

**READING NATURE IN THE LIGHT OF SCRIPTURE**

**The Case of Georges Cuvier (1769-1832)**

DRAFT

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Submitted for publication by Peeters, Leuven, Belgium.  
November 13, 2003

**Bibliographic Reference**

Van der Meer, J. M. (2006) "Reading Nature in the Light of Scripture: the Case of Georges Cuvier (1769-1832)" In: *The Book of Nature in Modern Times*. pp. 181-193 (Eds. K. van Berkel, A. Vanderjagt). Peeters, Leuven, Belgium.

*Introduction.*

The relationship between science and religion has been referred to as the relationship between the 'Book of Nature' and the 'Book of Scripture.' Thus, one way of exploring the 'Book of Nature' metaphor in relation to culture is to look into its relationship with religion both as a cultural phenomenon and as a culture-shaping force. As a case study of this relationship, Georges Cuvier comes recommended. While the relationship between science and religion is often a monologue, it is a dialogue in Cuvier. The engagement between religion and natural history in Cuvier moves not only from natural history to religion, but also from religion to natural history.<sup>1</sup> Cuvier was responsible for the promotion of public, government-sponsored science in France during and after the Revolution. The question arises how he combined the promotion of a public science with a role of religion in science? Thus the work of Cuvier provides an opportunity to study the Book of Nature metaphor as it is influenced by the demands both of public knowledge and of the Book of Scripture. Cuvier's work also helps to understand the Book of Nature metaphor in relation to religious context because his contributions to natural history concerned the organization and history of animals. Lack of knowledge about these fundamental issues created conditions for the metaphoric transfer of knowledge from other cultural domains which led to new interpretations of the Book of Nature.

The conditions surrounding Cuvier promoted an entanglement of religious beliefs and the concepts and explanations of natural history. First, Cuvier saw animals as created by God. In this respect he was like Kepler and Newton whose comprehensive religious view of reality coloured

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<sup>1</sup> Cuvier used the term 'particular natural history' for the comprehensive study of living things. This included comparative anatomy, zoological classification and paleontology. I will use 'natural history' for short.

their knowledge of nature. Second, the various dimensions of Cuvier's life did not exist in splendid isolation. For instance, he saw religious and moral instruction as a means to curb social unrest and level class differences. The purposeful harmony in nature could serve as a model for the ordering of society.<sup>2</sup> Finally, as an official in various government positions related to education he had the means to implement these ideals.

*What Cuvier said about nature as text.*

Cuvier saw nature as 'a happy allegory which plainly teaches us that one of our first duties is to fill our minds with the goodness and wisdom of the Author of Nature by a continued study of the products of His power.'<sup>3</sup> Thus he appears to be a representative of the tradition that sees Nature as a Book revealing the wisdom and power of its divine Author. However, when he introduced his ideal of biological classification he extended the metaphor of Nature as text with an Author to the metaphor of Nature as spoken language: 'I do not deny at all that systems [of taxonomy] are useful; they are the dictionaries of natural history, but when will one finally speak the language? Systems are mere ends, not the goal, who will have the courage to approach the

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<sup>2</sup> Cuvier, G., *Rapport historique sur les progrès des sciences naturelles depuis 1789, et sur leur état actuel.* (Paris, 1810), p. 293.

<sup>3</sup> Cuvier, G., *Recueil des éloges historiques lus dans les séances publiques de l'Institut de France.* 3 vols.(Paris, 1861), vol. III, p. 272, tr. Coleman, 1964: 180-181; See also: Cuvier, G. , Valenciennes, A., *Histoire naturelle des poisons.* 8 vols. (Paris, 1828-1833), vol. 1, p. 569; Cuvier, G., *Recueil des éloges historiques lus dans les séances publiques de l'Institut Royal de France,* 3 vols. (Paris, 1819-1827), vol. 3, p. 450: "... one of our first duties is to fill ourselves with the goodness and wisdom of the author of nature by an orderly study of the products of his power."

goal?’<sup>4</sup> A classification is useless unless it reveals the rules of nature:

It is in some respects, a sort of dictionary where one uses the properties of things in order to discover their names, but which is the inverse of ordinary dictionaries, where one uses the names in order to learn the properties. When the method is good, however, it is not limited to just nomenclature. If the divisions have not been established arbitrarily, but are based on true fundamental relations, [that is] on the essential affinities of beings, the method is the most sure means of reducing the properties of these beings to general rules, ....<sup>5</sup>

Cuvier transformed the Book of Nature metaphor into the metaphor of a dictionary to emphasize the inadequacy of existing classifications. To offer an alternative, he also transformed the Book of nature metaphor into the Language of Nature metaphor. Learning to speak the language of nature meant understanding the lawful relations between organisms. The purpose of classification was to uncover the rules that govern these relations and to reproduce them in a natural system. The search for such rules shows the cultural influence of the ancient natural law tradition. The extension of the Book of Nature metaphor to that of the Language of Nature metaphor may have been informed also by the Book of Scripture. Psalm 19 uses this metaphor

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<sup>4</sup> ‘Den Systemen [der Taxonomie] spreche ich keineswegs ihren Nutzen ab; sie sind die lexica der Naturgeschichte, aber wann wird man einmal die Sprache reden? Die Systeme sind bloss Mittel, nicht Zweck, wer wird denn so kühn sein, sich dem Zweck zu nähern?’ Cuvier to Pfaff, Nov. 17, 1788 in: Behn, W. F. G., (Editor) *George Cuvier’s Briefe an C. H. Pfaff aus den Jahren 1788 bis 1792, naturhistorischen, politischen und literarischen Inhalts - Nebst einer biographischen Notiz über G. Cuvier.* (Kiel, 1845), p. 67.

