

## Introduction

Today, we are becoming increasingly aware of the threats to Earth from space. We are conscious of the dangers of bursts of lethal cosmic radiation arising, for example, from a nearby supernova explosion, or from some other cause. We know of asteroids and comets in Earth-crossing orbits, some large enough to cause global devastation in the event of a collision, and we can see huge craters on the surface of the Earth that have resulted from past impacts. Regardless of hazards from above, we are also at risk from below: there have been several occasions during the history of the Earth when outpourings of lava on a continental scale, or the explosion of a supervolcano, must have caused worldwide havoc.

We have evidence of at least five major mass extinction episodes, when many species became extinct. It is still uncertain whether these occurred over millions of years or over a much shorter time-scale, but they nevertheless took place. Perhaps the best-known mass extinction event was that at the end of the Cretaceous Period, when the dinosaurs were amongst the victims. Relatively large amounts of iridium, which could have come only from space or the Earth's core, have been found at the Cretaceous–Tertiary boundary at sites throughout the world. This has stimulated arguments about the possible involvement of a catastrophic event, either an extraterrestrial impact or extensive volcanic activity, in these extinctions. It is even possible that both might have been involved. There is also increasing evidence that natural catastrophes, albeit on a smaller scale, have influenced the rise and fall of civilisations in more recent times. Indeed, as we shall be discussing in detail, many people are now convinced that the courses of both biological evolution and human history have been shaped by catastrophic events.

And yet, only twenty years ago, such ideas would have seemed unthinkable. As a matter of firm principle, it was believed that, ever since life had become established on Earth, all geological and environmental changes of any significance had taken place gradually. Thus, the fields of evolution and history could only be considered within that context.

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Trevor Palmer

Excerpt

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How did this gradualistic paradigm come to be so firmly established, and what brought about a re-assessment of the situation? There is a fascinating story to tell, and the aim of the first part of this book is to tell it. As we shall see, it is a saga involving honour and deceit, perception and blindness, pragmatism and dogma, careful strategies and accidental happenings. Let us start at the beginning, with the earliest written and oral traditions.

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Part I

*Catastrophism: the  
story of its decline and  
fall . . . and resurrection*

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## Section A

# From prehistory to 1899: catastrophism dominates for centuries, but then gives way to gradualism

## I Mythology, religion and catastrophism

### Ancient beliefs

In the ancient world, deities were generally believed to intervene in human history, often in a very major way. So, for example, according to the book of Genesis, in the Jewish and Christian traditions, God created the world. Then, six days later, after spending the intervening time filling it with fish, birds and land animals, he breathed life into Adam and Eve, the first man and woman. Just nine generations later, corruption had become so widespread that God brought about the Flood, when ‘the waters prevailed upon the earth an hundred and fifty days’, and ‘all the high hills, that were under the whole heaven, were covered’. However, Noah, who was an exception to the general rule of wickedness, had been given a warning about the coming deluge. That enabled his family to build a large boat, the Ark, on which to sail on the waters. In this way, they survived the Flood, supposedly the only humans to do so.<sup>1</sup>

These events were all believed to have taken place within the past six thousand years. Using genealogies and information about time-intervals taken from the Bible, James Ussher (1581–1656), the protestant archbishop of Armagh, and an authority on Semitic languages, argued in his book *Annales veteris testamenti* (‘Annals of the Old Testament’), published in 1650, that the Earth must have been created in 4004 B.C. For that he has become a figure of ridicule, but in fact he was only following a long tradition, using a well-established methodology. The Jewish calendar introduced by the Palestinian patriarch, Hillel II, in 359 A.D., and still widely used today, starts when the world supposedly began, at a date equivalent to 3761 B.C. Similarly, the Venerable Bede estimated in the eighth century of the Christian era that the Creation took place in 3952 B.C. Returning to the seventeenth century, the great polymath, Sir Isaac Newton, who included the chronology of the ancient world amongst his many areas of interest, agreed with the conclusions of Ussher. Indeed, a 4004 B.C. Creation became generally

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accepted in Britain and, for the next two centuries, dates from Ussher's chronology were often inserted in the margins of the Bible. One such date was that for the Flood, which was believed to have taken place in 2349 B.C.<sup>2</sup>

However, the legend of Noah does not stand in isolation. Indeed, it is just one of several hundred flood myths from around the world, many of which similarly involve a man and a woman escaping by boat. Amongst these is the one told in the Babylonian epic of Gilgamesh, where the hero, Uta-Napishtim, was warned by Ea, God of the Waters, about the coming deluge. Others include a Greek myth, where the survivors were Deucalion and his wife, Pyrrha, and one from the Aztecs of Mexico, where the equivalent figures were Coxcoxtli and Xochiquetzal.<sup>3</sup>

