

PETER HARRISON**The Bible and the Emergence of Modern Science¹**

The Bible played a significant role in the development of modern science. Most obviously, its contents were important because they could be read in ways that seemed either to conflict with or to confirm new scientific claims. More important, however, were changes to the way in which the Bible was interpreted during the sixteenth and seventeenth centuries. The move away from allegorical readings of Scripture and the new focus on the historical or literal sense – a development promoted by humanist scholars and Protestant reformers – contributed to the collapse of the symbolic world of the Middle Ages and paved the way for new mathematical and taxonomic readings of nature. Biblical hermeneutics was thus of profound importance for those new ways of interpreting nature that we associate with the emergence of modern science.

Keywords: allegory, ‘book of nature’, hermeneutics, literal sense, Reformation, scientific revolution.

Introduction

It has been almost fifty years since C. P. Snow (1905-80) delivered his famous Rede Lecture, entitled ‘The Two Cultures and the Scientific Revolution’. On that occasion Snow lamented a growing divide in Western culture between what he called ‘the literary intellectuals’ and ‘the scientists’. These groups, he remarked, ‘have a curiously distorted image of each other’ and are separated by a ‘gulf of mutual incomprehension’.² In support of his contention, Snow recounted the story of the convivial Oxford don, A. L. Smith, who was visiting Cambridge to dine at St Johns. Sitting at high table with the President he addressed himself to the person opposite him and got a grunt in response. Doing likewise with the person next to him, he was rewarded with another grunt. To compound his embarrassment, one of these individuals then addressed the other: ‘Do you have the faintest idea what he’s talking about?’ ‘I haven’t the least idea,’ came the reply. At which point, mercifully, the President intervened: ‘Oh, those are mathematicians! We never talk to *them*.’³

It is unnecessary to labour further the kind of distinction to which Snow

1 This article is based on a CiS – St Edmund’s College lecture given at Downing College, Cambridge, on 24 May 2005.

2 Snow, C. P. *The Two Cultures*, Cambridge: Cambridge University Press (1993), pp. 3f.

3 *ibid.*, p. 3.

helpfully drew our attention. Indeed, had he lived to witness the so-called ‘science wars’ and the ‘Sokal affair’, Snow would have been even more confirmed in his view about the polarisation of academic life in the West. Snow’s observations are directly relevant to the topic at hand, because much of my concern in this paper will be to pinpoint the historical moment that witnessed the emergence of these two characteristic types of scholar – those who deal primarily with words and texts (scholars in the humanities), and those whose main concern is with objects or things (scientists). What I shall suggest is that the distinct ways in which we now treat words and things have their origins in two closely-related revolutions that took place at the dawn of modernity: the Protestant Reformation and the scientific revolution. More specifically, I wish to examine how changing attitudes to the Bible – most importantly the way that it was interpreted, but also changing attitudes to its contents and its status as a religious authority – played a role here. My thesis, simply expressed, is that Protestant Reformers, with some help from Renaissance humanists, sponsored a new approach to the biblical text, and in so doing wrought a hermeneutical revolution that brought in its wake a new approach to natural objects. In rejecting allegory and insisting instead that the Bible, the book of God’s words, was to be read for its literal or historical sense, they inadvertently made possible a new approach to that other ‘book’, the book of nature. That new approach was essentially a scientific one. The historical origin of C. P. Snow’s ‘two cultures’ is closely related to the fortunes of the commonplace metaphor of God’s ‘two books’. Consideration of the ways in which the ‘the book of nature’ metaphor changed during the early modern period is perhaps the simplest way to understand the magnitude of the hermeneutical revolution which, I shall suggest, was initiated by the Protestant reformers. To grasp the significance of this, in turn, it is necessary to give some consideration to the history of the idea of ‘the book of nature’ and the allied practice of allegorical interpretation.

I Allegory and the Book of Nature

The idea that natural objects have meanings that can in some sense be ‘read’ like a book can be found in the Bible itself. In Genesis we are told that God placed lights in the sky to ‘serve as signs to mark seasons’ (Gen. 1:14), a passage from which it was often inferred that the heavens bore symbolic messages for its human observers. (Indeed, this passage was frequently used to provide biblical support for the practice of astrology.) St Paul had also written that ‘since the creation of the world God’s invisible qualities – his eternal power and divine nature – have been clearly seen, being understood from what has been made...’ (Rom. 1:20). Passages such as these inspired the third-century Alexandrian father Origen (c.185- c.254) to suggest that one of the very functions of the visible creation was the communication of a range of transcendental truths:

I think that He who made all things in wisdom so created all the species of visible things upon the earth, that He placed in some of them some teach-

ing and knowledge of things invisible and heavenly, whereby the human mind might mount to spiritual understanding and seek the grounds of things in heaven.⁴

The visible world, for Origen, was thus invested with symbols which, if correctly interpreted, would teach the diligent observer about God. In order to understand these, however, the reader needed to penetrate beyond the material appearances of the creatures, and discover their deeper and more profound meanings. Origen went on to suggest that the Bible, too, contained deeper messages that lay beneath the surface of the literal words. 'The Divine Scripture', he wrote, 'itself is written with wisdom of a rather similar sort.' Thus the literal account of the Exodus and the various encounters of the children of Israel with serpents, scorpions, thirst, and so on, contained hidden spiritual meanings that related to the Christian life, or to future events, or in some cases both.⁵ Origen went so far as to suggest that there were some passages of Scripture that had no literal meaning, or which, when taken literally became nonsensical.⁶ 'What man of intelligence', he famously wrote of the first chapter of Genesis, 'will believe that the first and the second and third day and the evening and the morning existed without the sun and moon and stars....'⁷ Scripture, Origen claimed, had a body, soul and spirit, which corresponded to its literal, moral and allegorical senses. The full meaning of Scripture was uncovered only when the each of these levels of meaning had been fully explored.⁸

While Origen was perhaps the most enthusiastic allegoriser amongst the Church Fathers, he was certainly not atypical in believing that both scripture and nature had deeper symbolic meanings. 'Visible things', according to Ambrose of Milan (340-397), should be regarded as a 'testimony of invisible things' and as 'an evidence of things that are not seen'.⁹ Basil the Great (329-379) wrote that the visible world was designed as 'a training place for rational souls and a school for attaining the knowledge of God, because through the visible and perceptible objects it provides guidance to the mind for the contemplation of the invisible.' It is also significant that Basil regarded the 'scientific' approach of the Greeks to be a distraction from the more edifying business of deciphering the theological and moral meanings of nature.¹⁰ It was Augustine (354-430), however, who formalised the business of allegorical interpretation, who provided it with a semiotic theory that placed it on a firm intellectual

4 Origen *The Song of Songs, Commentary and Homilies*, Lawson, R.P. (trans.), London: Longmans, Green and Co. (1957), p. 220.