<sup>5</sup> Cuvier, G., *Le règne animal distribué d’après son organisation pour servir de base à l’histoire naturelle des animaux et d’introduction à l’anatomie comparée.* 4 vols. (Paris. 1817), vol. 1, pp. 9-10.

extensively. Born, raised and educated a Lutheran, he must have encountered it in religious exercises.<sup>6</sup>

*How the Book of Scripture functioned in the thought of Cuvier.*

How did the Book of Scripture function in the thought of Cuvier? He was educated in the eighteenth century during which the notion of the Book of Nature was at its pinnacle in the form of natural theology. In natural theology there was an argument from knowledge of nature to the existence of God. In contrast, Cuvier argued from knowledge of God to knowledge of nature. This claim may seem to contradict his rejection of Noah's Flood as an explanation of the geological features of the earth. However, it makes sense in light of two traditions in the interpretation of the Book of Scripture. In the biblicistic tradition the Bible plays a direct role. Texts are used out of context as source of scientific information about nature (geocentricity, Scriptural geology). In the perspectival tradition, the Bible serves indirectly by providing a general view or perspective on nature (nature as purposive, as contingent). Both traditions are present in Cuvier's natural history. A text about the creation of the first human pair entered his definition of a biological species which was put in terms of the divine creation of pairs of animals.<sup>7</sup> In a discussion of Galileo, however, Cuvier applied the principle of accommodation according to which God had adjusted himself to the limitations of human language.<sup>8</sup> Likewise in

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<sup>6</sup> Negrin, H. E., *Georges Cuvier: administrator and educator*. Ph.D. Diss. New York University. 1977.

<sup>7</sup>letter to Pfaff, August 22/23, 1790, In: Behn, *Briefe an C. H. Pfaff*, p. 172.

<sup>8</sup> Cuvier, G., *Histoire des sciences naturelles, depuis leur origine jusqu'à nos jours, chez tous les peuples connus, professée au Collège de France par Georges Cuvier, complétée*,

geology he had rejected the biblicistic tradition characteristic of Scriptural geology.<sup>9</sup> Thus astronomy and geology influenced his interpretation of Scripture passages about astronomical and geological events, but it did not inform his knowledge of God. The perspectival tradition was present in the view that nature depends upon divine providence and reveals divine wisdom and power. The religious ideas of divine wisdom and power entered natural history as the argument from divine purpose and the argument from divine freedom, respectively.

*How the Book of Scripture entered the interpretation of the Book of Nature.*

How did the argument from divine purpose operate? Cuvier's overarching providential world view was focussed in two specific beliefs. God had embedded his plans and purposes in animals, and God had done so with absolute power and freedom. Let me illustrate these in turn. Cuvier wrote that '... the word creation is used for nature, world or the totality of created beings because their existence is considered dependent upon God as opposed to necessary.'<sup>10</sup> Organisms depended upon God in different, but related ways: '... they depend on the laws of movement as

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*rédigée, annotée et publiée par M. Magdeleine de Saint-Agy. 5 vols. (Paris, 1841-1845), vol. 2, pp. 285-286.*

<sup>9</sup> Outram, D., *Georges Cuvier: science, authority and vocation in post-revolutionary France*. (Manchester, 1984), p. 147. In a letter to Pfaff, October 1791, Cuvier explains alternating layers of chalk and silica near Fécamp, Normandy as the result of successive precipitations from seawater which he envisioned as having covered the entire earth: In: Behn, *Briefe an C. H. Pfaff*, p. 248.

<sup>10</sup> Cuvier, G., 'Nature' In: *Dictionnaire des sciences naturelles*, (Paris, 1825), vol. 34, p. 262. Cuvier does not present this as his own view, but I present it that way because this is consistent with Cuvier's opposition to the idea of necessary being. In equally general terms he observes that especially in the case of the laws of nature, people habitually personify nature and use its name for that of its author (Cuvier, *Le règne animal*, vol. 1, p. 1-2).

well as on the forms they have received when they were created, ...<sup>11</sup> The laws of movement were the laws of mechanics as understood in the Newtonian view of the world. ‘Form,’ ‘plan’ and ‘harmony’ referred to the organisation of relations between functions and the organs that perform them. The Forms were divine Forms because the harmony of parts in the whole was a production of absolute power and regulated by wisdom: ‘We conceive thus nature simply as a production of absolute power, regulated by a wisdom whose laws we discover only by observation; ...’<sup>12</sup> In sum, divine power rules and sustains the organisation of correlations between functions and organs according to a specific Form for a specific purpose. The purpose of a particular kind of organism is internal to it in the pattern of correlations between functions because this pattern or Form exists for the purpose of maintaining that particular kind of organism.

The argument from divine purpose originated in Cuvier’s belief that God had endowed each organism with a plan and purpose when it was created. This religious belief was translated into the metaphysical Principle of the Conditions of Existence (PCE). Theoretically, Cuvier reasoned, God is free to create any combination of parts of organisms. The actual combinations, however, are limited for two reasons. First, to fulfill their purpose, some parts require other parts thereby excluding certain parts. For instance, the teeth of a carnivore require a centralized nervous system with sense organs concentrated in a head for the purpose of catching prey. This excludes a diffuse nervous system with sense organs all over the body as well as the chambered intestinal system of the herbivores. Second, other parts do not require each other and their combination in one organism would be without purpose because it would be superfluous. For

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<sup>11</sup> Cuvier, ‘Nature’, p. 263.

