a superstitious practice, or at best a medium for the placebo effect (which can be said of most all indictments of superstition). Put slightly differently, the claimed effects of chicken soup fell outside the expectations derived from the then-canon of clinical medicine. More recently, however, clinical studies have shown that chicken soup slows the movement of white blood cells that cause congestion.[8] Now the Mayo Clinic recommends that cold sufferers drink chicken soup to thin mucous and ease congestion.[9] The recipe has not changed in the last generation of clinicians, but the body of canonical medical knowledge against which chicken soup is judged has.

The relationship between accusations of superstition and expectations holds especially true in matters said to involve the supernatural. In 1607, in order to affirm the Sacramental Mysteries in contrast with some vulgar notions about the Sacraments, the Catholic Church declared: 'It is superstitious to expect any effect from anything, when such an effect cannot be produced by natural causes, by divine institution, or by the ordination or approval of the Church'.[10] This statement makes explicit the relationship between superstition, expectations and background knowledge. Superstition is defined by contrast with the accuser's expectations of nature.

[7] See for example Buckley (1987).
[8] Carmel Smyth and Mike Gordon, 'Chicken Soup', *CBC: Marketplace*, accessed 15 July 2003: <http://www.cbc.ca/consumers/market/files/food/chickensoup/>.
[9] Camilla Cornell, 'Chicken Soup for the Sniffling Soul', *TodaysParent.Com*, accessed 15 July 2003: <http://www.todaysparent.com/food/allages/article.jsp?content=1786>.
[10] Turner (1971), 49.

The flipside of a more contextualized approach to superstition is that it highlights the significance of the background knowledge for the belief being labelled superstitious. For example, in a village where there have been dragon-sitings (a situation faced by Valvasor and discussed in section V), the attribution of a strange water phenomena to an angry dragon coheres with the villagers' background knowledge. Their explanation of the phenomena is not irrational in the context of their background knowledge, which included a man who had the corpse of a baby dragon in his home.[11] (It is important to note here that such an explanation is *not* entailed from the villagers' background knowledge in the sense of a mathematical deduction, where the falsity of the conclusion entails the falsity of the premises. Applied to the dragons and the strange water, there is no inconsistency in denying that a dragon causes this particular phenomenon yet still ascribing to the background knowledge of the existence of dragons.)

Presentist attributions of superstition risk obscuring factual content of folk-stories and commonly held beliefs by ignoring the background knowledge with the superstition coheres. Marija Stanonik's article about Valvasor's relation to folklore makes no mention of background knowledge relevant to beliefs in witches, healing water and the Devil, as encountered and sometimes accepted by Valvasor. She writes,

> quite often, Valvasor seems to believe these tales regarding natural phenomena such as water (lakes, streams, springs), caves, minerals, plants, and animals, altrough [*sic*] he seeks to reach a rational explanation for some unusual facts about them.[12]

Stanonik also cites Valvasor's belief in 'the devil, witches and other mythical beings'.[13] Literature about witchcraft is extensive, but there is no doubt that there existed men and women in the seventeenth-century who identified themselves with witchcraft, even in un-coerced testimony.[14] It is a different (though of course related) question whether or not witches possessed the power to conjure up thunder- and hail-storms, as maintained by some villagers.[15] But as with the dragon and the spring, a person can rationally accept background knowledge about witches' existence while denying their responsibility for a particular natural phenomenon.

[11] Valvasor (1994, orig. 1689), 96.
[12] Stanonik (1990), 310.
[13] Stanonik (1990), 310.
[14] see, for example Thomas (1971).
[15] Valvsor, 'An Extract of a Letter Written to the Royal Society out of Carniola, by Mr. John Weichard Valvasor, R. Soc. S. being a full and accurate description of the wonderful Lake of Zirknitz in that Country', *PT*, **16** (1687), 412.

The background knowledge involving healing properties of water is even more explicit in late seventeenth-century communities (both learnéd and formally uneducated), and is—as with dragons and witchcraft—ignored in the literature on Valvasor. The phenomenon of healing springs also shows how the same background knowledge can be compatible with different metaphysical postures. For some, healing waters derived their power from a particular saint,[16] while for others (Christian and other), the healing properties resulted from dissolved minerals. Yet this background data, including many accounts of healings (some reported in almost clinical terms—see below section IV), cohered with claims of Valvasor later labelled superstitious.

Due to the above considerations, in what follows I shall use the word 'superstitious' only when voiced by another author. For other purposes, I will in general use less polemical and presentist terms such as 'folk tales' and 'common beliefs' about nature.

Clearly 'science' too carries requires sensitive handling. For one thing, the term 'scientist' was not coined until 1834 by William Whewell, and even then did not gain currency until the latter part of that century. One can find references to 'the Sciences' in translated works, but this often derives from the Latin 'scientia', which generally meant certain knowledge. In this sense was theology considered the 'Queen of the Sciences'. As will be discussed below in section III, the participants in what is now considered the Scientific Revolution cast their own investigations and rhetoric not in terms of science, but of natural knowledge and philosophy (oftentimes Experimental, or the New Philosophy). A too-facile application of the label 'scientific' can distort past practices and gloss over subtleties both historical and modern.

One principal side-effect of presentist definitions of science and superstition is a neglect of Valvasor's methodology. With these categories of science and superstition firmly in place, Valvasor historiography tends to focus on what aspects of his research fit the modern view, to the exclusion of how Valvasor produced these results. Perhaps ironically, the clearest examples of Whiggish historiography are not concerned primarily with modern science per se. Two articles devoted to analyzing Valvasor in terms of modern science do indeed make mention of specifics of Valvasor's methodology. For example, Andrej Kranjc's article explains Valvasor's justification for

[16] Thomas (1971), 70.

positing one particular subterranean network.[17] Peter Habič also takes note of Valvasor's rationale for including an unobserved underground lake in his model, as well as mentioning Valvasor's use of natural history texts, supplemented by Valvasor's own investigations.[18] Both Habič's article and a short piece by Edvard Kobal recognize Valvasor's conversations with locals, but only in general terms, and without explication of how these conversations were used in practice (further, Habič adds the qualification that we cannot resent Valvasor for including in his descriptions of Lake Cerknica also some 'hoaxes' related to him by fishers and hunters).[19]

The more significant neglect of Valvasor's methodology resides in Valvasor historiography of a less technical nature, especially when concerned with accounts of the fantastic. As mentioned above, Stanonik's article on folklore offers conclusions on Valvasor's world-view without considering the particulars of his methodology. Her concern seems aligned more with a somewhat ahistorical conception of rationality than the particular reasons why, for example, Valvasor doubted that the miraculous arboreal phenomenon was a direct act of God, yet believed in the healing power of certain springs.[20] By ignoring the details of Valvasor's methods and reasoning, she divides his work into the rational and irrational, stating that his 'rational viewpoint' towards natural phenomena was not transparent, but was an 'exacting process with defeats and victories'.[21] She also describes his natural investigations as a 'struggle to break free of the clutches of magic and demonology . . . .'[22] By focusing on the *what* but not the *how* of Valvasor's writing, Stanonik presents as opposition and struggle what (as I shall argue below in section V) grew from consistent methodological choices regarding testimony during his investigations. Stanonik cleaves in two what Valvasor saw as a whole. Rather than being caught in metaphysical conflict, as Stanonik and Valvasor's biographer Reisp tend to present him, an emphasis on the *how* of Valvasor's investigations reveals a unified natural historian faced with pragmatic judgements about the credibility of his sources.

Moreover, this cleaving job into the scientific and the superstitious—cut along presentist lines by engaging with the *what* but not the *how* of Valvasor's research—tends to obscure the context in

[17] Kranjc (1990), 213.
[18] Habič (1990), 226.
[19] Habič (1990), 226; Edvard Kobal, 'Mehanizem prejihajočega Cerkniška jezera [Mechanism of the Intermittent Lake Cerknica]', *Raziskovalec*, **29** (May 1999), 78.
[20] Valvasor (1987), 33; Valvasor (1994, orig. 1689), bk. 4, ch. XXXI, 95; and Valvasor (1968, orig. 1689), bk. 2, ch. XLVII, 30.
[21] Stanonik (1990), 291.
[22] Stanonik (1990), 305, 310.

which Valvasor conducted his investigations. He is portrayed sometimes as a genius floating above the sea of ignorance which included superstition, magic and alchemy. Brank Reisp, in one of only two biographies composed on Valvasor, concludes:

> *The Glory of Duchy Carniola* and in the long run the [entirety of] Valvasor's work—including his personality—may be justly labelled an exception which was not created of the then rules and customs and cannot accordingly be built into the pattern thereof.
>
> In spite of this quality, we should concede that his work failed to transgress the boundaries imposed on it by the very time in which it was produced.[23]

And in his introduction to Valvasor's correspondence with the Royal Society, Reisp writes:

> With his broad scientific outlook . . . it is fair to say that he was ahead of it all on account of his understanding of the inter-relation between Nature and man.[24]

Such passages threaten to obscure the extent of Valvasor's engagement with academic communities and traditions surrounding him. Like his contemporaries in the Royal Society and on the Continent, he was acquainted with the writings of Aristotle, Ovid, Paracelsus, Pliny and Sabo,[25] as well as more recent sources for natural philosophy, including Rene Descartes,[26] Georgei Werner and Athanasius Kircher.[27] His virtual learnéd community included the roughly 1600 volumes of his library,[28] and his actual one included a solid Classical education of logic, rhetoric and grammar with Jesuits in Ljubljana,[29] as well as contact with learnéd society during his travels, including Franc Mercurius van Helmont, son of the famous Johann Baptista van Helmont.[30] He participated in optical experiments, and he used a wide array of mathematical and surveying instruments, thus establishing Valvasor's grounding in the experimental as well as mathematical sciences.[31]

This neglect of Valvasor's working context can lead to concrete misinterpretations of his words and activity. For example, despite his apparent rhetoric to the contrary Valvasor was involved in

[23] Reisp (1983), 413.
[24] Reisp, in Valvasor (1987), 17.
[25] Valvasor (1689), 2, 5, and 6.
[26] Valvasor (1969, orig. 1689), 149.
[27] Valvasor (1689), 4 and 7.
[28] Magić (1989), 162.
[29] Reisp (1983), 15.
[30] Reisp (1983), 84.
[31] Reisp (1983), 87. For a discussion of the distinctive roles played by the mathematical and experimental sciences, see especially J. A. Bennett, 'The Mechanics Philosophy and the Mechanical Philosophy', *History of Science*, **24** (1986), 1-28; and Thomas Kuhn (1977), 31-65.

alchemical investigations, as evidenced by the laboratory in his home.[32] Reisp, in praising Valvasor's criticisms of alchemy, overlooks the different forms of alchemy practiced in the late seventeenth-century. Just as a modern scientist might, without hypocrisy, engage in radio astronomy research while at the same time lambasting SETI, so could Valvasor (like Boyle[33]) engage in alchemical investigation while criticizing certain forms of alchemy. By employing modern categories of science and magic, Reisp reads into the context of the past a monolith where a closer look reveals a mosaic.

The Whiggish trend in Valvasor historiography has not gone unnoticed. Jože Vogrinc notes that concerns to 'save [Valvasor's] name as a scientist and to present him as torn between truly scientific enquiry on one hand and superstitious practices on the other still prevail'.[34] In his brief article, he draws attention to deficiencies in Valvasor historiography of witchcraft, church music and science, and points to the need to study Valvasor from his own epistemological and intellectual context.[35]

The neglect of Valvasor's methodology and working context in the literature reflects not only Whiggish historiography but also the paucity of scholarship on Valvasor. The combination of the presentist obscuring of Valvasor, and the obscurity of the sources has meant that there have been no scholarly attempts to either situate Valvasor in an intellectual context or analyze his methodology as a Natural Historian. In what follows, I hope to begin filling this vacuum.