5 *ibid.*, p. 223.

6 Origen *On First Principles*, Butterworth, G.W.(trans.), Gloucester, Mass.: Peter Smith (1973), IV ii 5, IV iii 4.

7 *ibid.*, IV iii 1.

8 *ibid.*, IV i 11.

9 Ambrose of Milan 'Hexameron' I iv 16, *Fathers of the Church* 42, Washington, D.C.: Catholic University of America Press (1961), pp. 15f.

10 Basil 'Hexameron' I vi; I viii; I xi, in *Saint Basil: Exegetic Homilies, Fathers of the Church* 46, Washington, D.C.: Catholic University of America Press (1963), pp. 11, 14, 19.

foundation and who ensured its tenure through the Middle Ages.

Augustine was the first person to use the expression 'book of nature' when he insisted, against the Manichaeans, that the created order was essentially good.¹¹ In the *Confessions*, in an extended exegetical reflection on Genesis, he again links reading of nature with the reading of Scripture:

You have extended over us like a skin the firmament of your Book, your harmonious discourses, by the ministry of mortals... Let the angels, your supercelestial people, praise your name. They have no need to look upon this firmament, to know through reading your word. For they always see your face, and read there without the syllables of time your eternal will. They read, they choose, they love [*Legunt, eligunt, diligent*]. They are always reading the changelessness of your counsel.¹²

But perhaps Augustine's most important contribution in this area was to formalise the relationship between words and things that was assumed in the practice of allegorical interpretation. In *De doctrina christiana* ('On Christian Doctrine'), a book that has been described as the first work of semiotics, Augustine explains that when we interpret Scripture, the literal meaning is established by connecting words with the objects to which they refer. The allegorical meaning, however, is established when the further meanings of these objects are determined. I shall provide some specific examples to show how this works in a few moments. For the present, however, we should understand that the practice of allegory rested upon the assumption that objects have referential functions; that God had invested the objects of the natural world with meanings that reinforce the message found in the book of Scripture.

This idea – the allegory is really a way of reading the meanings of objects – was subsequently endorsed by Thomas Aquinas (1225-1274), in the first part of the *Summa theologiae*: 'The author of Holy Writ is God, in whose power it is to signify His meaning, not by words only... but also by things themselves....' Aquinas continues: 'The multiplicity of these senses does not produce equivocation or any other kind of multiplicity, seeing that these senses are not multiplied because one word signifies several things, but because the things signified by the words can be themselves types of other things.'¹³ The representative power of natural objects, demanded by the logic of allegory, provided the world with its intelligibility.

Equally, this representative power of things lay at the heart of the medieval understanding of the book of nature. Hugh of St Victor (1096-1141), for example, provides us with this account of the metaphor:

11 'But had you begun with looking on the book of nature as the production of the Creator of all... you would not have been led into these impious follies and blasphemous fancies with which, in your ignorance of what evil really is, you heap all evils upon God.' *Contra Faustum Manichaeum* 32.20.

12 Augustine *Confessions*, XIII xv.

13 Aquinas, T. *Summa Theologiae*, 60 vols., Gilby T.(ed.), London: Blackfriars (1964-76), 1a 1, 10.

For the whole sensible world is like a kind of book written by the finger of God – that is, created by divine power – and each particular creature is somewhat like a figure, not invented by human decision, but instituted by the divine will to manifest the invisible things of God’s wisdom.¹⁴

While we are used to imagining a sharp division between knowledge of God derived from nature and knowledge of God derived from Scripture, this understanding of the book of nature blurred these lines to varying degrees. Thus Bonaventure (1221-1274) was to write that ‘The creature of the world is like a book in which the creative Trinity is reflected, represented, and written.’¹⁵ (The triune nature of God is typically regarded as a tenet of revealed, not natural, theology.) Considerations such as these led the fifteenth-century Spanish theologian Raymond Sebonde (fl. 1434) to pen his *Theologia naturalis seu liber creaturarum* (Natural Theology or the Book of the Creatures, 1434-6), in which it is argued that the book of nature, like God’s other book, was sufficient for salvation and communicated something of God’s triune nature.¹⁶

In sum, for the Middle Ages, the practice of allegory and the allied conception of the book of nature, made the natural world an intelligible realm that was ordered in terms of its transcendental meanings.

II Allegory in practice

Up to this point we have been considering the *theory* of a single integrated system of interpretation that linked the words of Scripture with the objects of nature. In order to understand fully how the books of Scripture and nature were ‘read’ in tandem we need to see how interpretative system worked *in practice*. Strictly speaking, allegorical interpretation was but one kind of non-literal interpretation. Over the course of the Middle Ages there had evolved a more formal division of the ‘senses’ of Scripture, which was known as the *quadriga*. In the classifications of the *quadriga*, Origen’s three senses of Scripture – ‘body, soul, and spirit’ – were extended to four. These were the literal, tropological (or moral), anagogical, and allegorical, as explained in the medieval verse:

*Littera gesta docet, quid credas allegoria,
Moralis quid agas, quid speres anagogia.*

(The letter teaches the deed, the allegory what you should believe,

14 Hugh of St Victor ‘De tribus diebus’ 4, in Migne, J.-P.(ed.), *Patrologia cursus completus, series Latina*, Paris, (1857-1912) [PL], 122, 176.814 B-C.