<sup>12</sup> Cuvier, ‘Nature’, p. 268.

instance, the branching intestinal system of flatworms makes a circulatory system that distributes nutrients unnecessary. The PCE excluded combinations of parts that have no purpose or are superfluous.<sup>13</sup> Thus, the PCE determined which combinations of parts are possible or impossible. This appears to be in conflict with Cuvier's belief that God is free to create what he wills. This freedom, however, was regulated by wisdom.<sup>14</sup> The idea of limitations placed by divine purpose upon divine freedom is a specific theological construction known as divine self-limitation. He believed that while God is omnipotent, there are things which God chooses not to do such as creating animals that are without purpose because they would be inconceivable. He believed that from an initial set of hypothetical possibilities, limited only by the condition that the outcome must not involve contradiction, God selected a subset which he willed to actualize.<sup>15</sup> The actual combinations of organs were those that are mutually compatible given the purpose for which the animal was created. Gaps of any kind such as between taxonomic groups, body types or developmental stages, represented hypothetical possibilities that were not realized because they were without purpose. The unrealized hypothetical possibilities are manifest in discontinuities between major types of body plans and between taxonomic categories. This made it impossible for Cuvier to envision transformation of biological form such as in embryonic and evolutionary development. He, therefore, assumed that the parts of an embryo pre-exist in the egg and that

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<sup>13</sup> Cuvier, *Histoire des sciences naturelles*, vol. III, lect. 3, p. 55; cited from Letteney, 1999: 435. See also, Cuvier, G., *Leçons d'Anatomie Comparée de Cuvier*. 2<sup>nd</sup> édition, corrected, amended and reviewed by M.G. Cuvier. (Paris, 1835-1846), vol. 1, p. 64.

<sup>14</sup> Cuvier, 'Nature', p. 268, quoted in n. 12.

<sup>15</sup> Cuvier, *Leçons*, vol. 1, pp. v-vi, 45-46; Cuvier, *Leçons*, 2<sup>nd</sup> édition, vol. 1, p. 64; Cuvier, *Histoire des sciences naturelles*, vol. 3, p. 55.

development consists of the growth of these parts, a view known as preformation. This explains why an expert in anatomy such as Georges Cuvier was led to believe that: “Normally, the foetus descends from the ovaries via the horns into the womb.”<sup>16</sup> For the same reasons he rejected Lamarck’s theory of evolution. In this way the description of the Book of Nature was constituted by a teleological perspective from the Book of Scripture. The engagement of the Two Books was mediated by the metaphysical PCE. There was, therefore, interposed between the Two Books a third Book containing Principles of Interpretation of Nature. Let me illustrate its effect in biological classification.

D R A F T

*Revision of Taxonomy.*

While at the Caroline Academy in Stuttgart (1784-1788), Cuvier classified plants and animals. Initially, he used the dichotomous classification principle of Linnaeus which originated with Aristotle. It classified organisms on the basis of the presence or absence of traits. For instance, the presence or absence of a spine led to a division of animals with and without backbone. Around 1785 Cuvier became dissatisfied with this principle of classification because a group defined by the absence of a trait becomes a grab bag of all sorts of organisms. The collection of animals considered worm-like such as mollusks, crustaceans, insects, worms, echinoderms and zoophytes was such a group. Later some of its members came to be recognized as different phyla. His solution involved the argument from divine purpose. In it, his religious belief in a God who gave a purpose to each organism when it was created was transformed into

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<sup>16</sup> Cuvier, G., *Tableau élémentaire de l’histoire naturelle des animaux*. (Paris, 1798), p. 66.

the PCE. This principle excluded combinations of parts that are without purpose or that are superfluous. An animal linking two groups would have to combine parts from animals in these groups. Such parts could not serve the purpose of the existence of the intermediate animal because their purpose was the existence of the animals in which they belonged. It followed deductively that taxonomic groups must be discontinuous. Identification of the actual members of the discontinuous groups, however, occurred empirically. Comparison of many animals revealed differences and similarities. The similarities fell into discontinuous groups. In this way one of the two crucial ideas in the taxonomic revision was developed, viz., the existence of discontinuous plans for animal organization. Each plan was characterized by a law or principle of correlation of parts.

The second crucial idea, that of the ranking of traits in order of importance, was developed as follows. If organ A requires for the fulfilment of its purpose more links with other organs than organ B, then organ A is more important than organ B. Thus organs can be classified according to functional importance. Cuvier applied this so-called principle of the subordination of characters to classify animals moving from the most to the least networked characters. The result was a hierarchy of groups or taxons such as classes, orders and families. It was recognized as a reformation of zoological taxonomy.<sup>17</sup> Cuvier believed that the principle of the subordination of characters would produce a system of classification that was natural because it was based on the natural correlation of parts of organisms.<sup>18</sup> Ultimately, the single Linnaean class of the worm-

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<sup>17</sup> Whewell, W. *History of the inductive sciences*. 3 vols. Parker, J. W., ed. (London, 1847), vol. 3, p. 516-517.

<sup>18</sup> Cuvier, *Le règne animal*, vol. 1, pp. 9-10.

like animals was replaced with four taxons of equal rank including the Vertebrata, the Mollusca, the Articulata, and the Radiata.<sup>19</sup> In sum, the religious belief in divine purpose was translated into the metaphysical PCE. From this both the correlation of parts and the subordination of characters were derived<sup>20</sup> These grounded the discontinuity of body plans in his classification of animals and served as principles for the interpretation of observations.