[32] Edvard Kobal, 'Načrt Podpeške jame (1689) [Plan of the Podpeška cave]', *Raziskovalec*, **29** (May 1999), 80.
[33] See Hunter (1994) and Principe (1998)
[34] Jože Vogrinc (1996), 497.
[35] Jože Vogrinc (1996), 503.

III. The Scientific Revolution and the Early Royal Society

Although Valvasor claimed that he was alone among his Carniolan peers as a researcher into nature,[36] as discussed above in section II his writings reveal that through travel and reading he actively engaged with the methods, instruments and writings central to seventeenth-century Natural Philosophy. Moreover, he followed the activity of the Royal Society through Latin translations of the Royal Society's *Philosophical Transactions* dating from 1665 to 1669.[37] As mentioned above, he was familiar with recent scientific texts, such as the Italian Athanasius Kircher's *Mundus Subterraneus* (which he may have learned of in the 6 November 1665 review in the *Philosophical Transactions*).

That Valvasor engaged with the emerging New Philosophy justifies an approach that situates his scientific methodology within the context of mid- to late seventeenth-century natural philosophy. And though he may have been an 'exception' in Slovenia at the time,[38] he did not work in an intellectual vacuum. Given the sketchy details of Valvasor's contact with learned communities during his Continental travels and the availability of English sources,[39] emphasis will be placed on the relation between his work and that described in the *Philosophical Transactions.* Valvasor's choice of the Royal Society as a vehicle through which to convey his account of Lake Cerknica further establishes his esteem for and attention to the brand of science displayed in the pages of the *Philosophical Transactions*.

But before turning to the particularities of the early *Philosophical Transactions*, it is first necessary to better understand the context from which the Royal Society emerged. A full account of historiography of the Scientific Revolution extends beyond the scope of this thesis.[40] I will instead focus on two authors whose work relates to both the English context and specifics of Valvasor's account of Lake Cerknica. The first derives from an article by J. A. Bennett about the relationship between mathematical sciences and the emergence of the New Philosophy, while the second draws upon Steven Shapin's books, *The Social History of Truth* and *Leviathan and the Air-pump*.

[36] Valvasor (1987), 22-3, 21.
[37] Šumrada, (1990), 65.
[38] Reisp (1983), 413.
[39] Reisp (1983), 87.
[40] See Lindberg and Westman (1990), especially chapter 1; and Cohen (1994).

Jim Bennett's article points to the practical significance of traditions in mathematical sciences in shaping the New Philosophy. Included in the mathematical sciences are geography, arithmetic, astronomy, cartography, navigation, and surveying, to name a few.[41] The question against which Bennett evaluates competing historiographies is: What was the conceptual source of natural philosophical mechanism as *used* in New Philosophy? Bennett's emphasis is on the categories that directly influenced the methodology of early science. Although a confidence in mechanism in nature and mathematically-characterized matter loomed large in scientific practice, Bennett argues that the metaphysical glosses stressed by some[42]—such as atomistic matter theory—were 'niceties that had little effect in practice'.[43] Even among Continental Natural Philosophers in the schools of Gassendi and Descartes, Bennett notes no narrow commitment to a particular metaphysical system.[44] His emphasis is on the problem-solving tools (both physical and intellectual) developed within the mathematical sciences and then applied to natural philosophy.

Bennett's approach represents a valuable one for Valvasor historiography, not just because of Valvasor's use of mathematical instruments, but also to tease out the implications of Valvasor's research. A historiography centred on Valvasor's methodological choices better characterizes his *practice* as a scientist than would an evaluation of his underlying metaphysical biases. The emphasis should be on the 'practical dimension' of Valvasor's work,[45] rather than aspects of his world-view that flatter—or oftentimes grate—modern sensibilities.

One of the principal tools of Valvasor's methodology was interviews with locals regarding the phenomena surrounding Lake Cerknica. As discussed above in section II, his writing has been praised or maligned in turns, according to whether he doubted or accepted the tales told him.[46] On the one hand, Valvasor earns laurels for rejecting a local story in favour of a law-like explanation, while on the other he receives sighs of approbation for his credulity. Both assessments grow out of a particular view of the Scientific Revolution.

Steven Shapin's books, *The Social History of Truth* and *Leviathan and the Air-pump* (with Simon Schaffer), provide valuable historical context for issues of scientific testimony and

[41] Bennett, 'The Mechanics Philosophy and the Mechanical Philosophy', *History of Science*, **24** (1986), 11.
[42] see, for example, Kargon (1966), M. Boas, 'The Establishment of the Mechanical Philosophy', *Osiris*, **10** (1952), 412-541.
[43] Bennett, 'The Mechanics Philosophy and the Mechanical Philosophy', *History of Science*, **24** (1986), 24.
[44] Bennett, 'The Mechanics Philosophy and the Mechanical Philosophy', *History of Science*, **24** (1986), 1.
[45] Bennett, 'The Mechanics Philosophy and the Mechanical Philosophy', *History of Science*, **24** (1986), 25.
[46] Kmed (1989), 73; and Stanonik (1990), 310.

ontological openness of seventeenth-century science. Even without taking Shapin's social constructionist/externalist views of seventeenth-century science at full force, his approach provides a good antidote to some caricatured versions of the Scientific Revolution as a merely intellectual or metaphysical enterprise. As in Bennett's article, Shapin stresses the need to understand science as it was practiced, not just as it was talked about by its practitioners and later commentators.

Shapin emphasizes the methodology employed by the early practitioners of the New Philosophy, which at times contrasts with received notions about the true essence of science and the scientific revolution. An important example is the creed, *Nullius in verba* ('On no man's word'). One caricature of science takes this maxim at face value: that science began when natural philosophers ended their deference to authority (namely Aristotle) and only trusted as true that which they had tested for themselves. While there is no denying the empirical element of the Royal Society (nor can one deny the empirical element of Aristotle's writing), Shapin maintains that in matters of practice, 'such a prescription was, and is, impossible to act upon'.[47] Authority and testimony factor heavily into scientific investigation, be it seventeenth-century Karst hydrology or twentieth-century DNA research. For Valvasor, as well as moderns, Shapin points to the practitioners' recognition 'that prudence sat poised between skepticism and credulity'.[48] The lesson for Valvasor historiography is not to base judgements on whether or not testimony from others was used (indeed, testimony from others comprised the whole of the *Philosophical Transactions* in its first decades), but on *how* it is used.

Connected to the question of testimony is the relationship between natural law and ontology. A common conception is that the birth of science entailed the death of fantastical beings and phenomena. As natural law encompassed greater territory, the reports of phenomena and beings outside of natural law became less and less credible. As science increased, the known population of the universe decreased.

Whatever validity this skeptical line may have today, it was not dominant in the scientific circles of late seventeenth-century England. Shapin notes that a 'degree of ontological openness was the mark of the free man as well as the wise man'.[49] He quotes John Wilkins, one of the founders of the

[47] Shapin (1994), 191.
[48] Shapin (1994), xxix.
[49] Shapin (1994), 199.

Royal Society, who counselled, 'It behoves everyone in search of truth, alway to preserve a philosophical liberty; not to be so enslaved to the opinion of any man, as to think whatever he says to be infallible'.[50]

This dictum held true especially of the new worlds opened up by the telescope and microscope. In his Robert Hooke's *Micrographia*, which detailed in word and image his research with the microscope, Hooke proclaims, 'Hence there is a whole new visible World discovered to the understanding'.[51] Travels to the New World also disrupted attempts to categorize the known. Not only did travellers bring back news of new animals and new plants, but interaction with other civilizations reinforced for some the dangers of rigid plausibility schemes. For example, Boyle recounts that European travellers were considered 'great Liars' in the West Indies for describing the phenomenon of frozen water. The inhabitants of the West Indies found it simply incredible that 'in *Europe* the fluid body of water was often without any artifice or endeavor of man turned in a few hours into a solid and compact body, such as ice'.[52] Shapin concludes, 'Who could confidently say what did and did not exist in the world when tomorrow might reveal as yet undreamed inhabitants in the domains of the very distant and very small?'[53] Thus judgments about Valvasor's relationship to testimony must take into account the ever-expanding horizons of the possible and the known as faced by the practitioners of the New Philosophy.

As for dwarves, demons and other legendary agents, the first two decades of the *Philosophical Transactions* avoids all mention of such beings, except to report on locally-held beliefs.[54] The relationship between belief in such beings and science, however, is not as straightforward a matter as it may at first appear. For example, in the famous Glanvill-Webster witchcraft debate, the empirical mechanical philosopher and apologist for the Royal Society Joseph Glanvill argued for the reality of witchcraft and the devil's agency, while the alchemist and occultist John Webster argued against witchcraft and the possibility of the devil intervening in the physical world (unless he inhabited a consenting agent).[55]

Questions of ontological openness in the New Philosophy leads to questions of credibility. Both

[50] Shapin (1994), 199.
[51] Hooke (1665), 4 pages after the Preface (pagination begins later).
[52] in Shapin (1994), 249.
[53] Shapin (1994), 194.
[54] Joseph Glanvill, 'Additional Answers to the Queries of Mines', *PT*, **3** (1668), 771.
[55] Thomas Harmon Jobe, 'The Devil in Restoration Science: The Glanvill-Webster Witchcraft Debate', *Isis*, **72** (1981), 343-356.

of Shapin's aforementioned books provide valuable resources in assessing the credibility issues faced by Valvasor's investigations into the fantastic, for both pick out conventions intended to establish credible 'matters of fact'. In *Leviathan and the Air-pump*, Shapin and Schaffer chronicle Boyle's 'technologies' for shoring up his experimental claims against Plenists. In particular, they note his meticulous reporting and illustrations that give the effect of 'virtual witnessing'.[56] These practices are geared toward bridging the credibility gap resulting from a fantastic claim (such as Boyle's achievement of a vacuum). In other words, this 'virtual witnessing' helps establish as a matter of fact what would otherwise require actual witnessing.

Tacit in Shapin and Schaffer's account of 'virtual witnessing' are conventions for credibility of received testimony. These conventions are made explicit in Shapin's later book, *The Social History of Truth*. Shapin's emphasis on 'gentlemanly codes of conduct' as guarantors of matters of fact proves useful in understanding Valvasor's relationship to his sources, and the general reception of fantastic accounts in Restoration England. Instances of confirmation of this thesis will be considered in sections IV and V, but I will also consider how codes of civility form but one part of the solution to credibility problems faced by Valvasor and the New Philosophy. Although specific parts of the solution will be discussed in more detail in sections IV and V, it is necessary to first better appreciate the philosophical context of the New Philosophy in general, and the early Royal Society in particular. One principal issue for Valvasor and the Royal Society is the linkage between theoretical explanations and ontology.

The relationship between ontology and scientific models in Restoration England displays greater texture than textbooks accounts of the scientific revolution sometimes reveal.[57] The association of several of the giants of the scientific revolution—namely, Copernicus, Galileo and Newton—with a philosophy of mathematical realism can give the lopsided impression that such a view was *the* position of the emerging science. Yet the program of the early Royal Society provides a valuable counterpoint to a mathematical realist's strong link between science and ontology.

The hallmark of a mathematical realist is the insistence that a successful mathematical or mechanical model reflects (or, for a stringent realist, determines) physical reality with certainty.[58]

[56] Shapin and Schaffer (1985), ch. II, 22-79.
[57] See for example Kline (1990).
[58] My usage of the term 'mathematical realism' derives from Duhem (1969).

The classic example of this position is Galileo's claim that the Copernican model not only fit the data better, but actually traced out the paths of the heavens. Galileo's remark that nature was written 'in the language of mathematics' points to the tight relationship between ontology and science for the mathematical realist.[59] In this view, confirming data or experiments confer certain ontological weight to a mathematical model.