15 Bonaventure *Breviloquium*, II 12.

16 Sibiuda, Raymon [Sebonde, Raymond] *Theologia naturalis seu liber creaturarum*, Stegmüller, F. (ed.), Stuttgart-Bad Cannstatt: Frommann (1966), Prologus.

The moral what you should do, the anagogical what you should strive for.)¹⁷

Together, the three higher levels of interpretation were often known collectively as the 'spiritual' or 'allegorical' sense, and they were linked to the three theological virtues: the tropological (moral) sense pertained to charity, the anagogical (prophetic or eschatological) sense to hope, and the allegorical sense to faith. In order to see how this worked in practice consider the example that Dante uses, an exposition of Psalm 114:1:

The meaning of this work is not simple... for we obtain one meaning from the letter of it and another from that which the letter signifies; and the first is called the literal, but the other allegorical or mystical. And to make this matter of treatment clearer, it may be studied in the verse: 'When Israel came out of Egypt and the House of Jacob from among a strange people, Judah was his sanctuary and Israel his dominion.' For if we regard the letter alone, what is set before us is the exodus of the Children of Israel from Egypt in the days of Moses; if the allegory, our redemption wrought by Christ; if the moral sense, we are shown the conversion of the soul from the grief and wretchedness of sin to the state of grace; if the anagogical, we are shown the departure of the holy soul from the thralldom of this corruption to the liberty of eternal glory. And although these mystical meanings are called by various names, they may all be called in general allegorical, since they differ from the literal and historical.¹⁸

In theory, the literal sense was foundational, for unless the basic reference of word to thing was established, the spiritual senses could not be determined. Moreover, there was a general consensus that only the literal sense was to be used in theological disputation. In practice however, the literal sense was often buried beneath a dense accumulation of spiritual meanings. The Song of Songs, to take a pertinent example, gave considerable scope to the allegorising imaginations of exegetes and consequently was the subject of more medieval commentaries than almost any other single book.

The interpretation of nature proceeded along similar lines. The key to understanding the manifold meanings of the creatures lay in a careful comparison of their known characteristics with biblical references that mentioned them by name. At some stage between the second and fourth centuries an unknown author – probably an Alexandrian – helpfully compiled this informa-

17 de Lubac, H. *Exégèse Médiévale: Les Quatres sens de l'écriture*, 2 vols. Paris: Aubier (1959-64), I 1, pp. 23ff. For general references in Medieval literature to three- or four-fold interpretation see Guilbert of Nogent *Quo ordine sermo fieri debet* (PL 156, 25D); Hugh of St Victor *Didascalicon* V 2; 'Bonaventure de reductione artium ad theologiam' 5, in *Philosophy in the Middle Ages*, Hyman, A. & Walsh, J. (eds.), Indianapolis: Hackett (1974), pp. 424f.; Aquinas, *Summa theologiae* 1a 1, 10; 1a 113, 7; 1a2ae 102, 2.

18 'Dante to Can Grande della Scala', in Sayers, D. (ed. & trans.) *Dante, Divine Comedy, Hell*, London: Penguin (1949), pp. 14-15.

tion in a work that later became known as the *Physiologus*.¹⁹ This book was subsequently translated into all the major European languages and indeed became one of the most widely known works of the Middle Ages. The *Physiologus* is the original source of the medieval books of beasts and the birds that we now call the 'bestiaries'. Again, the best way to see how these works functioned as interpretative devices is to consider an example. Here is the account of the pelican in the Aberdeen Bestiary:

'I am like the pelican of the wilderness'(Ps. 102:6). The pelican is a bird of Egypt, living in the wilderness of the River Nile, from which it gets its name. For Egypt is known as Canopos.

It is devoted to its young. When it gives birth and the young begin to grow, they strike their parents in the face. But their parents, striking back, kill them. On the third day, however, the mother-bird, with a blow to her flank, opens up her side and lies on her young and lets her blood pour over the bodies of the dead, and so raises them from the dead.

In a mystic sense, the pelican signifies Christ; Egypt, the world. The pelican lives in solitude, as Christ alone condescended to be born of a virgin without intercourse with a man. It is solitary, because it is free from sin, as also is the life of Christ. It kills its young with its beak as preaching the word of God converts the unbelievers. It weeps ceaselessly for its young, as Christ wept with pity when he raised Lazarus. Thus after three days, it revives its young with its blood, as Christ saves us, whom he has redeemed with his own blood.

In a moral sense, we can understand by the pelican not the righteous man, but anyone who distances himself far from carnal desire. By Egypt is meant our life, shrouded in the darkness of ignorance. For *Egyptus* can be translated as 'darkness'. In Egypt, therefore, we make a wilderness (see Joel 3:19), when we are far from the preoccupations and desires of this world. Thus the righteous man creates solitude for himself in the city, when he keeps himself free from sin, as far as human frailty allows.

The pelican kills its young with its beak because the righteous man considers and rejects his sinful thoughts and deeds...²⁰

On the basis of this description, the pelican was to become an enduring symbol of Christ's atonement. It is ubiquitous in medieval iconography and literature. Thomas Aquinas refers to it in his communion hymn, *Adoro Te Devote*; Dante speaks of Christ as 'nostro pellicano', and Shakespeare's *Lear* alludes to

19 *Physiologus*, Curley, M.J. (trans.), Austin: University of Texas Press (1979). For its medieval influence, see Hicks, C. *Animals in Early Medieval Art*, Edinburgh: University of Edinburgh Press (1993), pp. 106-111. Also see Neumann, Helga, 'Tiersymbolik', *Evangelisches Kirchenlexicon*, 3rd edn., Göttingen: Vandenhoeck & Ruprecht (1996), IV, 893-897.

