Tree-Rings Indicate Global Environmental Downturns that could have been Caused by Comet Debris

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5.1 Introduction

The dates of a series of *narrowest ring events* (dates where numbers of long-lived oaks showed catastrophically narrow growth rings at the same time) have been identified in a long Irish oak tree-ring chronology (Baillie and Munro 1988). The dates were christened 'marker dates' because they were immediately noted to fall in clusters of information relating to traumatic happenings in widely separated areas around the world. For example, one of the Irish oak dates was 207 BC. In China events in 208 BC, and the years following, included a dim Sun, crop failures, famine and high death rates; and a new dynasty, the Han, is believed to have started in 206 (Pang et al. 1987). Meanwhile, in Europe, problems in Rome called for consultation of the Sibylline Books resulting in the return of the Goddess Cybele from Asia Minor; Cybele was manifest as a 'small black meteorite.' This latter occurrence made sense of a series of references by Livy to 'stones falling from the sky' and strange lights in the sky, 'prodigies of Jupiter', et cetera (Forsyth 1990). Clearly, dates around 207 BC might be expected to show up in other records.

Earlier potential marker horizons are at 2345 BC, 1628 BC and 1159 BC, all fixed in time by tree rings. However, understanding these earlier events is hampered by the poor dating control in such ancient times. This threw the spotlight on the only narrowest-ring event in the present era, that at AD 540. As more tree-ring chronologies became available it was discovered that this Irish tree-ring event was duplicated in oak chronologies across Europe. The event was there in pines from Finland (Zetterberg et al. 1994) and Sweden (Briffa et al. 1992); it was there in trees from Siberia and Mongolia (D'Arrigo et al. 2001) and from North and South America (Scuderi 1990; Boninsegna and Holmes 1985), see Figs. 5.1, 5.2 and 5.3. Thus, by the mid-1990s it was realized that, around AD 540, there was a *global* environmental downturn that had affected tree growth in widely separated regions around the world (Baillie 1994, 1995). Moreover, it was almost immediately apparent that the event was two-stage. It appears that the initial effects were in 536 and that these were followed by a second pulse somewhere in the window 538–543; thus it became sensible to refer to the '540 event' as something spanning 536–545.

Clearly, from the period around AD 540 there should have been enough historical information to define the nature of the global event – just what did people record? A preliminary excursion into history indicated that whereas conditions were very bad in China in the late 530s (Weisburd 1985), and while Justinian's attempt to re-establish the Roman Empire was going into reverse around 540, there was actually notably little

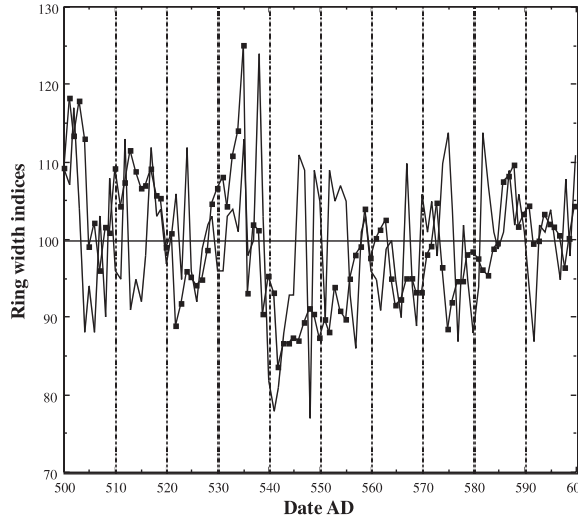

Fig. 5.1.
Plots of annual growth indices (raw ring widths normalised to values around 100) for Irish oak [*solid line*] (Baillie 1995) and Finnish pine [*black dots*] (Zetterberg et al. 1994), showing a notable simultaneous growth reduction in the early 540s

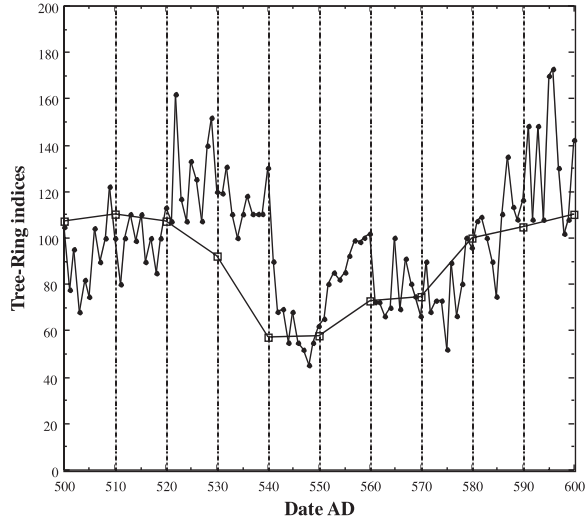

Fig. 5.2.
Plots of annual growth indices (raw ring widths normalised to values around 100) for Argentinian *Fitzroya* [*dots*] (Boninsegna and Holmes 1985), and 20-year averages of ring widths for Nevadan foxtail pine [*open squares*] (Scuderi 1990), showing the synchronous growth reduction across the 540s

information available about the years immediately around this precise date. To make it absolutely clear, according to *world* tree-rings this is the *worst* environmental downturn in the last two millennia. This made it all the more strange that the environmental event was not referred to in conventional history.