In contrast, the early Royal Society placed greater weight on the phenomena, or facts of experimental science, than on the models that held them together. Thomas Sprat chronicles, 'Their purpose was, to heap up a mixt Mass of *Experiments,* without digesting them into any perfect mode'.[60] This emphasis served both practical and philosophical ends. For one thing, the subject matter tackled in some of the early *Philosophical Transactions* of the Royal Society (e.g., earthquakes, infectious diseases and disappearing lakes[61]) defied any definitive causal model. Coupled with practicability is the practical social benefit of avoiding dogmatism. As Shapin and Schaffer emphasize, the prominence of experimental fact over explanation minimized ground for discord.[62]

On a deeper level, however, the reticence to assign certainty to models reflected a particular view of ontology and science. It spoke of the limits of rationality and scientific investigation. These limits applied to ontology, metaphysics in general and religion in particular. Whatever the origin—be it the Fall of Adam or humanity's status 'a little lower than the Angels'—the presence of limits seemed undeniable.[63] The Experimental Philosophy provided a course to better causal explanations, but humility—grounded in experience—militated against declaring a successful model *the* explanation. Thus Francis Bacon writes, 'I repeat once more that I do not mean to bind myself to these [hypotheses]; for in them as in other things I am certain of my way, but not certain of my position'.[64] The early Royal Society stressed the tentative nature of models, in contrast to the certainty of experimental facts. Thomas Sprat writes,

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[59] Galileo Galilei, in Dava Sobel, 'His Place in Science', *Galileo's Battle for the Heavens*, *Nova* (Public Broadcasting Association, USA), accessed 10 May 2003: <http://www.pbs.org/wgbh/galileo/science.html>.
[60] Sprat, (1966, orig. 1667), 115.
[61] Respectively, Martin Lister, 'Three Papers of Dr. Martin Lyster, the first of the Nature of Earth-quakes; more particularly of the Origine of the matter of them, from the Pyrites alone', *PT*, **14** (1684), 512-21; Valvasor (1987), 70-85; and William Monyneux, 'A Letter from William Monyneux Esq. of the Philosophical Society of Dublin, to a Secretary of the Royal Society giving an account of the Connough-Worm', *PT*, **15** (1685), 876-81.
[62] Shapin and Schaffer (1985), 73. For a critique of Shapin and Schaffer's emphasis on the political motives of the early Royal Society, see Wojcik (1997), 218; and Hunter (1989), 13.
[63] See especially, Boyle (1999, orig. 1681).
[64] Francis Bacon, in Purver (1967), 47.

> Whatever they have resolv'd upon; they have not reported, as *unalterable Demonstrations*, but as *present appearances:* delivering down to future Ages, with the good success of the Experiment, the *manner* of their progress, the *instruments*, and the several differences of the *matter*, which they have applied: so that, with their mistake, they give them also the means of finding it out.[65]

The looser link between science and ontology constituted more than pragmatic puddy to hold together warring factions. Rather, it represented a metaphysical position on what science can and cannot not say.

Characteristic of this looser connection between ontology and scientific models is Hooke's structure of his *Micrographia*, which is separated into 'Certainties' and 'Conjectures'. Among the conjectures are attempts to explicate the causes of the phenomena chronicled. Hooke exhorts the reader to look upon these causal explanations

> only as *doubtful Problems*, and *uncertain guesses*, and not as unquestionable Conclusions, or matters of unconfutable Science: I have produced nothing here, with intent to bind his understanding to an *implicit* consent.[66]

Besides Hooke and Boyle, another gifted navigator of the varying viewpoints of the early Royal Society was Henry Oldenburg. Michael Hunter notes that Oldenburg bridged philosophical poles with a 'strong but not uncritical Baconian viewpiont, stressing the need to collect the materials for induction and suspicious of premature hypotheses, but never wholly eschewing theoretical questions'.[67] Though not trained as a natural philosopher, his close relationship with the Royal Society—and Boyle in particular—gained him considerable competence in assessing recent activity.

For an understanding of Valvasor's scientific context, Henry Oldenburg proves especially important because of his hand in the *Philosophical Transactions*. Though not at first an official publication of the Royal Society, the *Philosophical Transactions* represented the only publicly available news from the Royal Society and—especially for foreign scientists—constituted the public face of Royal Society.

The first decades of the journal consist entirely of correspondence to Oldenburg, synopses of letters to Oldenburg, and accounts of books brought to Oldenburg's attention. Despite the central

[65] Sprat (1958), 108.
[66] Hooke (1665), 5 of Preface.
[67] Hunter (1989), 249.

role played by Oldenburg, he went to great lengths to stress that all letters in the journal were read before the Society, and that resultant decisions were corporate and official.[68]

The below survey of the *Philosophical Transactions* serves two purposes. First, all of the examples come from the period over which Valvasor had access to the Latin translations, *Acta Philosophica*. It is known without question that Valvasor read the number three issue of 1665-6 and number fifty-four of 1669, but he does not quote directly from any other issues. One goal of the survey, then, is to help determine how closely Valvasor followed the first five years of the *Philosophical Transactions*. But apart from questions of influence, considering the investigation of Valvasor's English contemporaries highlights the practical dimensions of late seventeenth-century natural philosophy. This approach promises to get behind the rhetoric of both the 'Virtuousi' themselves and their modern (and oftentimes presentist) commentators to the pragmatic methodological decisions involved in reporting and explaining 'marvels of nature'.

[68] Hunter (1989), 253.

IV. The Early Philosophical Transactions

The early years of the *Philosophical Transactions* testify to the encyclopaedic goals articulated in Thomas Sprat's *History*. A broad range of phenomena is considered and causal explanations, if given, are generally offered as provisional. Sensational episodes of death by lightning strike[69] and glow-in-the-dark slabs of meat[70] are chronicled in meticulous detail, seemingly in the faith that such matters of fact will prove useful to future generations. The examples that follow relate to Valvasor's writing either in content or in spirit of composition.

Given the epistolary nature of the *Philosophical Transactions*, subtitled 'Some Accompt of the Present Undertakings, Studies, and Labours, of the Ingenious in many considerable Parts of the World', travel accounts constituted a considerable interest for Oldenburg and the Royal Society. Robert Boyle dedicated one of his first entries in the *Philosophical Transacations* to guidance to those compiling a 'Natural History' of a country to 'superstruct, in time, a *Solid* and *Useful* Philosophy upon'.[71] The majority of questions to be answered in his Natural History contribute to the encyclopaedic project of the Royal Society. For example, Boyle encourages the investigator to determine the Longitude and Latitude of places being described, the different types of weather, what sorts of Meteors can be observed, how the winds blow, the currents and tides of the Sea and the magnetic declination in several places. He also puts forth questions about the local inhabitants, about their fecundity, susceptibility to diseases, diet, education and customs. With respect to subterranean characteristics, Boyle's chief interest is in mining, with a further article dedicated solely to such questions.[72] There he suggests that the investigator consider several phenomena later recounted by Valvasor in his treatment of Lake Cerknica: nocturnal lights, streams running their course underground, and any 'determinate change in weather' that accompanies the rising of subterraneous springs.[73]

Even though the suggested questions are encyclopaedic in nature, Boyle's project is not merely encyclopaedic. After urging the recording of magnetic declination, he adds a list of possible causes to explain any great variation in magnetic declination, asking the correspondent to enumerate 'what

[69] 'A Relation of a Sad Effect of Thunder and Lightning', *PT*, **1** (1665-1666), 247-248.
[70] Robert Boyle, 'Some Observations about Shining Flesh, Made by the Honourable Robert Boyle . . .', *PT*, **7** (1672), 5108-16.
[71] Robert Boyle, 'General Heads for a Natural History of a Countrey, Great or Small, Imparted Likewise by Mr. Boyle', *PT*, **1** (1665 - 1666), 186-189.
[72] Robert Boyle, 'Articles of Inquiries Touching Mines', *PT*, **1** (1665 - 1666), 330-343.
[73] Robert Boyle, 'Articles of Inquiries Touching Mines', *PT*, **1** (1665 - 1666), 343.

circumstances may assist one to guess at the Reason'.[74] Rather than a mere collector of facts, the investigator seems to constitute one organ of a far-reaching effort to expand natural knowledge, including hypotheses and conjectures where appropriate. The appropriateness depends on the type of phenomenon being considered. For the magnetic declination cited above, Boyle allows for speculations when the phenomenon is self-contained—that is, when the variation is great over an area investigable by one person. In contrast, Boyle expects no hypotheses about the tides, perhaps since any credible explanation would require data from widely-dispersed locations (a project collated in part by Sir Robert Moray).

Though Valvasor's uptake of this advice will be considered below, before 1669 only Joseph Glanvill took up Boyle's questionnaire wholesale as a template.[75] In his first article, he claims as 'probable' that mists and fogs covering the Mendip Mines arise from mineral and subterranean streams.[76] In the second, he reports on subterranean 'Daemons'. Though the miners have never seen any, Glanvill writes, they sometimes hear knocking sounds issuing from beyond their workspace, which, 'when follow'd by them, have afforded plenty of ore'.[77]

Though Glanvill's is one of the only mentions of a legendary beast in articles relating to Valvasor's (Edward Browne also notes the lack of such creatures in the Idria Mines[78]), there are many mentions of medicinal waters, a feature also of Valvasor's writing.[79] Mineral waters and springs are variously attributed powers to heal palsy, epilepsy, gout, leprosy, scabs, broken bones, obstructions of the bowels,[80] bad spleens, cases of the Worms,[81] ulcers, consumption, giddiness and headaches.[82] These healing effects are presented as remarkable and uncommon, but always in

[74] Robert Boyle, 'General Heads for a Natural History of a Countrey . . .', *PT*, **1** (1665 - 1666), 188.
[75] Joseph Glanvill, 'Answers to Some of the Inquires Formerly Publish'd Concerning Mines', *PT*, **2** (1666 - 1667), 525-7; and Joseph Glanvill, 'Additional Answers to the Queries of Mines' *PT*, **3** (1668), 767-771.
[76] Joseph Glanvill, 'Answers to Some of the Inquires Formerly Publish'd Concerning Mines', *PT*, **2** (1666 - 1667), 526.
[77] Joseph Glanvill, 'Additional Answers to the Queries of Mines *PT*, **3** (1668), 771.
[78] Edward Brown, 'A Relation Concerning the Quick-Silver Mines in Friuli; Communicated by Dr. Edward Brown; Co Firming as Well the Accompt Formerly Given of That Subject, in Numb. 2. of these Transactions, as Enlarging the Same with Some Additions', *PT*, **4** (1669), 1082.
[79] 'An Account of Hevelius His Prodromus Cometicus . . .', *PT*, **1** (1665-6), 104-18, esp. 116; 'Of a remarkable spring, about Paderborn in Germany', *PT*, **1** (1665-6), 133-134; 'Of Some other not-common Springs at Basel and in Alsatia', *PT*, **1** (1665-6), 134-6; 'Of the richest Salt-Springs in Germany', *PT*, **1** (1665-6), 136-7; John Beale, 'An Account of Some Sanative Waters in Herefordshire', *PT*, **1** (1665 - 1666), 358-359; Joseph Glanvill, 'Observations Concerning the Bath-Springs, Communicated by Mr. Joseph Glanvill, in a Letter to the Publisher Dated June 16. 1669: At the Bath', *PT*, **4** (1669), 977-982; Dr Highmore, 'Some Considerations Relating to D. Witties Defence of Scarborough Spaw (Abbreviated in Numb. 51.) together with a Brief Accompt of a Less Considerable Salt-Spring in Somersetsh; And of a Medical Spring in Dorsetshire; By the Learned Dr. Highmore in a Letter to Dr John Beale at Yeavil in Somerset', *PT*, **4** (1669), 1128-1131; John Beale, 'The Causes of Mineral Springs Further Inquired: And the Strange and Secret Changes of Liquors Examined; By Dr. J. Beale, to the Publisher', *PT*, **4** (1669), 1131-1134; John Beale, 'The Causes of Mineral Springs Further Inquired: And the Strange and Secret Changes of Liquors Examined; By Dr. J. Beale, to the Publisher', *PT*, **4** (1669), 1131-1134.
[80] Joseph Glanvill, 'Observations Concerning the Bath-Springs, Communicated by Mr. Joseph Glanvill . . .', *PT*, **4** (1669), 980.
[81] 'Of a remarkable spring, about Paderborn in Germany', *PT*, **1** (1665-6), 134.
[82] 'Of Some other not-common Springs at Basel and in Alsatia', *PT*, **1** (1665-6), 136.