20 Aberdeen University Library MS 24, fos. 34v-25v. Also online at http://www.clues.abdn.ac.uk:8080/bestiary_old/alt/comment/best_toc.html

Regan and Goneril as ‘those pelican daughters’. The pelican can still be seen perched on the top of the sixteenth-century sundial in the front quad of Corpus Christi, Oxford, on the lectern of Norwich Cathedral, in the painted glass of Bourges Cathedral, above the altar of St Giles-in-the-Fields, London, to name but a few remaining symbolic habitats.²¹ For the Middle Ages the question ‘Where does the pelican fit into the scheme of things?’, was not primarily a taxonomic question, far less an ecological, or a phylogenetic enquiry. What is being asked is what the pelican signifies, and how it fits into a complex, but nonetheless coherent web of theological and moral meaning. A natural world understood primarily in these terms, it need hardly be said, is rather different from the natural world we presently inhabit.

What I hope we can now see is that the allegorical reading of Scripture went hand in hand with a symbolic reading and ordering of nature. The interpretation of the book of nature and of the book of Scripture was part of a single hermeneutical enterprise. It follows that denial of the validity of allegorical interpretation would have far reaching consequences not just for the reading of Scripture, but for a whole religious, symbolic conception of the natural order. The sixteenth century witnessed just such a denial of allegory, and in the forefront of this development were the Protestant reformers.

III Reforming the reading of Scripture

In his classic work on biblical hermeneutics in the early modern period, *The Eclipse of Biblical Narrative* (1974), Hans Frei observes that ‘the affirmation that the literal or grammatical sense is the Bible’s true sense became programmatic for the traditions of Lutheran and Calvinistic interpretation.’²² In

21 The third verse of Thomas’s hymn reads: ‘*Pie Pellicane, Jesu Domine, / Me immundum munda Tuo sanguine*’ (Loving pelican, Oh Jesus, Lord / Unclean am I but cleanse me in your blood). For the pelican in art, architecture and literature see Mâle, E. *Religious Art in France: The Twelfth Century*, Mathews, Marthiel (trans.), Princeton: Princeton University Press (1978), ch. 9; Collins, A *Symbolism of Animals and Birds represented in English Church Architecture*, London: Pitman and Sons (1913), pp. 33f.; Charbonneau-Lassay, L. *The Bestiary of Christ*, New York: Arkana (1972), pp. 8f. For references to the pelican in Dante and Shakespeare, see Paradiso, xxv, 113, *King Lear*, III, iii, 75. Thomas Browne treats the story of the pelican as a vulgar error: *Pseudodoxia Epidemica*, IV v, Robbins, R. (ed.), 2 vols., Oxford: Clarendon (1981), I, 366-369; also see the comprehensive commentary provided by Browne’s editor (II, 946-948).

22 Frei, H. *The Eclipse of Biblical Narrative*, New Haven: Yale University Press (1974), p. 37. See also Pelikan, J. *The Reformation of the Bible, the Bible of the Reformation*, New Haven: Yale University Press (1996). For more detailed account of the hermeneutics of the Reformers see Thompson, J.L. ‘Calvin as a biblical interpreter’, in McKim, D.(ed.) *Cambridge Companion to Calvin*, Cambridge: Cambridge University Press (2004), pp. 58-73; McGrath, A. ‘The intellectual origins of the European Reformation’, Oxford: Blackwell (1987), ch. 6; Muller, R.A. & Thompson, J.L.(eds.), *Biblical Interpretation in the Era of the Reformation*, Grand Rapids: Eerdmans, (1996); Kraus, J. ‘Calvin’s exegetical principles’, *Interpretation* 31 (1977), 8-18; Hendrix, S. ‘Luther against the background of the history of biblical interpretation’, *Interpretation* 37 (1983), 229-239; Parker, T. H. L. ‘Calvin’s method and interpretation’, in *Calvin’s New Testament Commentaries*, Louisville: Westminster (1993), pp. 85-108.

light of the system of medieval interpretation that we have just outlined, this would entail, of course, a rejection of allegory, and this is precisely what we find when we turn to the major reformers themselves. Luther announced in his typically colourful style that allegory was for 'weak minds' and 'idle men'. The literal sense, he insisted, is 'the highest, best, strongest, in short the whole substance nature and foundation of the Holy Scripture.' The Scriptures, in Luther's final judgment, were to be interpreted 'in their simplest meaning as far as possible'.²³ John Calvin agreed that the exegete should seek the 'historical' or 'literal' sense of the text, which he again identified with the simple meaning of the words (*simplici verborum sensu*).²⁴ Like Luther, he contrasted this approach with that of the allegorisers:

Scripture, they say, is fertile and thus bears multiple meanings... But I deny that its fertility consists in the various meanings which anyone may fasten to it at his pleasure. Let us know, then, that the true meaning of Scripture is the natural and simple one, and let us embrace and hold it resolutely. Let us not merely neglect as doubtful, but boldly set aside as deadly corruptions those pretended expositions that lead us away from the literal sense.²⁵

In making these claims, the Reformers were quite clearly attempting to rescue the text of Scripture from what, in their eyes at least, were the corrupting obfuscations of their medieval predecessors.

These assertions of the primacy of the 'literal sense' should not be understood in light of such subsequent developments as the historical critical method or the phenomenon of post nineteenth century fundamentalism. On the first point, the reformers clearly read many passages of Scripture *typologically*: Adam could be regarded as a 'type' of Christ; the Ark as a type of the Church, and so on. In this manner they still allowed that Old Testament narratives had future-oriented, prophetic references.²⁶ But they argued that such typological readings were part of the literal sense. There was a clear precedent for this view in Nicolas of Lyra (c1270-1349), who had similarly spoken of two kinds of literal sense: the literal-historical sense, which is the more or less

23 Luther, M. 'The Babylonian captivity of the church', in *Three Treatises*, Philadelphia: Fortress Press (1970), pp. 146, 241; Luther 'Answer to the hyperchristian book', in Pelikan, J. & Lehman, H. (eds.), *Luther's Works*, 55 vols., St Louis: Concordia (1955-75), 39, 177.