*The unity of the Two Books.*

Cuvier's taxonomy was constituted both by the Book of Scripture (religion) and by the Book of Nature (observation). The Book of Scripture was involved indirectly as the source of a teleological perspective on nature. This combination of the two Books is characteristic for Cuvier. For one, the metaphysical PCE explained why there were discontinuous taxonomic groups, but observation determined which animals were the members of each group. Therefore, the belief in divine purpose and observation co-constituted the revised classification. For another, while in Aristotle both animate and inanimate beings combined matter and Form, Cuvier reserved this for animate beings.<sup>21</sup> Whatever the reason, the view that there is no purpose in

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<sup>19</sup> Cuvier, G. and Geoffroy Saint-Hilaire, E., 'Mémoire sur une nouvelle division des Mammifères et sur les principes qui doivent servir de base dans cette sorte de travail', *Magazin encyclopédique*, Year 1, Vol. 2 (1795): 164-190; Cuvier, *Leçons*; Cuvier, G., 'Sur un nouveau rapprochement à établir entre les classes qui composent le règne animal', *Annales Du Muséum* 19 (1812): 73-84; Cuvier, *Le règne animal*.

<sup>20</sup> 'For a good classification (...) we employ an assiduous comparison of creatures directed by the principle of the *subordination of characters*, which itself derives from the conditions of existence', Cuvier, *Le règne animal*, vol. 1, p. xvi.

<sup>21</sup> Cuvier, G., *Tableau élémentaire de l'histoire naturelle des animaux*. (Paris, 1798), pp. 4-5; See also Cuvier, *Leçons*, vol. 1, pp. 6, 9-10.

physical phenomena reveals that his natural history was influenced by a combination of experience of natural phenomena and a religious perception of them. Cuvier appears to have expected that experience and religious conception would converge on the same truth even though he never stated this.

*Metaphoric mediation between the two books.*

The unity of the two Books means that knowledge of the one is relevant for understanding the other. This is a necessary, but insufficient condition for the metaphoric transfer of knowledge between the Books. The sufficient condition is supplied by the imagination. The imagination produces the creative comparisons in which God may be alluded to in terms of conceptual beliefs about nature, and nature may be alluded to in terms of conceptual beliefs about God. In one direction, people think about God in terms of what they know about nature. If the cosmos is seen as a realm for causal processes, God is believed to act in the cosmos as a cause among other causes (the later Kepler<sup>22</sup>). If nature is believed to be essentially mathematical, God is believed to be a mathematician (Galileo). There has been a series of ‘incarnations’ of the God of Abraham, Isaac and Jacob as the God of the philosophers. Familiar metaphors include God as Designer, God as Geometer, God as Physician, God as First Cause, etc. In the reverse direction, people think about nature in terms of God. The best documented examples of scientists who thought about nature in terms of what they knew about God may be Kepler, Descartes and Newton.<sup>23</sup> For

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<sup>22</sup> Hübner, J., *Die Theologie Johannes Keplers zwischen Orthodoxie und Naturwissenschaft*, (Tübingen, 1975), p. 276.

<sup>23</sup> Hübner, J., *Die Theologie*; Barker, P. Goldstein, B. R., ‘Theological Foundations of Kepler’s Astronomy,’ in: Brooke, J. H., Osler, M. J., van der Meer, J. M., eds. *Science in*

instance, when Descartes derived the inertial law and the idea of conservation of the quantity of motion from the constancy of God<sup>24</sup>, meaning was transferred from a religious domain of knowledge to a physical one. A similar transfer of meaning occurred when Einstein saw reality as fundamentally deterministic, rejecting quantum physics because he believed that God did not play dice, or when Cuvier saw organisms as receiving their purpose from God and, therefore, incapable of possessing useless parts, and when his student Agassiz theorized that biological species do not change because they are the manifestation of divine ideas that were considered as immutable as God.

In the case of Cuvier the mediation goes both ways as well. On the one hand, there was a cognitive movement from religion to natural history. For instance, nature was interpreted in terms of Scripture which provided information based on isolated texts. The creation of the first human pair stood model for the creation of the first pairs of each species of animal. Furthermore, the Bible also provided a general teleological perspective on Nature based on the entire Scripture. The example is the argument from divine purpose which grounded the metaphysical PCE. The latter co-constituted Cuvier's natural history. On the other hand, his thought moved from what he

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*Theistic Contexts*. Osiris 16 (2001); Brooke, J. H., *Science and religion: some historical perspectives*. (Cambridge, 1991); Brooke, J. H., 'Religious Belief and the Natural Sciences: Mapping the Historical Landscape', in: van der Meer, J. M., ed. *Facets of Faith and Science*. Vol. 1. *Historiography and Modes of Interaction*, (Lanham, 1996), pp. 1-26; Dobbs, B. J. T., *The Janus Faces of Genius: The Role of Alchemy in Newton's Thought*. (Cambridge, 1991); Snobelen, S. D., "'God of Gods and Lord of Lords': The Theology of Isaac Newton's General Scholium to the *Principia*", in: Brooke, J. H., Osler, M. J., van der Meer, J. M., eds, *Science in Theistic Contexts*, Osiris 16 (2001).

<sup>24</sup>The Cartesian notion of "quantity of motion" is the product of speed (instantaneous velocity) and volume of a substance. Later, volume was replaced with mass in Newton's notion of linear momentum ( $p = m \times v$ ).

knew about nature to God. The study of nature revealed the wisdom and goodness the Creator, but it did not provide evidences for the existence of God. Natural theology was foreign to Cuvier.

Four conclusions follow. First, the cognitive effects of metaphorical analogy are not merely conceptual. The transfer of meaning between religious and scientific concepts is the result of creative ways of seeing the world involving the imagination. Such images are necessary for the transfer of meaning from concepts in the Book of Scripture to those in the Book of Nature.