matter-of-fact terms. One pair of articles features a debate about the source of the healing properties,[83] but in general the accounts are exclusively descriptive. Oldenburg is the only one to link the healing with a supernatural power, when he writes in his preface to the third year of the journal, 'Neither have we altogether omitted to commemorate those obvious reliefs, which the Divine Bounty has offered freely and in common, by *Springs*, *Baths*, *Bolus's*, *Medicated Earths*, *&c*'.[84]

Significantly, the reports of healing waters contain experiments and professedly reliable testimony. For example, Dr J. Beale determined 'by many tryalls upon [his] hands' that the vision-healing properties of this Hertfordshire spring increased in times of draught.[85] He includes a detailed account of the steps involved in the healing process, including holding the water in his mouth till warm and mingled with saliva and then depositing it on his skin disease, after which Dr Beale 'could see it immediately gather a very thin skin upon the raw flesh, not unlike that which is seen to gather upon Milk over a gentle fire'.[86] Another author from Germany reports on his experiments with hens and certain noxious water. He chronicles the food given the hens, the ameliorating effect of salt and vinegar, and the condition of their lungs upon autopsy.[87]

One particular mention of healing waters that Valvasor is known to have read forms part of Oldenburg's summary of the Italian Jesuit Athanasius Kircher's *Mundus Subterraneus*. The twelve books of this volume range over a broad swath of topics. He offers a proof that meteors owe their origin to subterraneous fires, and he discusses the formation of bony substances underground, which are 'by many esteemed to by the Bones of *Gyants*; and . . . taken for *Unicorns* horns'.[88] He also tackles alchemy, revealing as 'false and deceitful' the alchemical processes of several *Adepti*, including Paracelcus.[89]

The most important section for approaching Valvasor's work concerns Kircher's theories of underground passages through which oceans communicate and volcanoes draw their fire.

[83] Dr Highmore, 'Some Considerations Relating to D. Witties Defence of Scarborough Spaw (Abbreviated in Numb. 51.) together with a Brief Accompt of a Less Considerable Salt-Spring in Somerset; And of a Medical Spring in Dorsetshire; By the Learned Dr. Highmore in a Letter to Dr J. Beale at Yeavil in Somerset', *PT*, **4** (1669), 1128-1131; and John Beale, 'The Causes of Mineral Springs Further Inquired: And the Strange and Secret Changes of Liquors Examined; By Dr. J. Beale, to the Publisher', *PT*, **4** (1669), 1131-1134.
[84] Henry Oldenburg, 'A Preface to the Third Year of These Tracts', *PT*, **2** (1666-1667), 410.
[85] John Beale, 'An Account of Some Sanative Waters in Herefordshire', *PT*, **1** (1665 - 1666), 358.
[86] John Beale, 'An Account of Some Sanative Waters in Herefordshire', *PT*, **1** (1665 - 1666), 359.
[87] 'Of a remarkable spring, about Paderborn in Germany', *PT*, **1** (1665-6), 134.
[88] 'An Account of Hevelius His Prodromus Cometicus . . .', *PT*, **1** (1665-6), 111.
[89] 'An Account of Hevelius His Prodromus Cometicus . . .', *PT*, **1** (1665-6), 112.

Oldenburg's summary also mentions discussions of subterranean '*Store-houses*' holding water, fire and air.[90] But the greater source of influence comes from Kircher's volume itself, which includes a model of intermittent springs involving siphons that draw water from nearby mountains (see figure 2).

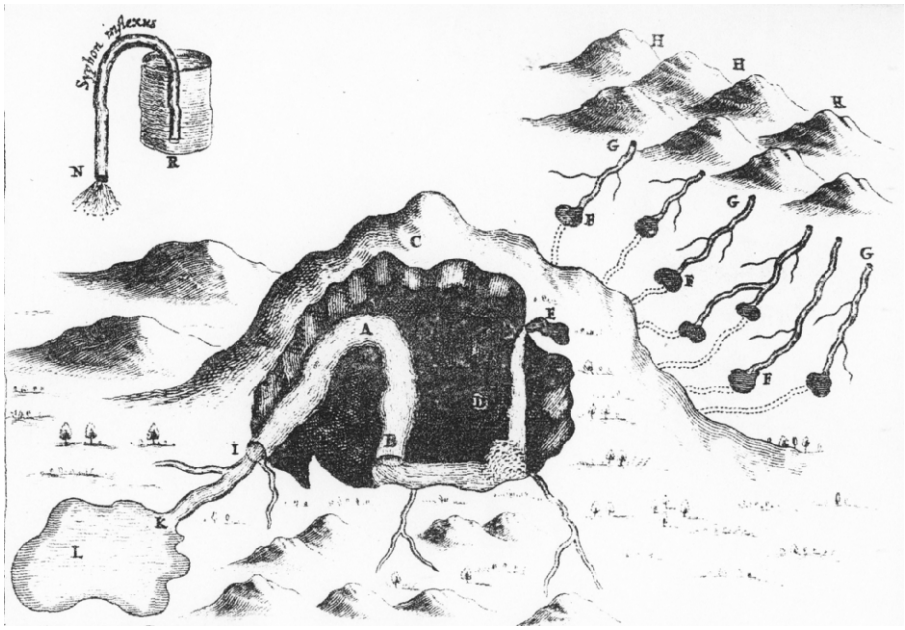

Figure 2. Kircher's siphon explanation for intermittent springs in *Mundus Subterraneus.* (Source: Shaw (1979), fig. 45)

In the English translation of Kircher's work, his treatment of volcanic activity highlights philosophical tensions in the early Royal Society over the ontological status of explanatory models. Kircher maintains that his proposed conservatories, 'Treasuries of Fire', vast abysses and 'bottomless Gulphs in the Bowels and very Entrals of the Earth' are so attested to by the effect of volcanic activity that 'no sober philosopher' can deny that 'the whole Earth is Cavernous, and the Terrene Globe contains vast spaces within its own bowels'.[91] He reasons by exclusion (i.e., no other known model can account for the phenomena) to the certainty of his explanation.

The English editor (whose name is not given) takes full advantage of his prefacing opportunity and qualifies Kircher's mathematical realism:

> Yet you are not to imagine, that the Fires and Waters, &c. are really thus disposed in Nature underground. For whoever has seen them? But this only was to signifie,

[90] 'An Account of Hevelius His Prodromus Cometicus . . .', *PT*, **1** (1665-6), 115.
[91] Kircher (1669), 1-2.

> according to the best imagination of the Author, that they are after some well-ordered and artificial, or organiz'd way or other, contriv'd by Nature.[92]

The editor considers Kircher's underground conservatories not as necessarily real entities, but as short-hand for the as-yet-undetermined reality. He writes,

> But let none perswade himself, as if the Fires were constituted, as here represented; and the *Firehouses* forthwith disposed in that order. In no wise this. We would only hereby shew, that the bowels of the Earth are full of *Aefluaries*, that is, places overflown, and raging with Fire, which we call Underground Fire-houses, or Conservatories; whether after such, or any other manner disposed.[93]

Kircher's dogmatism was not the only reason the editor of the English translation, as well as Boyle and Oldenburg, viewed his work with suspicion.[94] Kircher also represented a voluminous contributor to the Aristotelian tradition the New Philosophers strove to overturn. Yet Kircher did not confine his researches to one philosophical framework, but rather drew from many sources, secure in the knowledge, as Paula Findlen notes, that his openness would only contribute to the Aristotelian tradition.[95] In addition to his influence on Valvasor, Kircher serves as a counter to the Aristotelian straw men prevalent in the polemics of Bacon and the early Royal Society. Kircher clearly did not go running back to his *Metaphysics* at every turn, and he did not employ ad-hoc animism and word-splicing in his methodology as do Boyle and Oldenburg's Schoolmen.[96] Kircher's syncretic approach is one more reason to question the explanatory power of labels such as 'Aristotelian' and 'Atomist', and look especially at how these beliefs were or were not manifested in practice.

Besides Kircher, another author in the *Philosophical Transactions* explicitly mentioned by Valvasor is Edward Browne, son of Sir Thomas Browne. In his first letter to the Royal Society, Valvasor expresses astonishment that his native country—and especially Lake Cerknica—has received such 'superficial' treatment at the hands of Edward Browne.[97] Thus Browne's account and Valvasor's subsequent dissatisfaction offer a window into what Valvasor considers an acceptable approach to 'great natural miracle' Lake Cerknica.[98]

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[92] Kircher (1669), a4.
[93] Kircher (1669), a6.
[94] Findlen (1994), 33.
[95] Findlen (1994), 51.
[96] See for example Boyle (1996, orig. 1686), and Henry Oldenburg, 'Preface to the Third Year of these Tracts', *PT*, **2** (1667), 411.
[97] Valvasor (1987), 22.
[98] Valvasor (1987), 22.

Browne's article on Lake Cerknica (rendered *Zirchnitzer-Sea*) spans three pages and reflects a single day spent in June by the lake.[99] Browne describes the lake as two German miles long and one wide, draining in June and filling in September through 'pores of the Earth' as well as 'great holes' at the bottom of the lake. When filling, Browne notes that the water emerges from some holes with such force that it springs from the ground to the height of a pike. Browne also briefly describes the fishing at Lake Cerknica.[100]

In his travel book (also known to have been read by Valvasor[101]), Browne further (but not much further) describes Lake Cerknica, giving the names of the seven main valleys covered by the lake, as was told to him. He expands on the fishing practice by adding that the locals catch carp, eels and tench.[102] Valvasor's criticism of Browne focuses on both the shallowness of Browne's reporting and the errors in his reporting. On the second count, Browne either did not measure the lake himself, or measured the lake poorly, for Valvasor cites its dimensions as one by one-half German miles, one-fourth the size of Browne's figure.[103] Moreover, Browne mistakenly populated the lake with the above-mentioned fish and neglected significant sinkholes in his description.[104] According to Valvasor, Browne's methodological failure was three-fold: superficiality, untested reliance on testimony (especially in matters where testing was possible) and inaccurate measurements.