24 Hazlett, I. 'Calvin's Latin preface of his proposed French edition of Chrysostom's Homilies: translation and commentary', in Kirk, J. (ed.), *Humanism and Reform*, Oxford: Oxford University Press (1991), pp. 129-150.

25 Calvin, J. *The Epistle of Paul the Apostle to the Galatians, Philippians, Ephesians, and Colossians*, Parker, T. H. L. (trans.), Grand Rapids: Eerdmans (1964), pp. 84f.

26 On typology, see Korshin, P. *Typologies in England, 1650-1820*, Princeton: Princeton University Press (1982), esp. pp. 31, 68f. For examples of typological readings in England see Hill, C. *The English Bible and the Seventeenth-Century Revolution*, London: Penguin (1994), pp. 103, 109-125. See also Harrison, P. *The Bible, Protestantism and the Rise of Natural Science*, Cambridge: Cambridge University Press (1998), pp. 129-137.

straightforward meaning of the narrative, and the literal-prophetic sense, which has a future reference.²⁷ In any case, typology differs from allegory in a crucial way. Allegory assumes that God communicates through a more or less static symbolic order in *nature*; typology supposes God's self disclosure in *historical events*. The reading strategies of the reformers were thus consistent with the latter but not the former. Indeed, to a degree, the idea that Christianity was above all else a historical religion was a major emphasis of the Protestant reformers.

A second apparent departure from strict literalism was an allowance for the possibility of 'accommodation' – that God had *accommodated* his message in Scripture to the limited capacities of those who were to receive it.²⁸ Calvin, for example, wrote that when Moses had spoken in Genesis of the sun and the moon as 'two great lights', he was not asserting some philosophical truth, but was adapting his discourse to the common usage.²⁹ There was nothing particularly original about the principle, which had long been part of the practice of exegesis. What was original was the assumption that it could be applied without the official sanction of ecclesiastical authorities.

By now it should be fairly obvious what the consequences of this new hermeneutical strategy would be. To deny the legitimacy of allegory is to deny the capacity of natural objects to act as transcendental signs. And if nature can no longer be ordered on the basis of the symbolic properties of its various constituents, then it must be re-ordered in some other way. The book of nature, for its early modern interpreters, will now be understood as a book that derives its intelligibility from a mathematical or a taxonomic order, and its religious significance will be reduced to the single theological principle of design. Before looking at these dramatically revised book metaphors, it is worth giving some brief consideration both to the reasons for the Protestant insistence on the primacy of the literal sense, and to other features of the Reformation which contributed to the collapse of the symbolist mentality of the Middle Ages.

Part of the reason for the Protestants' desire to restrict the meaning of Scripture to the literal sense is surely to do with the principle *sola scriptura* – Scripture alone. Luther and Calvin both wished to argue that the Scripture was a *sufficient* source for our knowledge of God and his will. Allegory, however, actually led the reader away from the words of Scripture to the objects of nature, which were also supposed to be eloquent sources of divine knowledge.

27 See Steinmetz, D. 'Divided by a common past: the reshaping of the Christian exegetical tradition in the sixteenth century', *Journal of Medieval and Early Modern Studies* 27 (1997), 245-264; Burnett, R. 'John Calvin and the *Sensus Literalis*', *Scottish Journal of Theology* 57 (2004), 1-13.

28 See 'Akkomodation', *Historisches Wörterbuch der Philosophie*, Ritter, J. (ed.), Basel: Schwabe (1971), I; Funkenstein, A. *Theology and the Scientific Imagination*, Princeton: Princeton University Press (1986), pp. 213-221.

29 Calvin, J. *Commentary on Genesis*, King, J. (trans.), Grand Rapids: Eerdmans (1984), p. 87; cf. pp. 256f.; *Institutes of the Christian Religion*, I xiv 3, Beveridge, H. (trans.), 2 vols., London: Clarke (1953), I, 143; Luther, *Table Talk*, 119, Hazlitt, W. (trans.), London: Fount Paperbacks (1995), p. 58.

Allegory, in other words, compromised the principle that Scripture alone was a sufficient source of revealed truth, because it so closely tied the reading of Scripture to the interpretation of nature. It might also be said that allegorical interpretations related more to the intention of the reader than the original author. I am reminded here of Northrop Frye's remark about the rather opaque writings of the mystic and theosophist, Jakob Boehme. Boehme's writings, Frye wryly observed, are like a picnic where the author brings the words, and the reader brings the meaning.³⁰ It could be argued then, that inasmuch as allegorical interpretation requires much more intellectual input from the reader than does a simple literal account, authority comes to be shared between the text and the interpreter. To some degree, this situation was reflected in the physical layout of the then standard version of the Bible, the *Glossa Ordinaria*, in which the original text was surrounded by the glosses and comments of the Fathers and Doctors. In a sense the canonical text was enmeshed within a web of accumulated meanings that had been contributed by successive generations of readers over the centuries, and in such a way that it almost made no sense to distinguish between the bare text and its authoritative interpretation. It is significant that in August 1513, when as a young professor at Wittenburg Luther began to lecture on the Psalms, he had the university printer prepare a text of the Psalter from which all gloss and commentary had been removed.³¹ Later, he was to write that 'Scripture without any glosses is the sun and the whole light from which all teachers receive their light, and not vice versa.'³² From this we may conclude that the Protestant insistence that the true meaning of Scripture lay in the literal sense was closely related to the principle of *sola scriptura*, for allegory vested some religious authority in nature, and some in the interpreter.

Other Protestant reforms reinforced the demise of the symbolic conceptions of the natural order. Protestant iconoclasm, for example, evidences a deep distrust of objects purported to have significance as religious symbols. If the objects of nature came to be stripped of their symbolic associations, it is hardly surprising that human artefacts would similarly be regarded as religiously mute. Eamon Duffy writes that the iconoclasm that accompanied the English Reformation resulted in 'a stripping away of familiar and beloved observances, the destruction of a vast and resonant world of symbols'.³³ In Protestant wor-

30 Recounted in Hirsch, Jr., E. D. *Validity in Interpretation*, New Haven: Yale University Press (1967), p. 1

31 Bruns, G. *Hermeneutics Ancient and Modern*, New Haven: Yale University Press (1992), p. 139; Ebeling, G. 'Die Anfänge von Luthers Hermeneutik', *Zeitschrift für Theologie und Kirche*, 48 (1951), 162-230.