As well as legends of a catastrophic flood, there are other widespread myths where the Earth suffered near destruction by fire. According to the Aztecs, the present age (or 'sun') had been preceded by four others, each of which ended in catastrophic fashion. One of the transitions between world-ages involved (needless to say) a deluge, whereas another was brought about by fiery rain falling from the sky. Conflagrations were also a feature of the Greek tales of the battles fought by the Olympian gods against the Titans, the Giants, and the monstrous Typhoeus (or Typhon), when thunderbolts and molten rocks were hurled around as weapons. The fact that Zeus clashed with Typhoeus near Mount Vesuvius and finally trapped him under Mount Etna has suggested to some that these stories were inspired by a series of volcanic eruptions, involving an outburst of molten lava and ash from within the Earth, a process known alternatively as 'vulcanism' or 'volcanism'. These various terms were derived from the name of Vulcan, the Roman God of Fire, who was associated in legend with Vulcano, one of the Aeolian Islands off the northern coast of Sicily, between Vesuvius and Etna, and part of the same volcanically active region. Vulcano itself experienced major eruptions in 424 and 360 B.C. (and more recently in 1786 and 1888 A.D.).<sup>4</sup>

In Norse mythology, Odin and his fellow gods of Valhalla fought against the monstrous wolf Fenrir and the poisonous serpent Jormangard at the time of *Ragnarok* (or *Götterdämmerung*), when the world-order changed, accompanied by earthquakes, tidal waves, and episodes of fire and frost. Other legends where conflicts between heroic gods and evil monsters led to environmental convulsions on a massive scale include the battles involving Marduk and Tiamat in Babylonian mythology, Feridun and Zohak in stories from Persia, and Huitzilopochtli and Coyolxauhqui in Aztec tradition. Even where there were no such clashes between supernatural rivals, the human race could sometimes be threatened with mass destruction, as in the Greek myth where Phaeton tried to drive the Sun-chariot of his father, Helios, but lost control and came too close to the Earth. People were in danger of being burned alive until Zeus cast one of his thunderbolts, diverting the chariot and causing Phaeton to fall to his death.<sup>5</sup>

According to the philosopher Plato (c. 429–347 B.C.), writing in the *Timæus*, his distant ancestor Solon had been told by an Egyptian priest at Sais, in the Nile delta, that the Phaeton myth owed its origin to one of a series of cosmic disturbances which

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produced periodic catastrophes on Earth. The priest claimed, 'That story, as it is told, is in the style of a legend, but the truth of it lies in the shifting of the heavenly bodies which move around the Earth, and a destruction of many things on the Earth by fierce fire, which recurs after long intervals'.<sup>6</sup>

Naturally, we are under no compulsion to accept this as a statement of fact. According to the *Timæus* and another of Plato's works, the unfinished *Critias*, a separate and more detailed story told to Solon on the same occasion concerned the destruction of the island civilisation of Atlantis by a catastrophic flood, but this is generally regarded with considerable scepticism. Even if the two books were intended as strictly historical accounts, which is by no means certain, Plato might have been misinformed. By his own admission, Plato's source, Critias, was an old man of failing memory, who had learned the entire story at the age of ten from his ninety-year-old grandfather, whose father had been told it by Solon. Critias did, however, claim that he had some of Solon's original writings in his possession.<sup>7</sup> But even if the transmission of the story had been accurate, it might not have been so firmly based on knowledge as the Egyptian priest supposed.

How the ancient myths and legends came into being is far from clear, and the stimulus may have been quite different from one to the next. It is likely that some myths are dramas based on the replacement of one cult by another in a particular region, whereas others could be stories associated with rituals whose purpose was to induce fertility, the succession of seasons, or a hoped-for life after death.<sup>8</sup> It is also possible that some legends may, to a greater or lesser extent, have been inspired by actual happenings. It will probably never be known whether any of the specific characters mentioned in Homer's *Iliad* and *Odyssey* ever lived, or whether the events took place as described, but archaeologists such as Heinrich Schliemann, Wilhelm Dörpfeld, Sir Arthur Evans and Carl Blegan found abundant traces of pre-classical civilisations at sites located from details in these stories.<sup>9</sup> As to the flood and fire myths, they seem to indicate at the very least that ancient societies believed in the possibility of cataclysmic events, regardless of whether they themselves had actually experienced any.