These three issues feature heavily in the first decade of the *Philosophical Transactions*. On the last account, the encyclopaedic project of the early Royal Society encouraged a rash of measurements for a wide range of phenomena, from the tides to rain-water (used to explain the origin of fountains[105]) to death by swelling tissue.[106] Kircher also used a surveying tool to correct estimates about the interior dimensions of a volcano.[107] With regards to testimony, Shapin's emphasis in the *Social History of Truth* on social standing as a guarantor of reliable testimony is reflected in the early years of the *Philosophical Transactions*. A contributor is often identified as

[99] Šumrada (1990), 65.
[100] Edward Brown, 'An Accompt from the Same Dr. Brown Concerning an Un-Common Lake, Called the Zirchnitzer-Sea, in Carniola', *PT*, **4** (1669), 1083-1085.
[101] Šumrada (1990), 65.
[102] Browne (1687), 80-81.
[103] J. W. Valvasor, 'An Extract of a Letter written to the Royal Society out of Carniola . . .', *PT*, **16** (1687), 411.
[104] Šumrada (1990), 65.
[105] 'A Particular Account, Given by an Anonymous French Author in His Book of the *Origin of Fountains*, Printed 1674 at Paris; To Shew, That the Rain and Snow-Waters are Sufficient to Make Fountains and Rivers Run Perpetually', *PT*, **10** (1675), 447-450.
[106] William Darston, 'An Extract of a Letter Written by the Learned Dr. William Darston, Physitian at Plimouth, to the Right Honorable the Lord Vice-Count Br Uncker as President of the R. Society; Concerning a Very Sudden and Excessive Swelling of a Womans Breasts', *PT* **4** (1669), pp. 1047-1050.
[107] Kircher (1669), 37.

knighted, or a doctor, or labelled an 'Ingenious and Worthy Gentleman' or an 'Inquiring Gentleman'.[108]

These related issues of measurement and testimony tie in with the emphasis among the Royal Society (and especially Boyle) on establishing reliable matters of fact. As Shapin and Schaffer point out,[109] even experimental matters of fact (such as Boyle and Hooke's experiments with air-pumps) can only be witnessed by a handful of people. As with air-pumps, so with fantastic accounts of the *Philosophical Transactions*. Analogous conventions to Boyle's populate the above-mentioned letters in the *Philosophical Transactions*. The meticulous reporting regarding sanatative waters, glow-in-the-dark meat[110] and lightning induced death[111] address the credibility problem faced by Boyle's air-pump experiments (especially against Aristotelian critics who maintained that a vacuum was impossible). By extensively documenting the circumstances surrounding the reported phenomenon, the author established both his personal involvement in the matter at hand, and his dispassionate attention to accurate reporting. Looked at from the other side, the detailed reporting made charges of fraud more serious. Any disputation of the reported matters of fact would necessitate that the author either lied in great detail or was duped in great detail. Here Shapin's 'Gentlemanly Codes of Conduct' form part of the solution to the problem of credible testimony faced by Oldenburg, the Royal Society and Valvasor.[112]

Conventions to secure honest testimony, however, do not constitute the entire rationale behind the style of reporting for the Royal Society and, as will be shown below, Valvasor. Thomas Sprat's justification for detailed reporting of experiments so that, 'with their mistake, they give them also the means of finding it out', plays a role as well.[113] Departing here from Shapin, Boyle's air-pump was replicated and improved by others, notably Christian Hugyens.[114] In the same way, the

[108] For example, Robert Moray, 'A Relation of some extraordinary Tydes . . .', *PT*, **1** (1665-6), 53-5; Dr John Beale, 'An Account of Some Sanative Waters in Herefordshire', *PT*, **1** (1665 - 1666), 358-9; Dr Highmore, 'Some Considerations Relating to D. Witties Defence of Scarborough Spaw (Abbreviated in Numb. 51.) together with a Brief Accompt of a Less Considerable Salt-Spring in Somersetsh; And of a Medical Spring in Dorsetshire; By the Learned Dr. Highmore in a Letter to Dr John Beale at Yeavil in Somerset', *PT*, **4** (1669), 1128-1131; 'The Description of a Well, and Earth in Lancashire . . .', *PT*, **2** (1966-7), 482-4; and 'Of a remarkable Spring . . .', *PT*, **1** (1665-6), 133-4.
[109] Shapin and Schaffer (1985), especially 55-69.
[110] Robert Boyle, 'Some Observations about Shining Flesh, Made by the Honourable Robert Boyle; Febr. 15. 1671/72 and by Way of Letter Addressed to the Publisher, and Presented to the R. Society', *PT*, **7** (1672), 5108-16.
[111] 'A Relation of a Sad Effect of Thunder and Lightning', *PT*, **1** (1665-1666), 247-248.
[112] Shapin (1994).
[113] Sprat (1958), 108.
[114] Shapin (1985), ch. VI, 225-282.

meticulous attention to location of streams, methods employed and even names and titles of sources helps make the reported matters of fact traceable and potentially replicable.

That the two issues, credibility and traceability, both contribute to securing matters of fact can be seen in the following episode from the Royal Society's journal book. A Dr Ball had just reported on credible information of a metal brought from the East Indies, now residing four miles from Exeter that, when struck lightly with a finger or 'much softer bodies' gave a loud noise, but when struck by an iron hammer, only 'a low and doadish noyse'. When members of the Royal Society doubted the credibility of the report, Dr Ball reaffirmed that credible men (including, it seems, a relative of Dr Ball) had conducted experiments upon the metal. Nevertheless, the Royal Society decided it might do well to 'order some sound bodies to enquire' further.[115]

The charge of superficiality levelled by Valvasor is a more difficult one. If 'superficial' is taken to mean a presentation of facts without a theoretical superstructure, then the majority of accounts communicated in the early *Philosophical Transactions* deserve this label. As chronicled above, 'matters of fact' constituted for many the ontological anchors of the New Philosophy. On the other hand, 'superficial' could refer to reliance on testimony when personal experience and measurements are possible. Where Valvasor stood on this question will be considered the following section.

[115] *Journal Book of the Royal Society* [microfilm], J. No. 3, 27 January 1669, 109.

V. VALVASOR'S METHODOLOGY OF THE FANTASTIC

With Valvasor's English context better established, I turn now to the practical dimension of Valvasor's natural investigations. In *Slava Vojvodine Kranjske*, Valvasor describes the methodological challenges of reporting on the fantastic and 'marvels of nature':

> Nature often far exceeds our expectations. In foreign countries I have spoken with various learnéd men who laughed at [another Natural Historian] Sebastian Munster and his description of Lake Cerknica, and asked me about the proper structure of this lake; I was unable to tell them anything, since then the lake was still unknown to me. And who would believe that a walnut tree, which was completely dry and leafless the night before the feast of St John the Baptist, would be by early the next morning not only green, but even bearing walnuts just like other trees? Who would believe such a report, if he had not with his own eyes seen that it is not a myth? But it is entirely true and I will corroborate it more extensively among the rarities of Carniola.[116]

In his investigations and writings, Valvasor faced the same problems of credibility as the Royal Society, and the New Philosophy as a whole.

But before considering his treatment of specific phenomena, some general rhetorical conventions and remarks of Valvasor deserve attention. Chief among these is Valvasor's use of an asterisk when writing in the first person. He explains that the asterisk signifies that whatever follows is a claim of the main author himself, Baron Valvasor. When the first person is not accompanied by an asterisk, the ensuing content is due to Valvasor's editor and German stylist, Erazem Francisi.[117]

Valvasor gives his own estimation of his methodology and investigations in several passages throughout his correspondence with the Royal Society and *Slava Vojvodine Kranjske*. He presents himself to the reader

> as a life-long lover of all free and natural arts, I have been prodded by curiosity and a thirst for knowledge toward research of natural rarities and mysteries. Wherever I have been able to learn more of man's quest for knowledge, there have I traveled—no path has been too long, no danger to large, no trouble too straining. The hope that in time I would discover and learn something unusual has sweetened all bitterness. . . . Thus I have learned of many a thing with my own eyes and hands.[118]

[116] Valvasor (1969, orig. 1689), bk. 2, ch. XLVII, 66-67.
[117] Valvasor (1968, orig. 1689), bk. 2, ch. I, 11.
[118] Valvasor (1969, orig. 1689), bk. 2, ch. XXVIII, 122.

In addition to his general curiosity and motivations, Valvasor elaborates on his interests and conceptual categories in his correspondence with the Royal Society. There he expresses his delight in all sciences and arts, in mechanical as well as other forms, but especially in the mathematical sciences.[119]

Valvasor complements his devotion to mechanical and mathematical sciences with rhetoric of artifice in nature. In numerous passages, Valvasor speaks of the art and artifice worked by nature in the marvels and miracles he comes across.[120] Thus Valvasor echoes the language of Boyle and other followers of the New Philosophy in thinking of nature in analogy with human artifice. As will be seen below, Valvasor's confidence in the existence of mechanism in nature and in the utility of mathematical instruments contribute to his methodology of the fantastic. The first example below, however, exemplifies a prodigy about which Valvasor declined to explain in terms of mechanism or artifice.

THE MIRACULOUS WALNUT TREE

In a letter dated 23 June 1684 to the Royal Society, Valvasor describes a miraculous walnut tree not far from Lake Cerknica. The tree remains barren until the feast of St John the Baptist (by the new calendar), and then in one night sprouts both leaves and walnuts. Valvasor relates to Thomas Gale, the secretary of the Royal Society, that he had recently spent a night beneath this tree accompanied by two servants, the chaplain of a nearby Baron and a villager. The tree had a few leaves three days before the feast, but they were very small. By sunrise, the tree had large leaves, like other trees, and walnuts a little smaller than hazlenuts.

As further confirmation, Valvasor relates how several years back, a Count, Janez Herbard Kacijaner, came to investigate the same tree. Finding the tree barren, he wrapped one of the branches in paper and sealed the paper with wax. In town, he offered money to anyone who would bring him the branch in bloom. To the Count's surprise, the following day a peasant brought him the branch, with his seal still intact, and large leaves and a big walnut sprouting from the branch.

[119] Valvasor (1987), 23, 22.
[120] For example, Valvasor (1968, orig. 1689), bk. 1, 6; Valvasor (1969, orig. 1689), bk. 2, ch. L, 71; and Valvasor (1968, orig. 1689), bk. 2, ch. LXVIII, 39.

Valvasor declines to speculate on the cause of the sudden growth, since he was distracted by conversation with the priest and thus 'through carelessness' did not observe the process. But he did see the result, which came about very quickly. He relates that all in the area believe the tree to be divine and miraculous. Valvasor instead maintains that the tree's blossoming is not a direct act of God, but happens according to 'nature's path'. Thus far the account seems confirmation of Stanonik and Reisp's metaphysical conflict model. Significantly, Valvasor's reason for deciding against the miraculous explanation is grounded in pragmatic consideration of the data at hand. The blossoming usually occurs on the night of the feast of St John the Baptist, but not always. About twenty years ago, Valvasor relates, it began to blossom five days before. Since this particular marvel does not exactly coincide with the feast, as one would expect of a divine commemoration of St John the Baptist, Valvasor instead calls the phenomenon a 'miracle of nature'.[121]

Thomas Gale's response is similarly illuminating. First, Gale counsels Valvasor to relate as certain and indubitable only what he has personally ascertained with his own trials. Other testimony, as truthful and trustworthy or faithful as the source may be, should only be presented as hearsay. It would be easy to see Gale's counsel in the spirit of the naïve version of *Nullius in verba*. But as seen in section III there are at least two problems with this reading. First, dismissing all evidence except what one has personally ascertained is a self-defeating program, especially in this situation (for then Gale would have no use for Valvasor's correspondence). And second, even in the rhetoric, the New Philosophy reserved a role for matters that were not certain and indubitable, namely theoretical models. As with explanatory models, the call is not for rejection of any data not personally verified, but for sensitive and honest handling. Gale himself specifically couches the advice in terms of *how* Valvasor presents his investigations, and not *what* Valvasor presents.

With regards to Valvasor's relation of the tree, Gale considers the account 'miraculous beyond belief', except that Valvasor himself witnessed the outburst from nearby, and also that there exist similar, though not identical trees, in the New Forest in Hampshire and in Glastonbury. These trees grow slowly, then suddenly send up a sprout of a foot or more in a single day.[122] As in the conventions discussed in sections III and IV, Valvasor secures the matter of the fact of the miraculous tree by supplementing his report of direct experience with attention to details of the tree

[121] Valvasor (1987), 31-33.
[122] Thomas Gale in Valvasor (1987), 35-36.