Second, one can think about God in terms of what is known about nature, but one can also think about nature in terms of what is known about God. That is, the metaphoric transfer of knowledge and meaning between the two Books occurs in both directions. Third, the transfer of meaning may involve any religious belief because making creative comparisons is a natural characteristic of cognition and imagination, not of religion. All it requires is similarities between nature and a deity. Fourth, the metaphoric transfer of knowledge between the two Books is a special case of the transfer of knowledge that can occur between any two domains of knowledge as a result of the metaphoric nature of cognition. Source domains have ranged from metaphysics and religion to sociology and politics as well as other scientific disciplines. Most importantly, cultural perspectives on nature that had been inspired originally by the Book of Scripture have functioned as source domains. Thus while the imagination is a natural capacity of human beings leading to the transfer of knowledge, the specific content of the knowledge transferred depends on historical and cultural circumstances. The cognitive influences originate in the culture in which scientific explanations are embedded. Therefore, one would expect readings of the Book of Nature to be informed by the local culture. This is what we saw in the Language of Nature metaphor which appealed directly to the natural law tradition which had become an established part of Western

culture. Ultimately, however, this was an appeal to the Book of Scripture which is the source of the metaphor of God the king and legislator and of the natural law tradition. The benefit of a metaphoric theory of the engagement of religion and science is that it limits neither the content of knowledge transferred between them nor the kinds of relationships enabling the transfer. A metaphoric theory thereby meets the requirement of not imposing a universal point of view on the diversity of interactions between science and religion revealed by recent historical research.

Fifth, the metaphoric nature of cognition also explains why the need of science for cognitive scaffolding of a religious or other kind is periodic. Theories need a permanent cognitive scaffold. In times of conceptual stability it is provided by a research tradition. This tradition is the source of the ideas, of the questions and of the working hypotheses without which a theory cannot be constructed. A research tradition also determines the meaning of concepts used in the theories.<sup>25</sup> However, a research tradition may become unstable. Metaphor can transfer knowledge only when existing domains of knowledge are in need of reconstruction or unexplored domains open up. For instance, Cuvier needed new ideas when he was charting the unexplored domains of the history and organisation of organisms which resulted in the new research traditions of comparative anatomy and paleontology. These new ideas were imported metaphorically from his religion into his biology. Thus, the metaphoric nature of cognition explains why the influx of knowledge from other sources including religion is not a historical curiosity, but occurs in episodes of conceptual upheaval. The conceptual instability is over when new observations and a new research tradition have replaced religious or metaphysical scaffolds.

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<sup>25</sup> Laudan, L., *Progress and its Problems: Towards a Theory of Scientific Growth*, (Berkeley, 1977).

It is, therefore, to be expected that the disappearance of the Book of Scripture metaphor from Western culture spells the end of the Book of Nature metaphor.

Sixth, since cognition is metaphoric in nature, scientific language has a metaphoric nature as well.<sup>26</sup> That is, the transfer of knowledge and meaning at the level of cognition manifests itself in language. This linguistic counterpart is emphasised in the Two Books metaphor because it alludes to the possibility that they can be translated into each other. Cuvier translated religious language about divine power, plan, wisdom and freedom into the metaphysical language of vital force, Form, purpose and diversity, respectively. This translation or mediation between the Book of Scripture and the Book of Nature may be understood as an effect of the metaphoric nature of cognition.

In sum, the metaphoric nature of cognition explains why constitutive effects of religious and other beliefs occur in science, why they are natural and why they regain prominence periodically. Ironically, Cuvier expressed himself strongly against the use of metaphor and metaphysics by his colleagues. His failure to practice what he preached reveals the subjectivity of scientific knowledge. Cuvier was concerned with the speculative and irrational aspects of this subjectivity and feared that this might introduce into science conflicts between materialists and idealists of the magnitude he had experienced during the Revolution. Cuvier's concerns are surprisingly similar to those of practising scientists today for whom the classical objection to religious dogmatism in science has been replaced with a concern about subjective pluralism. The common concern is that a subjective plurality of beliefs, when introduced into science, will be

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<sup>26</sup> Hesse, M. B., 'The Cognitive Claims of Metaphor', *The Journal of Speculative Philosophy* 2 (1988): 1-16; Soskice, J., *Metaphor and Religious Language*, (Oxford, 1985).

the end of science as public knowledge or even as a search for truth.

*Is the ideal of a public science compatible with a constitutive role for religion?*

Cuvier was involved in building disciplines and their public nature was one of his main concerns. In Cuvier's view culture had to be shaped in the public context.<sup>27</sup> Yet he also allowed his science to be shaped by his religious beliefs and was publicly perceived to do so.<sup>28</sup> How did Cuvier envision a public science shaped by private beliefs? While he is silent on this question, his practice reveals two strategies. They are revealed by the way in which the Book of Nature metaphor was influenced by the demands both of public knowledge and of the Book of Scripture. One strategy consisted of moving the emphasis from reading the Book of Nature to learning its language. This became the Language of Nature metaphor, a move that allowed him to introduce the idea of laws of nature into natural history where they appeared as the laws governing the correlations of functions and parts. In the culture of the Enlightenment the laws of nature metaphor provided a common language that defined the pursuit of public knowledge as the pursuit of natural law. Cuvier's second strategy was to distinguish between speculative and responsible or empirical metaphysics. Responsible metaphysics was empirically testable metaphysics. The more tests it passed the more such a metaphysical principle could be considered settled as a low-level theory or explanation.<sup>29</sup> This distinction allowed him to define

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<sup>27</sup> Outram, 'Georges Cuvier: science, authority and vocation', p. 107.