In most ancient traditions, catastrophes were associated with divine displeasure. In the book of *Genesis*, as we have seen, God caused Noah's Flood because of the increasingly wicked behaviour of humankind. Shortly afterwards, the twin cities of the Dead Sea plain were destroyed for similar reasons. As related in *Genesis*, 'the Lord rained upon Sodom and upon Gomorrah brimstone and fire . . . out of Heaven', because not even ten righteous people could be found within them.<sup>10</sup> Prophecies of further punishment for evil abound. According to *Psalms* 11, 'Upon the wicked he shall rain snares, fire and brimstone, and an horrible tempest';<sup>11</sup> whilst *Malachi* warns, 'For behold, the day cometh, that shall burn as an oven; and all the proud, yea, and all that do wickedly, shall be stubble; and the day that cometh shall burn them up, saith the Lord'.<sup>12</sup>

In an Egyptian myth, the sun-god, Ra, began to lose the respect of humankind as he grew older, so he loosed his 'eye' upon the Earth, causing great slaughter.<sup>13</sup> Similarly,

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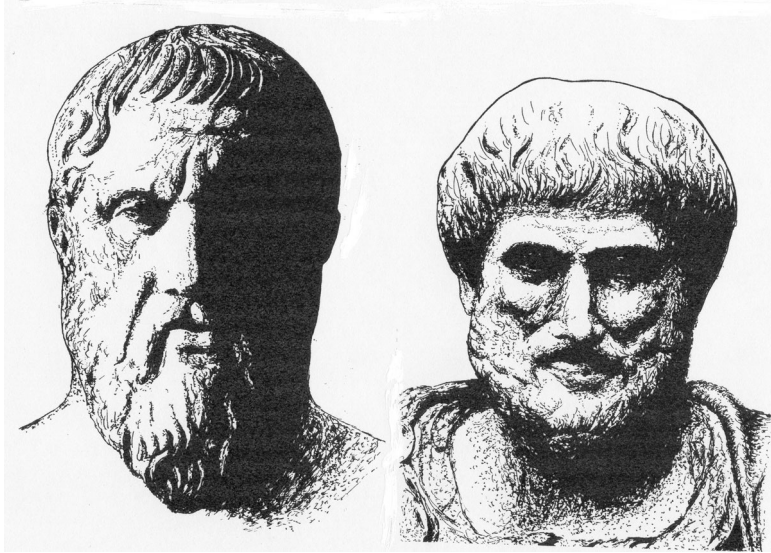
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Figure 1.1 Left: Plato, based on a bust in the Fitzwilliam Museum, Cambridge, a first century A.D. Roman copy of a bronze by Silanion, probably made during Plato's lifetime. Right: Aristotle, based on a bust in the Kunsthistorisches Museum, Vienna, a Roman copy of a Greek original dating from the fourth century B.C.

in Greek mythology, Zeus often indicated his displeasure by casting thunderbolts, as in the story of Phaeton, whilst Poseidon was inclined to cause floods or storms when annoyed. So, for example, when the Trojan king Laomedon broke a promise to him, Poseidon flooded the nearby coastal plain and, for good measure, sent a sea-monster to terrorise the people.<sup>14</sup>

Such floods had undoubtedly occurred. By the time of Aristotle (384–322 B.C.), a pupil of Plato (figure 1.1), the evidence of marine fossils in outcrops of rock made it clear that at least part of what was now land had once been covered by sea. In his *Meteorologica*, Aristotle wrote that there were periodic transpositions of land and sea, but generally those occurred too slowly and over too long a time interval for anyone to notice them happening. Nevertheless, on rare occasions a great winter could occur, bringing protracted heavy rainfall and causing devastating floods, such as that of Deucalion.<sup>15</sup> Similarly, there could be a very lengthy arid period, a great summer. The Greek word for the great winter flood, *kataklysmos*, is the origin of the modern word *cataclysm*.

Aristotle had views very different from those of his teacher Plato who, as we have seen, accepted that sudden and violent events could take place in the heavens, with serious consequences for the people below. According to Aristotle, writing in his *De Caelo*, the stars and planets occupied a series of concentric spheres and, unlike the corrupt



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Earth, which was located at the centre, the heavens were perfect and unchanging.<sup>16</sup> Comets and shooting stars, as he explained in another book, the *Meteorologica*, were purely terrestrial phenomena, caused by changes of temperature, coupled with friction between the Earth's atmosphere and the innermost sphere.<sup>17</sup>

Many of Aristotle's ideas, including his concept of a stable Universe, with the heavens segregated from the Earth, were taken up by the Christian philosopher Thomas Aquinas in the thirteenth century, and remained influential amongst scholars for many centuries afterwards.<sup>18</sup> At the same time, the Church maintained a belief that the world would come to an end in catastrophic fashion. As prophesied in the *New Testament*, 'the day of the Lord will come as a thief in the night; in which the heavens shall pass away with a great noise, and the elements shall melt with fervent heat, the earth also and the works that are therein shall be burned up'.<sup>19</sup> There was not seen to be any contradiction here: cosmic catastrophes could be brought about by the intervention of God, but not by any natural process.