(e.g., the size of the newly grown walnuts) and by recording personal information and social standing of his fellow witnesses.

An implicit element of the above account is Valvasor's relationship to his sources. How did Valvasor learn of the tree? How did he receive the initial reports of the tree? This relationship bears directly on Valvasor historiography, especially instances of praised skepticism and poo-pooed credulity. This relationship comes to the fore in the accounts from Valvasor's main work, *Slava Vojvodine Kranjske*.

BELA VODA AND THE DRAGON

Valvasor makes explicit his interaction with local testimony in his account of a water phenomena in a cave near Lake Cerknica named *Bela Voda* ('White Water'). Though published in 1689, his investigation occurred in 1684, a little over a year before Valvasor began his correspondence with the Royal Society. The locals relate to Valvasor a professedly unbelievable property of the water flowing from the cave: it runs twice a day, and also if the cave is touched. The name of the cave derives from the appearance of the water reported to flow when the cave is poked properly.

Valvasor checks the claims, confirming the approximate timing of the daily outpourings and exploring the cave as far as he could on horseback. He tries also with a long pole to poke between the rocks of the cave to induce the water to run, but meets with no success. This failure awakens in him significant doubts of the truth of the account as told him by the villagers. Yet Valvasor continues to ask the locals for information, meeting with additional assertions of the truth of the commonly held claim. He spends several afternoons in a pub, pressing one particular farmer for more information about *Bela Voda*. After these additional interviews, Valvasor sets out again, this time with four farmers. When they reach the cave, Valvasor takes a long pole, pokes it between the rocks, pulls it out and pushes it in again several times. The water rushes out so suddenly that Valvasor reels in surprise. It is white, like foamy soap. He fills a glass with the water, and found that the water quickly cleared. After half an hour, Valvasor repeats the procedure, and shudders at such a violent outpouring of water.

He records that he paid close attention from the beginning of his investigation to whether or not the pole became wet when instigating the gushing of *Bela Voda*. Since the pole remains completely dry, Valvasor concludes that the phenomenon is caused by the rarefaction of air, bringing about *motus* or *impetus* to start the water flowing in a siphon, or something akin. Faced with the puzzle of the sudden gush of water, Valvasor turns to analogy with artifice that can produce a similar burst of water. Since the cave does not recede straight back into the hill, but slopes steeply downward (nearly twenty-two degrees, by Valvasor's measurement[123]), it seems a simple tunnel would not suffice. He adds that water seems to be elicited by loud snarling and shouting. Significantly, Valvasor connects the siphon explanation of *Bela Voda* with his model of Lake Cerknica.

There are some questions as to why Valvasor appealed to siphon mechanisms in his model of Lake Cerknica. Kircher's influence (perhaps augmented by Oldenburg's summary) goes some way to answering this question, but his experience with *Bela Voda* must also constitute a large portion of the answer. As will be seen below with the cave *Pod pečjo*, Valvasor justified some of the more fantastic aspects of his model of Lake Cerknica through analogy with related, and better understood phenomena. An initially incredible mechanism, such as a siphon, seems more believable if demonstrated in a nearby and related phenomenon.

Besides the matters of Kircher and siphons, Valvasor's account of *Bela Voda* lays bare his relationship with his sources. Even when he is tempted to laugh off stories told him by villagers, he still recognizes the possibility of matters of fact within the stories he is inclined to doubt. That Valvasor went a second time to check on the phenomenon of *Bela Voda* is even more remarkable given his reaction to the popular explanation for why *Bela Voda* runs twice a day and also when touched. Any ontological openness Valvasor might display does not seem to extend to expositions of natural phenomena that invoke dragons.

As the 'simple people' tell it, the appropriate poke elicits water flows from *Bela Voda* because it infuriates the resident dragon, who spews out the water accumulated in his lair. Valvasor's enquires about the waters' flow are met by the one villager who shares the following 'peasant wisdom':

> I see that you are still not educated enough, if you don't know this, which to us is well known: there is a dragon inside. The cause is this—there, where the dragon lies, is a spring; when the water collects to the point that the dragon has too much, he pours it

[123] Valvasor (1994, orig. 1689), bk. 4, ch. XXXI, 94-96; and Valvasor (1969, orig. 1689), bk. 4, ch. XXXI, 150.

out.[124]

Valvasor relates difficulty in holding back laughter, but still marvels that such a man, without education, professing an 'otherwise wholly mistaken and empty answer', could come up with such a clever explanation. He continues the conversation, hoping to learn more subtleties from 'this noble village physicist and paradoxicist',[125] but after hearing more about resident dragons, Valvasor relates that he could not longer hold back his laughter at the musings of this 'new Cartesian or Paracelsus'.[126]

Here, perhaps more than in any other example, the Stanonik/Reisp conflict model finds its fodder. Valvasor seems to be pulling a natural explanation from folklore not just because he has found what seems to him a plausible naturalistic explanation, but because he finds the folk-explanation ridiculous. The population of Valvasor's world-view does not include dragons, so he seemingly rejects the common explanation as ludicrous.

Nevertheless, there is an interesting twist chronicled by Valvasor. His Cartesian friend has himself seen three dragons (the last two years ago, which he caught and hung up in his home), and the town's postman, Gospod Hoffman, currently has the corpse of a young dragon in his home. When they go to see the dragon, Valvasor finds the corpse resembles a lizard, and concludes that it is a worm or vermin of some kind. Yet this episode affects a change in Valvasor's take on *Bela Voda*. He records that he no longer doubted the natural marvel of *Bela Voda* after so many witnesses had testified to him out of their own experience.[127] Even before witnessing the dead dragon, Valvasor tips his hat to the proverb, 'there is no fairy-tale so shameless as to be without a witness'.[128]

DORMICE AND THE DEVIL

After the above 'triumph', I will now turn to one of his principal 'defeats': the curious behaviour of dormice in Carniola. While accompanying a hunting party in the forest, Valvasor hears a thunder-

[124] Valvasor (1994, orig. 1689), bk. 4, ch. XXXI, 95.
[125] Valvasor (1994, orig. 1689), bk. 4, ch. XXXI, 95.
[126] Valvasor (1969, orig. 1689), bk. 4, ch. XXXI, 149.
[127] Valvasor (1994, orig. 1689), bk. 4, ch. XXXI, 96.
[128] Valvasor (1969, orig. 1689), bk. 4, ch. XXXI, 149.

like clap, a whip-like cracking and a whistling sound, followed by a multitude of dormice racing toward the group. The men fill their overcoats and boots with the animals. They use their coats and boots due to the commonly held belief that the Devil, who chases the dormice, has no power over them when hidden in human clothing. Moreover Valvasor notes that these round-ups only occur on Saturday evenings and at other 'holy times' (this in contrast to the above miraculous tree, which did not always bloom on the day of the feast day of St John the Baptist). Valvasor asserts he confirmed all of the preceding with his own eyes and ears.

Yet Valvasor does not fully sympathise with this explanation of the dormice behaviour, adding that no one knew of a 'proper cause' to relate to him, except the one involving the Devil. He finds two farmers who profess to have seen the Devil in the same forest. When questioned further, the one describes his sighting as half-goat, the other as half-man. Despite this eye-witness testimony, Valvasor admits that he cannot firmly say whether the farmers truly saw anything or were dreaming. Still it is certain, he continues, that villagers have many times heard the Devil when chasing the dormice, and with the chase loud claps, snaps and whistling. Significantly, Valvasor adds that many villagers of high social standing did not want to believe such a tale, until their own experiences removed their doubts. In another interesting twist, Erazem Francisi, who is implicated in much of Valvasor's superstition,[129] weighs in against the sightings being the Devil, maintaining instead that it is Pan or a satyr, as many have seen when travelling alone through the forest.[130]

In a paradigmatic example of Stanonik's notion of pulling natural explanations from the chaff of superstition, a subsequent investigator of Lake Cerknica criticized Valvasor's account of the dormice and purported to have demonstrated a naturalistic cause. Franz Anton von Steinberg describes how, upon catching a resident owl of the forest and poking it in the eyes, the owl's screeching occasioned the running of the dormice. What Steinberg did not know, however, is that the owls of that particular forest ate insects and not dormice.[131]

[129] Reisp (1983), 408-9.
[130] Valvasor (1968, orig. 1689), bk. 3, ch. XXXI, 50-51.
[131] Carmichael (1993), 159.

THE DWARVES OF IDRIJA

For Valvasor and many of his time, the relationship between superstition and belief in the Devil is not as cozy as Stanonik makes it appear. Valvasor warns how Satan, if allowed, leads people into old pagan superstitions.[132] Sir Thomas Browne, the famous father of Edward Browne, also cites the Devil as an instigator of vulgar supersitions (including beliefs about amulets and fairy-stones).[133] And in the section about the mercury mines of Idrija, Valvasor quotes Kircher's condemnation of the miners' belief in dwarves, writing: 'Just so Satan, the enemy of the human race, leads the superstitious by the nose'.[134]

Kircher relates (as reported to him by a monk named Eissart) that the miners of Idrija attribute the knocking sounds in the mines to dwarf activity, which if followed leads them to rich veins of mercury (as in Glanville's account in section IV above). To keep the dwarves content, the miners place a pot of food in a particular spot each day. Once a year they also offer a red overcoat, sized to fit a small boy. Edward Browne also reports on the commonly held belief among the miners in dwarves.

Valvasor engages with the accounts of dwarves of the mercury mines, but offers a different perspective than do Kircher and Browne. For one thing, both reports are included under the heading, 'False Views about Dwarves'. From Valvasor's conversations with the miners of Idrija, he affirms that no bread and coat ritual occurs or has ever occurred. Kircher bought into a tale fabricated for visitors both foreign and domestic to bring more fame to the mines.

Yet Valvasor scolds Kircher not only for uncritically accepting the story about the food and clothing rite, but also for denying, against the testimony of miners the world over, the existence of dwarves. The dwarves are never seen, and do no mischief to humans (except to the occasional good-for-nothing), but Valvasor asserts, against the claims of Browne and Kircher, that the well-known knocking and beating sounds are not just 'empty whispers and without any effect'. Valvasor echoes the claim of Glanvill about the mines of Mendip in section IV. He even goes so far as to chastize

[132] Valvasor (1969, orig. 1689), bk. 2, ch. XVII, 43.
[133] Browne (1981, orig., 1646), book I ch 11 and book II, ch. 5.
[134] Valvasor (1969, orig. 1689), bk. 3, ch. XXVIII, 123.

Browne, a man of such wide horizons, for accepting as a myth something that has been reported throughout the whole world from of old.[135]

Valvasor's relation to the reports of the miners, and of Browne and Kircher, emphasize the importance of considering not just the *what* but also the *why* of Valvasor's investigations. Both Browne and Kircher had tarnished credibility in Valvasor's eyes—Kircher for accepting uncritically the tale of the food and clothing offering, and Browne for superficial and occasionally mistaken reporting. Moreover, both Kircher and Browne, even to modern sensibilities, threaten to throw out the baby with the bath-water. By dismissing as superstition the stories about dwarves, they also gloss over the significance of the knocking sounds, and the experience of miners in following the sounds to mineral veins.