<sup>28</sup> Appel, T. A., *The Cuvier-Geoffroy debate: French biology in the decades before Darwin*. (New York/Oxford, 1987), pp. 58, 140.

<sup>29</sup> This view of Cuvier is similar to that of Popper, K. R., *The Logic of Scientific Discovery*. (London, 1959), pp. 277-278.

public knowledge of nature as knowledge to which everyone could contribute private beliefs provided these beliefs were open to empirical test. Public science is a science free from speculative metaphysics. Arrival at the truth requires both the Book of Nature (observation) and the Book of Scripture (religious beliefs). Convergence of observation and religion on the same truth involved a translation of religious beliefs such as the belief that God had created each animal with a purpose into responsible, that is empirically testable, metaphysical beliefs such as the principle of the conditions of existence. Cuvier could risk exposing his responsible metaphysical beliefs to empirical test because the two Books had a single Author guaranteeing that both would lead to the same truth.

This single Authorship, however, was not enough to save the cultural good of a public knowledge. Cuvier was correct in holding that public knowledge can be suggested by private beliefs. However, the contribution of private beliefs to public science could not be justified in terms of a common Author of the Book of Nature and the Book of Scripture. The two Books had to be interpreted and this introduced the interpreter's views. That is, there were more than two Books from which knowledge could be imported metaphorically. Such sources included religions other than Christianity as well as popular science, philosophy and the social sciences. In Cuvier's days the unity of the Two Books approach was starting to crumble due to a growing awareness of religions other than Christianity including materialism and atheism. Moreover, in practice it was difficult to decide when one of the Books needed reinterpretation in light of the other.

### *Discussion and Conclusions.*

Cuvier read the Book of Nature because he believed it revealed the Author's wisdom and

power. This religious belief entered his science as the arguments from divine purpose and divine freedom. Together with observation they constituted the cognitive content of his natural history. However, Cuvier intended his biology to be public despite the role of his private beliefs. In his response to this pressure for public knowledge of nature, the Book of Nature metaphor functioned in two ways. First, by transforming the Book of Nature metaphor into the Language of Nature metaphor he appealed to a publicly accepted discourse about the laws of nature. This discourse already existed in chemistry, for instance, where Cuvier's colleagues Berthollet, Fourcroy, Guyton and Lavoisier had developed a nomenclature guided by the idea that it is a language that has to reflect the natural composition of chemical compounds.<sup>30</sup> This common discourse could be interpreted as the language of the Author of Nature, but did not have to be taken that way. Cuvier took it that way because he wanted to show the Author's wisdom in the lawful relations between the parts of an organism. Second, the Book of Nature metaphor justified the expectation that observation and religion would converge on the same truth because the two Books had the same Author. Already during Cuvier's life it was clear that this expectation would not be fulfilled due to the presence of alternative 'religions' such as idealism and materialism.

Metaphor focuses attention on some aspects of a phenomenon and ignores others. The Two Books metaphor ignores other books. Cuvier may have used a total of six books. In addition to the Book of Scripture there was the Book of Theology containing the doctrine of divine self-limitation. Mediating between these two books was a Book of Hermeneutics of Scripture present as biblicism and perspectivalism. Further, the religious belief that God had endowed each

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<sup>30</sup>Brock, W. H. *The Chemical Tree: A History of Chemistry*. (New York, London. 1992), pp. 114-116.

organism with a purpose was translated into the metaphysical PCE and the principles of the correlation and subordination of parts. That is, the Book of Scripture was translated into a Book of Hermeneutics of Nature containing the conceptual framework within which Cuvier interpreted nature. This framework included the metaphysical concepts of vital force, Form, purpose and diversity which had been translated from the religious concepts of divine power, plan, wisdom and freedom. The translation occurred by means of the arguments from divine purpose and freedom. Finally, Cuvier's understanding of the correlation of functions is reflected in the lay-out of the books in which biological classifications are presented. They are not mere dictionaries, but offer a translation of the Book of Nature. This is seen most clearly in the discontinuity between the main groups of animals, the so-called 'embranchements,' but also in the awareness that a classification presented on a two-dimensional page of a book is an inadequate representation of the multi-dimensional network "that makes up organized nature."<sup>31</sup>

The history of science is punctuated with episodes of intense dialogue between interpreters of Nature and interpreters of Scripture. The paradigm events took place when in theory Copernicus moved the earth from the centre of the planetary system and Darwin showed that humanity was misplaced at the top of the hierarchy of nature. Careful historical analysis has revealed that the Copernican and Darwinian episodes involved as many mutually entangled levels of interpretation as in the case of Cuvier.

Galileo Galilei (1564-1642) had four rather than six books even though he mentioned only the Book of Nature and the Book of Scripture explicitly. The Book of the Hermeneutics of

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<sup>31</sup> Pietsch, T. W., (Editor) *Historical Portrait of the Progress of Ichthyology, from its Origins to Our Own Time*. (Baltimore and London. 1995), p. 281.