So, what can cause a global environmental downturn? Several things were known from the historical record. There was a severe 'dry fog' in 536–537, assumed by volcanologists to be the dust-veil associated with a large volcanic eruption (Stothers and Rampino 1983; Stothers 1984). There were famines in China and in the Mediterranean region in the later 530s. A major plague, named after the Emperor Justinian, broke out around 540 and arrived into Constantinople in 542, thereafter killing perhaps one third

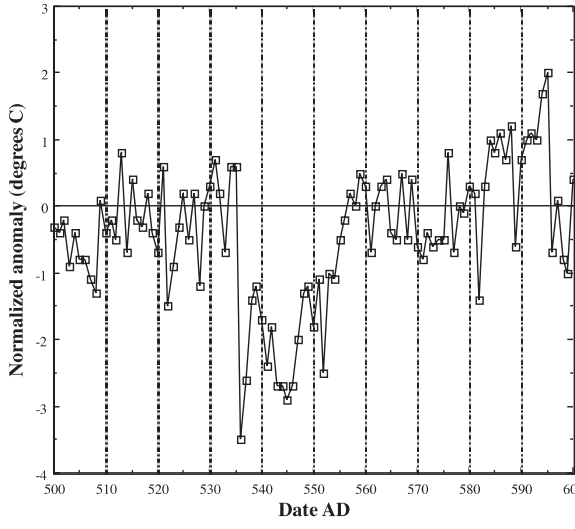

Fig. 5.3.
Average series of temperature anomalies (normalised to values around 0 °C) constructed using three Eurasian chronologies from Tornetrask (Sweden), Yamal and Taimyr (Russia). Figure re-drawn from data provided by Keith Briffa (pers. comm., 9 January 2004), see also Briffa (1999). Note the dramatic reduction in 536 and the more prolonged departure in the 540s

of Europe's population. In terms of cause, all the initial thinking, following Stothers and Rampino, involved volcanoes. Was the event the result of an exceptional volcanic eruption that produced unusual levels of atmospheric aerosol? Was there more than one large volcano involved? Here it is necessary to turn from tree-rings and history to the ice-core record from Greenland. A preliminary analysis of the ice records raised questions about linking a volcano to the event (Baillie 1994). It is now known, on the basis of three replicated ice cores (Dye3, GRIP and NGRIP), that there is no significant volcanic-acid signal in the time window 536–545 (Clausen et al. 1997). The latest statement states specifically:

> With the chemistry and the isotope data it is possible to do a very precise dating for the eruption. The volcanic eruption is dated to AD 527 ± 1 year. The AD 527 volcanic eruption is the only eruption in the period (Larsen et al. 2002).

The authors go on to say that this volcano is the only likely candidate to have caused the 536–545 global event, but that the dating 'suggest(s) that the event is not the same one described by other sources' (Larsen et al. 2002). There are two ways to deal with this observation. One option is to disregard the dating by the ice-core workers and simply assume that 527 ± 1 really *means* 536 or 540 – there are currently no compelling arguments for moving the date derived from three replicated ice-cores in this manner. The other is to make the more logical jump, namely that the global environmental downturn was not volcanic in origin, but rather was caused by loading of the atmosphere from another source, presumably from space. Such a suggestion immediately reduces to the idea that around 536–545 we most probably had a brush with a comet or its debris. This is the logical step that this author made after 1994. Instead of asking the historical record what happened around 540 – a question that produces almost no answer – the question was re-worded as 'we suspect that the Earth had a brush with a comet – what do the records say'? Let us look at what the records do say and be prepared to 'read between the lines' of the only relevant historical records.

5.2 The Historical Record

It transpires that the historical record is un-naturally thin around 540. For example, in Britain there is only one writer believed to be contemporary, Gildas. Morris, in the foreword to the 1978 edition, says "Gildas wrote his main work, the 'Ruin of Britain', about 540 AD or just before…" (Winterbotham 1978). Note that trees suggest a world-wide environmental downturn just at this date, and the *only* known British text is entitled the 'Ruin of Britain.' Gildas' writings are, moreover, essentially apocalyptic.

In the Mediterranean area there is a strange pattern. One major writer, Cassiodorus, stops writing in 538 (Barnish 1992). Another, Malalas, produces a record so thin as to be useless across the relevant period (Jeffreys et al. 1986). Zachariah of Mythilene, whose 12 volume history, compiled in the sixth century, originally covered the 460s to 560s, is complete only to the end of volume nine which *ends* in AD 536 (Hamilton and Brooks 1899). Of significance for this article, Zachariah's key volume 10 is missing and much of the rest is fragmentary. Procopius, who is a major source for the Justinian period does mention the sun being dim in 536, and the major plague, but provides no really useful record of any 'global' event. It is fair to say that there is little in the mainstream historical record that would have led anyone to believe, *pre tree-rings*, that there had been a global environmental event around 540; however, there are historical hints.