ALCHEMY

The reports of dwarves are not the only mistaken view of the mines of Idrija, according to Valvasor. He also lambastes alchemical beliefs about the transformation of mercury to silver. This section represents in Reisp's view Valvasor's characteristically sharp stance against alchemy. He begins by recounting experiences from his own travels in France, where he met many a chemist completely devoted to the idea of transforming mercury to silver. He tells specifically of his experiences in Lyon and Vienna among chemists able to turn bronze and lead respectively into the best and noblest gold using tinting techniques. Thus his ire is directed principally at those who purport to create the Philosopher's Stone, and those who claim as transformed metal what is only coated (though convincingly) with gold tincture. Of the Philosopher's Stone (believed in by Boyle[136]), Valvasor writes that 'nature knows nothing about the Philosopher's Stone'.[137]

OBEDIENT LEECHES

Valvasor quotes Kircher more approvingly in describing the curious behaviour of leeches in two caves near Lake Cerknica. Locals affirm (and Kircher as well as another author testify) that the

[135] Valvasor (1969, orig. 1689), bk. 3, ch. XXVIII, 122-3.
[136] Principe in ed. Hunter (1994), 93.
[137] Valvasor (1969, orig. 1689), bk. 3, ch. XXVIII, 120-122.

leeches respond to particular words. If a person remains silent while wading through these leech-infested waters, the leeches keep to themselves. However, if the wader says, 'Come drink me, leeches!', the leeches swim with great haste and in great multitudes toward the unwise wader. Of this phenomenon, Valvasor reports to the Royal Society that he would not have believed it, had he not seen it himself. On 1 October 1685, accompanied by an old fisherman (whose name Valvasor gives), he witnessed how the repetition of the above phrase elicited an onslaught of leeches toward the man. After exiting from the water, the man once again waded in. Only a few leeches made their way toward him, but once he began repeating the above phrase, they immediately rushed toward him in swarms.[138] Valvasor witnessed this event after he had begun his correspondence with the Royal Society. Though his account may seem outrageous to modern ears, he throughout follows Gale's advice to report as certain what he has seen directly.

SANATIVE WATERS

Unlike the authors in the early *Philosophical Transactions*, Valvasor devotes little attention to healing springs. He does make mention of some as he surveys the different regions of Slovenia, though he seems to accept the healing benefits uncritically.[139] Yet the extent and unanimity of reports about the healing properties of certain waters (see footnote seventy-nine) should be taken into account before assigning the label of credulity. Just as writers today would feel no need to further establish health benefits of red wine, Valvasor likely approached sanative waters in the same way. There was no credibility gap to be bridged. Incidentally, Stanonik makes no note of Valvasor's claim about health benefits of certain Slovene wines.[140]

LAKE CERKNICA

More than his other accounts of natural phenomena, the extent of his investigations into Lake Cerknica lays bare his relationship with his sources, and the relationship between 'matters of fact' and his proposed model. In particular, what follows will focus on how and how strongly Valvasor

[138] Valvasor (1987), 78.
[139] Valvasor (1994, orig. 1689), bk. 4, ch. XXXI, 95; Valvasor (1968, orig. 1689), bk. 2, ch. XLVII, 30.
[140] Valvasor (1968, orig. 1689), bk. 2, ch. XXIX, 26.

justifies his model of this miracle of nature, Lake Cerknica. Valvasor's model will be considered in the following order: first, as Valvasor described it to the Royal Society, then as in *Slava Vojvodine Kranjske*, and finally, as edited for the *Philosophical Transactions*.

In keeping with Gale's advice regarding the tree, Valvasor asserts in his introduction to the description of Lake Cerknica that what follows is 'nothing besides truth, all of which I myself have experienced'—anything he has not seen with his own eyes represents testimony from trustworthy people.[141]

Although fishing practices and customs have no direct relationship to the essential workings of the lake, Valvasor's descriptions of them bring out the practical dimension of Valvasor's investigations. As mentioned in section I, the nature and timing of the lake's filling and draining was of great practical interest for the nearby residents. Valvasor himself verified the order and timing of the draining of the major pits along the bottom of the lake, but he also makes clear his reliance upon local testimony. For example, he affirms that the described order and timing of the drainage is 'certain and never failing', though he spent just two years investigating the lake.[142]

He makes his reliance on the records of locals more explicit in recounting several peculiar incidents, including a serendipitous lightning strike of seventeen years back that stunned the fish and facilitated a huge haul (as told to him by trustworthy people).[143] Moreover, in his description of the pits through which the lake drains, he acknowledges that there are several other small caves or pits, but these he does not mention, for there is no fishing in these pits.[144] On expeditions into the caves, Valvasor is once accompanied by two experienced fisherman (one of whom is named), as well as a Frenchman (also named).[145]

While certain aspects of Valvasor's account are necessarily taken from testimony, for the most part Valvasor uses the testimony of locals as foundations from which to launch his own investigations. Thus the scaffolding and substance of Valvasor's model derive from phenomena experienced by Valvasor, guided by local testimony. What follows will consider three points: the

[141] Valvsor (1987), 70.
[142] Valvsor (1987), 74; and J. W. Valvasor, 'An Extract of a Letter written to the Royal Society out of Carniola . . .', *PT*, **16** (1687), 415.
[143] Valvsor (1987), 77; and Valvsor, 'An Extract of a Letter written to the Royal Society out of Carniola . . .', *PT*, **16** (1687), 418.
[144] Valvsor (1987), 74; and Valvsor, 'An Extract of a Letter written to the Royal Society out of Carniola . . .', *PT*, **16** (1687), 415.
[145] Valvasor (1987), 79 and 72.

main characteristics of Valvasor's model, his justification for the model, and his own estimation of the model.

Valvasor accounts for the workings of Lake Cerknica by means of five underground lakes connected to Lake Cerknica and/or each other with a network of tunnels and siphons, and connected to the super-terranean world by caves and streams that later surface. In figure 3, Lake Cerknica is AA, and the subterranean lakes are F, BB, D, E and CC. The lakes are arranged in order of relative elevation (i.e., CC is below lake Cerknica, AA, and lakes D and E are between lakes BB and Cerknica, in terms of elevation). The dotted lines in the cave represent the normal water level for the underground lakes, and the depicted ducks and fish represent, well, ducks and fish. The curved tunnels represent siphons (e.g., K and *l*), and the small circles drawn at the end of branching tunnels in Lake Cerknica represent the pits or caves involved in the draining of the lake, as mentioned above. The depiction of the model is not, Valvasor qualifies, drawn to scale.

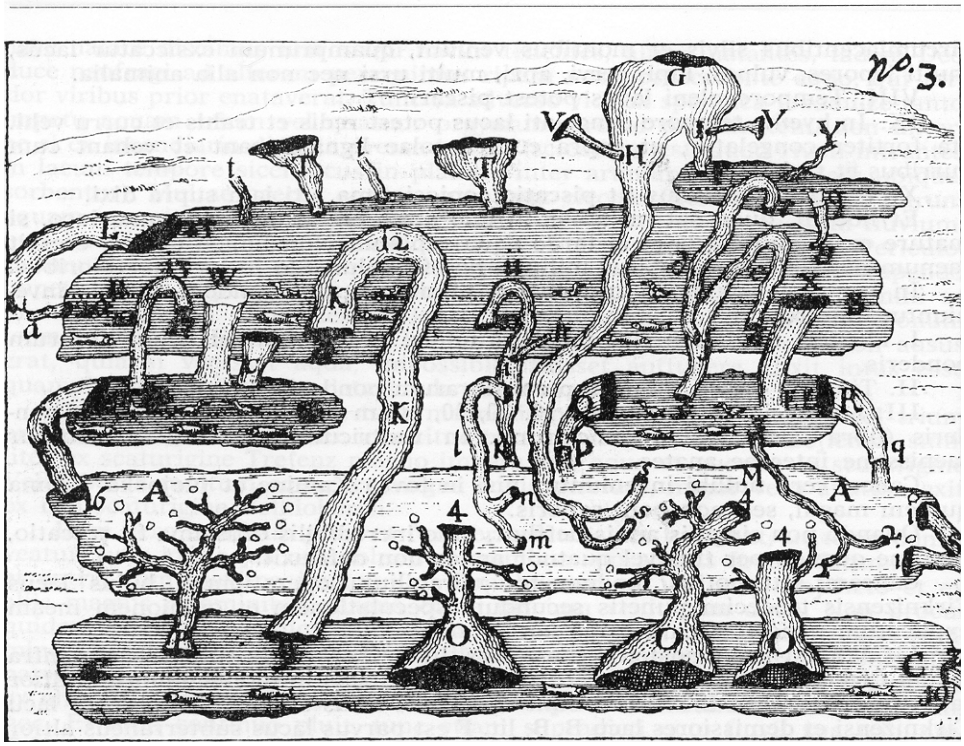

Figure 3. Valvasor's model of Lake Cerknica, as in his letter to the Royal Society and *Slava Vojvodine Kranjske*. (Source: Valvasor (1987), 64.)

Fifteen of the elements (excluding Lake Cerknica itself) of Valvasor's model correspond to well-known caves, outlets and streams. The rest are either unnamed and known to Valvasor or hypothetical elements of Valvasor's model, whose existence is justified in three main ways: by

analogies regarding water-flow and thunder-sounds; by fish and ducks that are or are not burped up into Lake Cerknica; and by measurements from mathematical and astronomical instruments.

On first score, Valvasor judges that Mala and Velika Karlovica (both denoted by *l* in figure 3) communicate with the underground stream Jezero due to the correlations of water flow in each of them. For when the fullness of Lake Cerknica significantly fills Mala and Velika Karlovica, Jezero runs with 'great violence'. But when the lake fills only Mala Karlovica, Jezero flows less rapidly. When both cease to draw water from the lake, Jezero reduces to a trickle, which after two days voids no more water than is provided by the eight small rivulets that feed into Lake Cerknica. This relationship Valvasor considers 'clear proof' that Mala and Velika Karlovica connect to Jezero.[146]

For the relative positioning of the canals and siphons connecting the underground lakes to Lake Cerknica, Valvasor appeals to the different times at which the caves stop voiding water into Lake Cerknica. Thus the siphon 17, which ultimately connects to Velik Obrh, must be higher than siphon 10, which connects to Kotel and Češljenica, since the former stops emptying water into Lake Cerknica before the latter does.[147]

It is not entirely clear why Valvasor appeals to siphons, or what he intends by siphons. In some places, he considers tunnels and siphons to be interchangeable.[148] He seems to connect the speed of the eruptions of water to siphons, as well as responsiveness to loud noises such as thunder (as in *Bela Voda*, above). Trevor Shaw's questions about Valvasor's use of siphons, as well as Halley's concerns will be discussed below when considering Valvasor's account as it appeared in the *Philosophical Transactions*.