Scripture had rules for the relationship between Copernicanism and Scripture modeled on Augustine.<sup>32</sup> For Galilei, the Scriptures were not intended to teach physical science because it contains accommodated language. Also included was the rule that Biblical interpretation must be separate from the other sciences in order to maintain the integrity of each. Further, Scripture may be reinterpreted in accordance with so-called demonstrated propositions of science because the truths in the two books are unified by a single Author. These demonstrated propositions referred to the kinds of proof required by Aristotelian standards of the day which were part of Galilei's Book of Hermeneutics of Nature. Such a book was necessary because interpretation was a feature of the study of natural phenomena.<sup>33</sup> This book also included his view that mathematical descriptions of the world are not mere instruments for calculation, but contained knowledge of the real world. Mathematics was the language of the Book of Nature:

Philosophy is written in that grand book, the universe, which stands continually open to our gaze. But it cannot be understood unless one first learns to comprehend the language and read the letters in which it is written. It is written in the language of mathematics, and the characters are triangles, circles, and other geometrical figures, without which it is not humanly possible to comprehend a

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<sup>32</sup>McMullin, E., 'Galileo on Science and Scripture'. in: Machamer, P. K. ed., *The Cambridge Companion to Galileo*. (Cambridge. London, 1998), pp. 291-299; Howell, K. J. *God's Two Books: Copernican Cosmology and Biblical Interpretation in Early Modern Science* (Notre Dame, Indiana, 2002), pp.186-196.

<sup>33</sup>Feldhay, R., *Galileo and the Church: Political Inquisition or Critical Dialogue?* (Cambridge, New York, Melbourne, Madrid. 1995), p. 282-283.

single word.<sup>34</sup>

This mathematical realism implied the potential for real conflict between the Book of Scripture and the demonstrated propositions of the Book of Nature. Another rule in the Book of the Hermeneutics of Nature was the relativity of the observer. Galilei used it to argue that while an observer on earth may not be able to see the motion of the earth directly this limitation did not apply to a celestial observer. The same rule occurs in his Book of the Hermeneutics of Scripture as the principle of accommodation which distinguished between the divine and human point of view. The mathematical realism of Galilei was underwritten by his Book of Theology according to which God had written the Book of Nature in the language of mathematics.<sup>35</sup> This involves a translation of knowledge about God as the divine mathematician into knowledge of nature as structured mathematically. Compared with Cuvier such a translation occurred only once in Galilei probably because he wanted to keep the interpretation of Scripture independent of the interpretation of Nature. The Book of Theology also affirmed God as the author of both Nature and Scripture and, thereby, of the unity of truth, a principle in the Book of the Hermeneutics of Scripture.

In the case of Galilei attitudes towards the Book of Nature clearly show the influence of differences in the cultural context between Protestant and Roman Catholic countries in Europe. In Protestant countries responses to Galilei's reading of the Book of Nature were diverse because the interpretation of Scripture was seen as an individual responsibility. In Roman Catholic

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<sup>34</sup>Galileo Galilei, *Il Saggiatore*, in *Opere*, vol. 6, p. 232, translated in Drake, S., *Discoveries and Opinions of Galileo*. (New York, 1957), p. 238.

<sup>35</sup>Howell, *God's Two Books*, p. 8.

countries, however, a unified response emerged because the interpretation of Scripture was an institutional responsibility.<sup>36</sup> Galileo needed to line up with Augustine on matters of biblical hermeneutics in order to undercut the cultural power of the Roman Catholic Church as well as the possible opposition of his audience both of which stood in the same hermeneutical tradition.

Charles Darwin (1809-1882) exemplifies a far more complex role of the Book of Nature metaphor. It was not mentioned explicitly except in a quotation from Francis Bacon (1561-1626) opposite the title page of the *Origin of Species*:

let no man [ ] think or maintain, that a man can search too far or be too well studied in the book of God's word, or in the book of God's works; divinity or philosophy; but rather let men endeavour an endless progress or proficiencie in both.<sup>37</sup>

Yet in its implicit form the Book of Nature metaphor continued to shape his thought in fundamental ways. It was the defining metaphor of the tradition of Natural Theology from which Darwin sought to take distance. But in doing so the tradition shaped the questions, the conceptual

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<sup>36</sup>Howell, *God's Two Books*, p. 182.

<sup>37</sup>Bacon, F., 'Advancement of Learning', in: *Great Books of the Western World*, vol. 30, ed., Hutchins, R. M. (Chicago. 1952), p. 4. I checked the following publications by Darwin for occurrences of the expression 'Book of Nature': Barrett, P. H., Weinshank, D. J., Gottleber, T. T., eds. *A Concordance to Darwin's Origin of Species First Edition*. (Ithaca. London, 1981); Barrett, P. H., Weinshank, D. J., Ruhlen, P., Ozminski, S. J. eds., *A Concordance to Darwin's The Descent of Man, and Selection in Relation to Sex*. (Ithaca. London, 1987); Barrett, P. H., Weinshank, D. J., Ruhlen, P., Ozminski, S. J., Berghage, B. N., eds., *A Concordance to Darwin's The Expression of the Emotions in Man and Animals*. (Ithaca. London, 1986); Darwin, C. *The Collected Papers of Charles Darwin*, Barrett, P. H. ed. (Chicago. London, 1977); Darwin, C. *Charles Darwin's Notebooks, 1836-1844*. Barrett, P. H., Gautrey, P. J., Herbert, S., Kohn, D., Smith, S. eds. (Ithaca, New York. 1987).

framework, and the patterns of argumentation of Darwin's biology.<sup>38</sup> In this negative sense the Book of Nature was overwhelmingly present in his work. This presence is an indirect manifestation of the influence of the Book of Scripture, but otherwise the latter was absent except for a few references to it as a source of information on minor ethnological issues.<sup>39</sup> Its use was undercut by his rejection of the reliability of the Bible as divine revelation which was the combined effect of his experience of different religions around the world and his negative response to Natural Theology.<sup>40</sup> Thus the Book of Nature continued to shape his world implicitly. So did the Book of Theology, particularly the doctrine of God. In his theology of creation by law Darwin revealed the assumption he shared with Natural Theology, namely that creatures reflect the attributes of their Creator. If God is directly involved in the design of animals and plants, then their adaptation must show the perfection characteristic of God. This theological inference together with the absence of perfect adaptation led Darwin to conclude that God acted indirectly through natural law rather than directly through the creation of particular organisms. Darwin came to see divine perfection in natural law rather than in the creatures governed by it.<sup>41</sup> This

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<sup>38</sup>For the structural parallels between Darwin's biology and natural theology, see Brooke, J. H. 'The Relations Between Darwin's Science and his Religion', in: Durant, J., ed. *Darwinism and Divinity: Essays on Evolution and Religious Belief*, (Oxford, 1985). For natural theology as the adversary, see Gillespie, N. C. *Charles Darwin and the Problem of Creation*. (Chicago. London, 1979), p. 68.