The appearance of a comet in the sky was generally viewed with alarm, as it was thought to signal some coming disaster.<sup>20</sup> For example, the Venerable Bede, in his *Ecclesiastical History of the English People*, wrote, 'In the year of the incarnation of Our Lord 729, two comets appeared about the Sun, to the great terror of the beholders'.<sup>21</sup> The very word 'disaster' was derived from the Latin words 'dis' and 'astrum', together meaning 'evil star'. The disaster could be to the population as a whole, or to an important individual. So, in William Shakespeare's play *Julius Caesar*, written in 1599, Caesar's wife, Calpurnia, is concerned by unusual features in the sky, and warns her husband, on the night before his assassination, 'When beggars die there are no comets seen; The heavens themselves blaze forth the death of princes'.<sup>22</sup>

**Cosmogonists: blending belief and observation**

In the seventeenth and eighteenth centuries, various theories of the formation and development of the Earth were put forward by the so-called cosmogonists. Their interest was the origins of stars and planets, whereas the main concern of a different group, the cosmologists, was the nature of the Universe as it actually existed at the time. Posterity has consistently admired cosmologists such as Galileo Galilei (1564–1642) and Sir Isaac Newton (1642–1727), who followed the example of Nicolaus Copernicus (1473–1543) in rejecting Aristotle's geocentric Universe in favour of the modern system in which the Earth and planets orbit the Sun, according to natural laws. In contrast, for reasons we shall come to later, twentieth century geologists generally believed that the cosmogonists who lived around the same time as Galileo and Newton had been extremely poor scientists.

The cosmogonists were catastrophists, i.e. they believed that 'the history of the Earth has to be explained by events radically different from anything going on at the present day', which is the definition of catastrophism given in the *Cambridge Encyclopedia*.

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Other reference books define catastrophism as the theory that the Earth's geological features have been fashioned by 'sudden, short-lived, worldwide events' (the *McGraw-Hill Dictionary of Scientific and Technical Terms*), by 'sudden, violent and unusual events' (the *Oxford English Reference Dictionary*) or by 'infrequent violent events' (the *Chambers Dictionary of Science and Technology*).<sup>23</sup>

Whichever of these precise definitions is used, it is clear that geological catastrophism, in itself, is a perfectly rational notion, regardless of whether or not it is correct. However, it has generally been supposed that a characteristic feature of seventeenth, eighteenth and nineteenth century catastrophism was an association with supernatural forces, particularly as an explanation of the replacement of one set of fossil forms by another during the course of the Earth's history. So, for example, in 1982, the University of Guelph science historian Michael Ruse wrote of the catastrophists in his book, *Darwinism Defended*: 'They argued flatly that new species of organism, including God's final creation, man, were produced miraculously by God. God wants no nonsense about unbroken laws coming between them and his handiwork. He intervenes personally.'<sup>24</sup> Similarly, a few years later, the Oxford University zoologist Richard Dawkins claimed in his book *The Blind Watchmaker* 'Catastrophism was an eighteenth – and nineteenth – century attempt to reconcile some form of creationism with the uncomfortable facts of the fossil record'.<sup>25</sup> Again, the Johns Hopkins University palaeontologist Steven Stanley wrote in *Earth and Life Through Time*, published in 1986, that, up until the early nineteenth century, many natural scientists were catastrophists who believed that 'floods caused by supernatural forces formed most of the rocks visible at the Earth's surface'.<sup>26</sup>

As we shall see, such statements present a false picture of the catastrophists of the seventeenth to nineteenth centuries. Whilst it is true that they were unable to separate science from religion, the same was true of all their contemporaries. There seems no justification for making critical judgements on, say, cosmogonists, by the strict application of twenty-first century standards, whilst ignoring some of the strange views of cosmologists. We have to consider both groups in the context of the times in which they were living, including the fact that they were sometimes forced to adopt orthodox views (as Galileo was compelled by Pope Urban VIII to recant his belief that the Earth moved around the Sun), or risk sharing the fate of the philosopher Giordano Bruno who was burned to death as a heretic in 1600.<sup>27</sup> If cosmogonists and cosmologists are looked at together, it can be seen that they had much in common, operating within the complex intellectual climate of their day.<sup>28</sup> Even Newton, who is justly given great credit for formulating the mathematical laws of gravity, could never accept that gravitational forces were purely materialistic phenomena. Rather, he considered them to be an expression of God's will.

That comes over clearly in an exchange of letters between Newton and Richard Bentley, Chaplain to the Bishop of Worcester, following a series of sermons on the 'evidences for Christianity' preached by Bentley at St Martins-in-the-Fields, London,