32 Luther, M. *Answer to the Hyperchristian Book*, *Luther's Works*, 39, 164.

33 Duffy, E. *The Stripping of the Altars: Traditional Religion in England, c.1400-c.1580*, New Haven: Yale University Press (1992), p. 591. Cf. Aston, M. *England's Iconoclasts*, vol. I, Oxford: Clarendon (1988), p. 16; Green, I. *The Christian's ABC: Catechisms and Catechising in England, c. 1530-1748*, Oxford: Clarendon (1996), pp. 431-437.

ship, the centre of attention was no longer the drama of the Mass, but the preaching of the word. The pews of Protestant churches would thus be typically rearranged to face the pulpit, rather than the altar.³⁴ This shift of focus from religious objects to words also effected a momentous change in religious consciousness. 'On the eve of the Reformation', writes Edward Muir, 'Eucharistic piety composed one of the great pillars of the Christian ritual system.' Yet there were increasing reservations about this central symbolic ceremonial practice, and some expressed the view that the goals of the Christian life might be better served 'by prayer and improved knowledge of the scriptures, the Word that assumed meaning through study rather than flesh through ritual'.³⁵ The Reformation represented the concrete realisation of these reservations. Protestant ideas and Protestant practices, in sum, played a key role in that profound transition in which, as Lawrence Stone describes it, 'Europe moved decisively from an image culture to a word culture.' As a consequence of this new concentration on words, most clearly exemplified in the literalist turn, natural objects were freed from their subsidiary role in the business of biblical exegesis, and became susceptible to new ordering principles. These, as by now you can guess, were provided by the nascent natural sciences.

IV Reinterpreting the Book of Nature

In *Les mots et les choses* (1966), historian Michel Foucault suggested that the seventeenth century witnessed a shift in the foundations of knowledge from an interpretative system based on resemblances or similitudes, to one based on what he calls *taxinomia* and *mathesis*. According to Foucault, the new sciences of order thus now look to classificatory schemes in the realm of natural history and mathematisation in the realm of natural philosophy.³⁶ When we view Foucault's suggestions in the light of the history of biblical exegesis, we are in a position to see that mathematics and taxonomy fill the void left by the demise of medieval allegorical readings of nature. This shift to something that looks recognisably like modern science is apparent in changes that we encounter in the book of nature metaphors of the period.

In this final section of the paper, I shall consider the approaches of four individuals – Bacon, Galileo, Boyle and Ray – in order to make the case for a quite radical shift of attitude to the natural world, a shift in which the objects of nature, now cast loose from the business of biblical interpretation, were reorganised on mathematical and taxonomic lines, and were investigated by the more intrusive techniques of experimentation.

34 White, J. F. 'From Protestant to Catholic plain style', in Finney, P. C. (ed.), *Seeing beyond the Word: Visual Arts and the Calvinist Tradition*, Grand Rapids: Eerdmans (1999), pp. 457-475.

35 Muir, E. *Ritual in Early Modern Europe*, Cambridge: Cambridge University Press (1997), p. 165.

36 Foucault, M. *The Order of Things: An Archaeology of the Human Sciences*, New York: Random House (1970), pp. 71f.

Francis Bacon (1561-1626) is generally (and rightly) regarded as a key figure in the development of the new methods of seventeenth century science. His 'book' metaphors give a fairly clear indication of the kinds of changes that we have been discussing. There are, he says, 'two books or volumes to study, if we will be secured from error; first the Scriptures, revealing the will of God, and then the creatures expressing his power; whereof the latter is a key unto the former.' Here, then, there is no overlapping of content, for the Scripture reveals God's salvific *will*, but nature reveals his *power*. From the study of nature, then, we can *infer* certain things about God – his power and his wisdom – but we do not see reflections of theological truths, and we do not see representations of the divine nature. Elsewhere, Bacon expresses it this way: the works of God 'show the omnipotency and wisdom of the maker, but not his image'.³⁷ Bacon insists that knowledge 'is first of all divided into divinity and philosophy', and he admonishes his readers not to 'unwisely mingle, or confound these learnings together'.³⁸ For Bacon, nature retains some theological significance in that it provides indirect evidence of the wisdom of the creator. But what we do not find there are representations of theological truths that parallel those found in Scripture. Neither is it the case that the study of nature is driven by biblical hermeneutics. These are now independent disciplines that are not to be confused.

Galileo (1564-1642) adopts a similar position, but goes further in specifying that the book of nature is now to be interpreted according to mathematical principles:

Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures without which it is humanly impossible to understand a single word of it.³⁹

Part of what Galileo was concerned to assert – and in this he was joined by Kepler and Descartes – was that mathematical relations were divinely instituted, and thus real.⁴⁰ Kepler wrote that geometry was 'coeternal with God' and

37 Bacon, F. *The Advancement of Learning*, Johnston, A. (ed.), Oxford: Clarendon (1974), I vi 16 (p. 42); II vi 1 (p. 86). Cf. *Novum organum* I, §89, in *The Works of Francis Bacon*, 14 vols., Spedding, J., Ellis, R.L. & Heath, D.D. (eds.), London: Longman and Co. (1857-74), IV 88. Boyle, R. 'Some motives to the love of God', in *The Works of the Honourable Robert Boyle*, 6 vols., Birch, T. (ed.), Hildesheim: Olms (1966), I, 264.

38 *ibid.*, I.i.3; II.v.1 (pp. 9f., 83).