Secondly, Valvasor appeals to the ejection of fish and especially ducks from particular caves into Lake Cerknica as proof that the caves connect to underground lakes. For example, Valvasor concludes that Vranja cave and Suhadolica (P and q, respectively) connect to the same underground lake below the moutains Javorniki for, though far from one another, they both have the property that during thunder and lightning, they expel water with astonishing force, sometimes accompanied by large multitudes of blind ducks and smaller groups of fish. This phenomenon Valvasor records witnessing on 18 October 1685 with the two old fishermen. Besides witnessing the eruption of

[146] Valvasor (1987), 82; and Valvsor, 'An Extract of a Letter written to the Royal Society out of Carniola . . .', *PT*, **16** (1687), 424.
[147] Valvasor (1987), 83.
[148] Valvasor (1987), 82, 83 for canal or siphon K.

ducks, Valvasor catches some, kills them, and opens up their stomachs to see what they eat. In many he found sand, in some fish, and in a few others vegetation, like grass or herbs. These blind ducks regain their sight generally within two weeks time, after which they can fly as well.[149]

The emergence of blind ducks from these caves not only establishes for Valvasor the existence of an underground lake beneath Javorniki, it also provides him with the relative heights for the mouths of the connecting tunnels and siphons. For if ducks and fish emerge from a cave, then its mouth must lay near the surface of the lake from which it draws. But if only fish, or no animals at all, then the mouth of the canal or siphon is taken to be below the usual water level of the underground lake.[150]

And finally, Valvasor bases certain aspects of his model upon direct measurements. As with *Bela Voda* and the siphons, Valvasor's incorporation of measurements involves a nearby and, as Valvasor sees it, analogous phenomenon. Using topographical and mining instruments, Valvasor judges that two underground lakes (*Pod pečjo* and the one in *Kompolje*) lay on the same horizon, even after changes in the absolute height of their water levels. This constitutes for Valvasor proof that the two are one and the same subterranean lake. That such a phenomenon would exist so near to Lake Cerknica Valvasor considers a boost to the credibility of his model. It answers those who cannot believe that 'such subterranean lakes, siphons and canals' exist. Valvasor himself admits it is a hard things to believe, except for the phenomenon of *Pod pečjo*, which Valvasor considers an analogy to Lake Cerknica.[151]

Valvasor sets out these details of and justification for his model in a series of thirteen questions and answers. Each question corresponds to a particular unusual lake phenomenon. The answers involve both observed caves and phenomena, as well as postulated caves, siphons, canals and lakes. Although the answers to questions two through thirteen are presented as certain answers (each begins with 'The cause is this . . .'), for the first question, Valvasor writes 'As a cause I allege . . .' In introducing the thirteen questions and answers, Valvasor writes, 'The cause, or better said, the manner of such unusual workings of Lake Cerknica I explain according to my own observations and

[149] Valvasor (1987), 78-79, 83-84; and Valvsor, 'An Extract of a Letter Written to the Royal Society out of Carniola. . .', *PT*, **16** (1687), 420-21, 425.
[150] Valvasor (1987), 81.
[151] Valvasor (1987), 84-85.

opinion . . .'[152] Though not as explicitly as in Hooke's *Micrographia*, Valvasor here gives ontological priority to his measurements and observations over the theoretical superstructure of his model. Later in the letter, however, Valvasor claims that the elements of his model are necessary for the lake to work in the manner witnessed and truly chronicled by Valvasor.[153] This mathematical realism plays a greater role in Valvasor's account of Lake Cerknica in *Slava Vojvodine Kranjske*.

Valvasor employs the same thirteen questions and answers in *Slava Vojvodine Kranjske*, but he there spends more time defending his model. For example, should a 'Doubting Thomas' find it hard to believe that such tunnels and siphons are indeed in the hills, and thus that the elements of Valvasor's model are just empty appearances and inventions of his imagination, then he would also have to doubt the above mentioned workings of the lake. Valvasor here assumes a mathematical realist position as above: since these phenomena are real, and since his model is the only conceivable way to account for the phenomena, then the elements of the model must be real as well. Thus, there must be the two large, subterraneous lakes, plus all of the other elements of his model as shown in the diagram (figure 3), he claims. He refers to his reasoning regarding the height of the lake below the Javorniki mountains as 'incontestable knowledge'. Valvasor supplements the reasoning involving the blind ducks with numerous measurements with mathematical instruments such as astrolabes and a 'metropas geometricum', invented by himself.[154] This mathematical realist line is not the only one offered by Valvasor, however. He also seeks to bridge the credibility gap by pointing the doubting reader to the Postojnska caves, where he will find such caves, pipes and the like.[155]

It is possible that the differences in presentation resulted from Valvasor tailoring his account to the given audience: the mathematical reticence of Boyle and Hooke for the English correspondence, and the mathematical confidence of Kircher for the Continental *Slava Vojvodine Kranjske*. As for the English reception, the estimation of Valvasor's model can be seen in two concrete ways. First, in the edited version of Valvasor's letter as published in the *Philosophical Transactions*. And second, in Edmond Halley's estimation of Valvasor's model, as seen in his demonstration before the Royal

[152] Valvasor (1987), 80.
[153] Valvasor (1987), 84.
[154] Valvasor (1969, orig. 1689), bk. 3, ch. LIII, 166-8.
[155] Valvasor (1969, orig. 1689), bk. 3, ch. LIII, 166-7.

Society of an apparatus involving tubs and tubes to model Valvasor's model, and also in his letter to Valvasor.

Although Valvasor's entire letter was likely too long to be reproduced in full, the particular omissions made for the extract published in the *Philosophical Transactions* shed light on what the Royal Society most and least valued in Valvasor's account. The introductory descriptions, account of fishing rights and account of the timing of the draining of the different caves are translated verbatim. As for omissions, the extract printed in the *Philosophical Transactions* excludes all names given by Valvasor, including a reference to Kircher regarding the leeches. Perhaps more significantly, the extract only includes snippets of Valvasor's thirteen questions and answers in which he presents his model. In particular, the extract makes no mention of siphon mechanisms. Even the section about *Pod pečjo* omits Valvasor's reported discovery of a 'true siphon' that conveys water.[156] The consistent omission of siphons likely arose from Valvasor's own ambiguity. He was not entirely consistent or clear in what he meant by his siphon mechanisms. The behaviour for which he considered siphons necessary (notably the sudden rushes of water and the sensitivity to changes in air pressure of *Bela Voda*) are reminiscent of, but not analogous to, siphon behaviour. A change in air pressure could elicit water from a siphon mechanism, assuming that the water level of the reservoir is level with the mouth of the siphon, but it would not cause a significant outpouring of water. The observed gushing of water would only happen if the reservoir level were significantly higher than the mouth of the siphon, such as could come about by a sudden rising of the reservoir level or an obstruction in the mouth of the siphon (as based on experiments conducted by myself during the third week of July 2003 using a bucket 20.7 cm in diameter and 6.7 cm deep for the reservoir, and for the siphon a translucent flexible tube 96.3 cm in length, and with a diameter of 2 cm for the lower section of hose and 2.6 for the upper section).

Edmond Halley picked up on another problem with Valvasor's proposed siphon mechanisms. While agreeing with Valvasor's reasoning about the respective heights of interconnecting tunnels (i.e., based on the outflow or lack of ducks and fish), Halley mentions that one might rightly dispute Valvasor's siphon mechanism. Halley points out that a siphon will only function if both its legs are filled with water. Once air enters the siphon (as would happen were the water level to drop below

[156] Valvasor (1987), 85.

the mouth of the siphon), the effect ceases and will not resume before the air is removed from the siphon, even if the water returns to its previous level.[157]

Thus Halley's model of Valvasor's model, as demonstrated before the Royal Society on 14 December 1687, makes no use of siphons, as in the extract published in the *Philosophical Transactions*. Although transparency and meticulous reporting were helped secure matters of fact for the New Philosophy, the printed extract makes gives no indication of where or why omissions were made. This negligence has led at least one historian astray. Trevor Shaw devotes a brief discussion to why Valvasor complicated his original, simpler, and, according to Shaw, more accurate model of 1687 (as in the *Philosophical Transactions*) by adding siphon mechanisms for the 1689 version of *Slava Vojvodine Kranjske*. Since Valvasor's model as described in his letter to the Royal Society is nearly identical to that of *Slava Vojvodine Kranjske*, Shaw must have based his conception of the supposedly original and simpler model, which was really the stylized excerpt of the *Philosophical Transactions*. By not laying bare their own editorial tracks, the *Philosophical Transactions* passed off as Valvasor's what would more properly be called the Royal Society's (or even Halley's) amended model of Lake Cerknica.

Nevertheless, Halley's letter contains high praise for Valvasor's 'clear and accurate description' of such marvels, especially his chronicling of the circumstances necessary to explain the true causes of the lake's behaviour. Through Valvasor's account, Halley claims he could look on the lake 'as if it were present'.[158] Excepting the siphons, Valvasor's account bridges the credibility gap for Halley through this 'virtual witnessing'.

[157] in Catherine Carmichael, 'Pismo Edmonda Halleya Valvasorju [Edmond Halley's Letter to Valvasor]', *Zgodovinski Časopis* [*History Journal*] , **47** (1993), 86. Translation from the Latin by Wolfgang deMelo.
[158] in Catherine Carmichael, 'Pismo Edmonda Halleya Valvasorju [Edmond Halley's Letter to Valvasor]', *Zgodovinski Časopis* [*History Journal*], **47** (1993), 86. Translation from the Latin by Wolfgang deMelo.

VI. Conclusions and Future Directions

Though Valvasor's esteem for the Royal Society and New Philosophy is evident from his correspondence, it is not unambiguous. Valvasor tips his hat to the ontological modesty of Boyle and Hooke, but his general position reflects more closely that of Kircher (minus the English editor's annotations). And even though Boyle and Hooke's names littered the first five years of the *Philosophical Transactions* (including an issue quoted by Valvasor[159]), he mentions neither of them in his list of sources.[160] The influence of Kircher, though accepted critically by Valvasor, seems the more substantial one. Besides *Mundus Subterraneus*, Valvasor uses eight other books by Kircher, making him the most referenced author in *Slava Vojvodine Kranjske*.[161]

Nevertheless, it is both possible and fruitful to situate Valvasor in the historical and philosophical context of the New Philosophy. Applied to Valvasor, Bennett and Shapin's emphasis on the practical dimensions of the New Philosophy remedies some of the Whiggish excesses in the existing literature, thus enabling Valvasor's investigations into the fantastic to be seen more as he saw it—as a whole and not a metaphysical struggle between science and superstition.

As seen above, Valvasor's methodology for bridging the credibility gap of fantastic accounts mirrors that utilized by the practitioners of the New Philosophy—attention to detail, chronicling of fellow witnesses and their social standing, measurements with mathematical instruments and explanatory models, where deemed appropriate. And as emphasized by Shapin, these conventions ensure a forum for dispute. Halley's letter exemplifies how Valvasor's methodology of the fantastic enabled a critic to doubt his theoretical superstructure without questioning his matters of fact. The value of these conventions shows itself even when a critic questions matters of fact. For example, Tobias Grüber, finding no blind ducks at Lake Cerknica a century after Valvasor, concludes that Valvasor dreamt them.[162] Unless Valvasor dreamt the described autopsies, fellow witnesses and date of his experience, Grüber's criticism faces a serious credibility problem.

Yet conventions of civility form just one aspect of the solution to the credibility problems encountered by Valvasor, the New Philosophy and the contributors to the *Philosophical Transactions*. Sprat's emphasis on conducting investigations so that 'with their mistake, they give

[159] *PT*, **1** issue 2 (1665-6), 17-32.
[160] Valvasor (1689), 2-7.
[161] Valvasor (1689), 2-7.
[162] Carmichael (1993), 63.

them also the means of finding it out' rings true with Valvasor and the early *Philosophical Transactions*.[163] Whatever successive investigators of Lake Cerknica thought of Valvasor's dwarves and Devils, they were crucially indebted to his meticulous account of the lake.[164] Valvasor, echoing Bacon and Sprat, acknowledges this approach when he writes, 'I have shown the path and by this I have done my share . . .'[165]

The above constitutes one element of Valvasor's context, and one focused analysis of his methodology. Despite its relevance, the Continental influence on Valvasor has received scant attention. Research into the Continental context of Valvasor's methodology of the fantastic is much needed. Kircher's influence in particular has gained little to no attention. In his biography of Valvasor, Reisp mentions Kircher only twice in passing. Besides the mistaken references in Shaw[166] and brief mention in Carmichael,[167] Kircher is virtually ignored.

Therefore another key to both dismantling distortions rendered by Whiggish Valvasor Historiography and uncovering a more nuanced picture will be to approach Valvasor through his Continental context, with a particular emphasis on Kircher. With the English and Continental pieces in place, we will draw nearer to a full appreciation of Valvasor's relationship with these 'miracles of nature'.

[163] Sprat (1958), 108.
[164] Carmichael (1993), 67-75.
[165] Valvasor, in Kranjc (1989), 217.
[166] Shaw (1979).
[167] Carmichael (1993), 26.

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