<sup>39</sup>Darwin, *Notebooks*, C219, D104e, M121; Barrett, *et al.*, eds., *A Concordance to Darwin's The Descent of Man, and Selection in Relation to Sex*, p. A182n.

<sup>40</sup>On Darwin's rejection of the Bible, see Gillespie, *Problem of Creation*, pp. 136-137.

<sup>41</sup>For Darwin's theology, see: Cannon, S. F. *Science in Culture; the Early Victorian Period*. (New York, 1978); Gillespie, *Problem of Creation*; Moore, J. *The Post-Darwinian Controversies*. (Cambridge. 1979); Ospovat, D. *The Development of Darwin's Theory*. (Cambridge, 1981); Cornell, J. F. 'God's Magnificent Law: the Bad Influence of Theistic

relocation of divine action was also inspired by a philosophy of science which stipulated that explanation in terms of God's will is no explanation because it does not explain in terms of physical law. Darwin's view of science was supported in part also by the theological consideration that since we know nothing of God's will, nothing can be inferred from it about the particulars of creation.<sup>42</sup> These examples do not do justice to the full complexity of entanglement among biological, epistemological and theological aspects. They suffice, however, to show that even though the Book of Nature metaphor was not explicitly mentioned it continued to shape Darwin's biology in fundamental ways. The natural law metaphor functioned explicitly as well as substantially as the tip of an iceberg signaling the presence of the Book of Nature below the surface.

The intricate role of the Book of Nature in Darwin's thought can be understood as a response to cultural circumstances in Victorian England. When the *Origin* appeared it entered a society that was already divided on questions of Bible interpretation and theology as well as on the public authority of the Church of England particularly regarding intellectual freedom. Christians including scientists, theologians and others could be found on either side of the divide. Given that context, the *Origin* was drawn into the conflict not between religion and science, but

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Metaphysics on Darwin's Estimation of Natural Selection', *Journal of the History of Biology* 20 (1987): 381-412; Richards, R. J. 'The Theological Foundations of Darwin's Theory of Evolution', in: Theerman, P. H., Parshall, K. H., eds. *Experiencing Nature*. (Dordrecht. Boston. London, 1997): 61-79. On the role of Darwin's theology in recent discussions, see: Nelson, P. 'A Sensible God: The Bearing of Theology on Evolutionary Explanation'. in: van der Meer, J. M., ed. *Facets of Faith and Science*. Vol. 3. *The Role of Beliefs in the Natural Sciences*, (Ancaster/Lanham, 1996), pp. 169-197; Nelson, P. 'The role of theology in current scientific reasoning'. *Biology and Philosophy* 11 (1996): 493-519.

<sup>42</sup>Gillespie, *Problem of Creation*, p. 68.

between religious and irreligious science.<sup>43</sup> It ended up on the side of irreligion because it was one long argument against Anglican creationism and in support of a deistic understanding of natural law. This was what Darwin wanted to avoid. His deliberate strategy in the *Origin* was to use the term creation and its cognates more than a hundred times and to avoid the term evolution.<sup>44</sup> Thus Darwin hoped to be seen as a friend of religion while keeping distance from the natural theologians by avoiding references to the Book of Nature.<sup>45</sup> This was all the more important because by far the majority of Victorian scientists were Christians and felt that religion had not hindered their scholarly freedom. Many were theologically conservative and signed the so-called ‘Declaration’ of 1864 which stated that “it is impossible for the Word of God as written in the book of Nature, and God’s Word written in Holy Scripture, to contradict one another, however much they may appear to differ.”<sup>46</sup> The quotation of Roger Bacon opposite the title page of the *Origin* had its political purposes in a society that understood the meaning of the Book of nature metaphor.

In conclusion, the Book of Nature metaphor is diagnostic for a culture that sees nature as a book written by God. The case of Darwin shows that the absence of the metaphor can be as telling as its presence. His opposition to Natural Theology and its Book of Nature stands revealed

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<sup>43</sup>Moore, *Post-Darwinian Controversies*, p. 84; Moore, J. R. ‘Charles Darwin.’ in: Ferngren, G. B. ed. *The History of Science and Religion in the Western Tradition: an Encyclopedia*. (New York. London, 2000).

<sup>44</sup>Moore, ‘Charles Darwin.’

<sup>45</sup>For instance, Darwin had to battle interpretations of say ‘natural selection’ in terms of the Book of Nature. See Gillespie, *Problem of Creation*, pp. 82-83.

<sup>46</sup>*Declaration of Students of the Natural and Physical Sciences*, deposited at Oxford in the Bodleian Library. For details, see Moore, *Post-Darwinian Controversies*, pp. 83-84.

both in the structure of his biological thought and in his terminology. But the Book of Nature has been interpreted in different ways and its absence may also mean obsolescence. This does not mean that there is no engagement of religious belief and scientific explanation or that the culture has lost its view of nature as creation. It does mean that the absence of the Book of Nature metaphor requires further analysis before any conclusions can be drawn.

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