39 Galileo 'The Assayer', in *Discoveries and Opinions*, Drake, S. (trans.), New York: Anchor Books (1957), pp. 237-238. Cf. Galileo *Dialogue concerning the Two Chief World Systems – Ptolemaic & Copernican*, Drake, S. (trans.), Berkeley: University of California Press (1962), p. 3.

40 For another argument for the link between Galileo's book of nature rhetoric and his realism, see Bagioli, M. 'Stress in the book of Nature: the supplemental logic of Galileo's realism', *Modern Language Notes (MLN)*, 118 (2003), 557-585.

that it provided the pattern 'for the furnishing of the world'.⁴¹ For Descartes, God had actually willed mathematical relations into existence, before stamping them onto the cosmos.⁴² These views were opposed to the common Aristotelian assumption that mathematics was a construction of the human mind. In the Aristotelian scheme of things, mixed-mathematical disciplines such as astronomy were granted only an instrumental status and were thus regarded as useful fictions or calculating devices that 'saved the phenomena'.⁴³ Galileo's claim thus represents an interesting reversal. Hugh of St Victor, you may recall, had stated that the system of symbolic references of natural objects, the language of nature if you will, was 'not invented by human decision, but instituted by the divine will'. Now Galileo wishes to suggest that mathematics is the divinely instituted language of nature. He left it to others to draw the obvious corollary: it was symbolic associations of the medieval world, and not mathematical relations, that were human inventions. As the Swiss biblical scholar Jean Le Clerc put it, allegory 'wholly depends upon the fancy of the interpreter'.⁴⁴

An alternative way to read the book of nature was proposed by Robert Boyle (1627-1691), one of the seventeenth century's best exponents of the 'experimental philosophy'. Boyle held the view that experimentation and dissection were the ways in which the philosopher read the book of nature. In an extended, and somewhat tortured metaphor, Boyle explains that while the meaning of nature is often quite explicit – God having accommodated it to the comprehension of its readers – sometimes more invasive methods of interpretation are called for.

... for as (such is God's condescension to human weakness) most of the texts, to whose exposition physiology is necessary, may be explicated by the knowledge of the external, or at least more easily observed qualities of the creatures; so, there are divers not to be fully understood without the assistance of more penetrating indagations of the abstrusities of nature, and the

41 Kepler, J. *The Harmony of the World*, translated and introduced by E. J. Aiton, A. M. Duncan, J. V. Field, Philadelphia: American Philosophical Society (1997), p. 146.

42 'Descartes to Mersenne, 15 April 1630', in *The Philosophical Writings of Descartes*, 3 vols., Cottingham, J. et al. (eds.) Cambridge: Cambridge University Press (1984), 3, 23; 'Objections and Replies', in *Philosophical Writings*, 2, 291-293. Kepler explicitly opposes his position to that of Aristotle. See *Harmony of the World*, p. 115; *Mysterium Cosmographicum* Duncan, A.M. (trans.), Norwalk, CT: Abarus (1999), pp. 123-125.

43 Aristotle *Metaphysics* 1025b-1026a. For Aristotle, the application of mathematics to real objects took place in the 'subordinate sciences', or in what Aquinas would later call the 'middle sciences'. Aristotle *Posterior Analytics* 78b34-79a; *Physics* 194a. See also Laird, W. R. *The Scientiae Mediae in Medieval Commentaries on Aristotle's Posterior Analytics*, Toronto: University of Toronto Press (1983). Not all scholars agree on the extent to which astronomy was conceived of instrumentally, however. The classic statement of the instrumentalist position is Duhem, P. *To Save the Phenomena: An Essay on the Idea of Physical Theory from Plato to Galileo* [1908], Chicago: University of Chicago Press (1969). For discussions see Lindberg, D. *The Beginnings of Western Science*, Chicago: University of Chicago Press (1992), p. 261; Barker, P. & Goldstein, B. 'Realism and instrumentalism in sixteenth century astronomy: a reappraisal', *Perspectives on Science* 6 (1998), 232-258 (249).

44 Le Clerc, J. *Twelve Dissertations out of Monsieur Le Clerc's Genesis*, London (1696), pp. 143f.

more unobvious properties of things, an intelligent and philosophical peruser will readily discern.⁴⁵

For Boyle, the ‘resemblance of shapes’ (Foucault’s ‘similitudes’), provided the basis for only the most superficial reading of the book of nature. What was now called for was an examination of the ‘internal contrivances of things’, which in turn necessitated ‘dissections, skilfully made’. Boyle explained to his readers that he had not only grown accustomed to the messy and manual business of dissection – as he put it, ‘tracing in those forsaken mansions, the inimitable workmanship of the omniscient Architect’ – but that he had come to enjoy it far more than the hours he spent studying books in libraries.⁴⁶ The proper interpretation of the book of nature required, for Boyle, not a mere contemplation of the appearances of things, but an active and painstaking investigation of their internal structures.

The fourth, and final example that we shall consider is the naturalist, John Ray (1627-1705), perhaps best known for his pioneering efforts in the field of taxonomy and for his classic work of natural theology, *The Wisdom of God manifested in the Works of Creation* (1691). In the Preface to his *Ornithology* (1678), a work written jointly with Francis Willughby, Ray provides a quite explicit repudiation of the older-style symbolic and moral readings of the natural world. We have omitted from this volume, he writes, ‘what we find in other Authors concerning *Homonymous* and *Synonymous* words, or the divers names of Birds, *Hieroglyphics*, *Emblems*, *Morals*, *Fables*, *Presages* or ought else appertaining to *Divinity*, *Ethics*, *Grammar*, or any sort of *Humane Learning*’. The reader is presented instead ‘only with what properly relates to their *Natural History*’. Ray does not name names. But he does not have to, because it was standard for works of natural history to provide precisely this kind of information because it was regarded as necessary for the joint hermeneutical endeavour in which Scripture and nature were interpreted together. Clergyman Edward Topsell (1572-1625) had written one of the standard works of this kind. On the title page of his *Historie of Four-Footed Beastes* he advertised the volume as being ‘necessary for all divines and students because the story of euery Beast is amplified with Narrations out of Scriptures, Fathers, Phylosophers, Physicians, and Poets: wherein are declared diuers Hyeroglyphicks, Emblems, Epigrams, and other good Histories’.⁴⁷ Ray’s assertion that a ‘proper’ natural history no longer includes these symbolic and moral associations is thus an important manifestation of a new approach to nature – one that excluded those elements that belonged to what Ray calls ‘Humane Learning’, and what we would call ‘the humanities’.

While Bacon, Galileo, Boyle, and Ray may have adopted different

45 Boyle, R. *The Usefulness of Natural Philosophy*, Works II, pp. 62-63

46 Boyle, R. *A Disquisition about the Final Causes of Natural Things*, London (1688), p. 7.

47 Topsell, E. *The Historie of Fouere-Footed Beastes*, London (1607), title page.

approaches to the natural world, what they share is a repudiation of the older idea that the study of nature is to do with the religious symbolism of its various elements. And while they clearly retain a religious vision of nature and, arguably, are prompted to study it on account of religious motivations, they nonetheless carefully distinguish the business of biblical exegesis from the study of nature. This parting of the ways, on the account that I have set out above, was owing in large measure to the new interpretative strategies introduced by the Protestant reformers.

Conclusion

In this paper I have not attempted to provide an overarching account of how the 'scientific revolution' came about. Ignoring for the moment some of the historiographical difficulties with the very notion of the scientific revolution, it must be acknowledged that a number of other factors played a role in the emergence of modern science. What I have tried to show, however, is that the gradual disintegration of the symbolist mentality of the Middle Ages – a process to which particular features of Protestantism made a major contribution – made room for alternative new accounts of the order of nature. I should add that, even as an account of the place of the Bible in the origins of modern science, I have told only part of the story. In focusing on the role played by changes in the *interpretation* of the Bible, I have completely omitted any reference to its specific *contents*. As it turns out, certain biblical narratives, now taken solely in their literal or historical sense, played a crucial role in motivating the pursuit of the sciences and in legitimating particular methods of investigation. This is particularly true of the Genesis narrative of the creation and fall, which had a major impact on the development of experimental science in seventeenth-century England.⁴⁸ It is also possible to make a further case for the substantive role played by religious ideas in promoting the idea of nature as governed by inviolable mathematical laws – laws that were identified as divine volitions. The notion that nature is directly governed by divine decree is a distinctive feature of early modern science which owes much to theological developments which cannot be discussed in detail here.⁴⁹ These developments, it must be said, were only very indirectly related to the hermeneutical revolution propagated by Protestants in the sixteenth century.

Two final remarks are in order, and they concern the difference all of this makes to our understanding of this remarkable period of history and to the

48 See Harrison, P. 'Original sin and the problem of knowledge in early modern Europe', *Journal of the History of Ideas* 63 (2002), 239-259.

49 See Henry, J. 'Metaphysics and the origins of modern science: Descartes and the importance of laws of nature', *Early Science and Medicine* 9 (2004), 73-114; Harrison, P. 'Voluntarism and early modern science', *History of Science* 40 (2002), 63-89; Padgett, A. 'The roots of the Western concept of the "laws of nature": from the Greeks to Newton', *Perspectives on Science and Christian Faith* 55 (2003), 212-221.

nature of modernity itself. First, there is a common view that biblical literalism is inimical to science. While the recent historical manifestation of fundamentalism lends this view a certain credence, and while it is undoubtedly true that some passages of Scripture, taken in their literal sense, have been used to suppress views that have subsequently been endorsed by the scientific community, I have suggested that the kind of literalist mentality characteristic of early modern Protestants gave rise to a world-view that provided a congenial environment for the flourishing of the natural sciences. In this respect, then, I join that line of historians who have advanced the admittedly risky proposition that modern science, and indeed modernity in general, is in some way deeply indebted to Protestantism.

Secondly, and following on from this point, it is also commonly assumed that science is one of the main engines of secularisation. Because scientific explanations displace religious ones, it is thought, science brings about a disenchantment of the world. On my account, something like the reverse is the case. The disenchantment of the world was effected, in large part, by the desacralising tendencies of Protestant religion. The removal of religious meaning from the natural world established the conditions that made possible the flourishing of the sciences. This brings me back to where we began, with C. P. Snow's 'two cultures'. One relatively recent attempt to address this divide is Richard Dawkins' *Unweaving the Rainbow* (2000), which tackles such questions as whether science has room for aesthetics, and whether poets and scientists can have meaningful conversations.⁵⁰ Detailed discussion of the contents of this work must await another occasion. My interest here is in the premise of the book, inspired by Keats's poem 'Lamia', in which Keats complains that science has removed the mystery and meaning from the world. Newton, by providing a scientific account of the colour spectrum had thus 'unweaved' the rainbow:

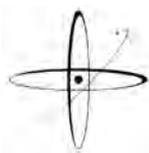
Do not all charms fly
At the mere touch of cold philosophy?
There was an awful rainbow once in heaven:
We know her woof, her texture; she is given
In the dull catalogue of common things.
Philosophy will clip an Angel's wings,
Conquer all mysteries by rule and line,
Empty the haunted air, and gnomed mine –
Unweave a rainbow, as it erewhile made
The tender-person'd Lamia melt into a shade.

What I have suggested in this paper is that the stripping of meaning and mystery from the natural world is not to be attributed to the 'touch of cold philosophy', but rather in large measure was owing to the religious Reformation

⁵⁰ Dawkins, R. *Unweaving the rainbow: Science, Delusion and the Appetite for Wonder*, London: Penguin (2000).

of the sixteenth century. Keats's complaint nonetheless leaves us with an intriguing question, to do with whether the hermeneutical revolution that took place at the dawn of modernity has been wholly desirable in all of its consequences. On the one hand, the desacralisation of nature was the precondition for the emergence of modern science. On the other hand, it arguably diminished the scope of the religious significance of nature, and possibly even provided sanction to a range of activities that have led to the exploitation and despoiling of the natural world.

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