Cassiodorus in one of his last letters – that describes the dry-fog, or dim-sun, event of 536–537 – does make a note that people may be worried about "what is coming on us from the stars." Gibbon (1832) mentions a "great comet" in 539 that caused worry of calamitous things to come, and whose "prognostications were abundantly fulfilled". The medieval historian, Roger of Wendover, writing in the thirteenth century, makes the following statement concerning 540/541:

> 540 Battles in the Air
> The reference is probably to aurorae seen in France [Britton's suggestion]. Roger of Wendover has an account of this: In the year of grace 541, there appeared a comet in Gaul, so vast that the whole sky seemed on fire. In the same year there dropped real blood from the clouds … and a dreadful mortality ensued … (Britton 1937).

Britton did not know that there was a global environmental event around 540, so, in keeping with the prevailing paradigm that there is no threat from space, he interpreted this statement as the probable appearance of an aurora. We now know about the 536–545 global tree-ring event, *and* the dry-fog references, *and* the plague. Wendover's record would therefore appear to be accurate; especially as the ice-core evidence now suggests that the event did not involve a volcano. This Wendover statement, in keeping with most early isolated references has been dismissed elsewhere as "These entries are almost certainly purely fictional" (James 1999) telling us that we cannot expect historians to do much "reading between the lines." However, there is another ancient record from Britain apparently relating to this period. In AD 542, according to Hector Boetius:

> The sun appeared about noondays, all wholly of a bloody colour. The element appeared full of bright stars to every man's sight, continually, for the space of two days together (Chatfield 2002).

This seems to fit well with the other available comments. Returning to Gildas, writing around 540, he uses passages from the Bible to illustrate what may happen to contemporary sinners, effectively making a collage of quotations all of an apocalyptic nature. Here is an example:

> Behold, the day of the Lord shall come … to make a wilderness of the land … the brilliant stars in the sky shall cease to spread their light, and the sun shall be shadowed at its rising … The moon will grow red, the sun will be confounded … (Winterbotham 1978; 44:1).

Gildas seems to be drawing together references that relate to a dust veil that affects the light of the Sun, the Moon, and the stars, and which in turn produces a "wilderness". This seems to be a purposeful use of biblical quotation to describe something affecting Britain that we already know had affected the Mediterranean in 536–537. Overall, these British sources appear to confirm the idea of a dust-veil, with material dropping from the sky, a dim Sun and a plague, combined with a close comet. It could be asked why Gildas does not mention a comet overtly? The answer may be that the word *comet* does not appear in the Bible and hence no relevant quotation was available. Gildas does however make an interesting statement based on an early version of the Book of Zechariah:

> And the angel said to me: What do you see? I replied: I see a flying sickle, twenty cubits long. It is a curse that goes over the face of the whole land … and I shall cast it forth, says the almighty Lord … (Winterbotham 1978; 57:2).

By the seventeenth century the King James Bible version of this text says "Then I turned, and lifted up mine eyes, and looked, and behold, a flying roll…" (Old Testament, Zechariah 5,1) rendering it essentially incomprehensible. Historically, of course, comets with their curved tails are often described as *sickles*; the later translation as *roll* appears to have no meaning at all. So although Gildas did not mention a comet directly, he came as close as was possible using biblical quotes. His selection of quotations also included "When the overflowing scourge passes over" (Winterbotham 1978; 79:1) and assorted allusions to "fire from heaven," "famine" and "the land will be scattered and laid waste".

Everett (2001), who went through Gildas' apocalyptic choices in detail, points out a pattern wherein Gildas uses these Old Testament quotations but makes them contemporary.

> Gildas continues ad nauseam to hammer home his apocalyptic message, and it could only have carried conviction if his contemporaries had had some sort of apocalyptic experience (Everett 2001).

For example here is Gildas making a "telling aside"

> After a while he [Isaiah] discusses the day of judgment and the unspeakable fear of sinners: 'Howl! The day of the Lord is near' (and if it was near then, what are we to suppose today?) 'for destruction is on the way from the Lord.' (Winterbotham 1978; 44:1; Everett 2001).

The comment in brackets is one of several where Gildas relates his quotations to contemporary sixth century happenings that would be recognisable to his readers. Again, here is Everett making such a point:

> Gildas refers to the immoral actions of Constantine as 'poisoned showers of rain' (28:4), a curious phrase to use unless the population had recently experienced such a downpour. He (also) urges Aurelius Caninus to shake himself 'free of your stinking dusts' (30:3) (Everett 2001).

Given Gibbon's strange reference:

> Such was the universal corruption of the air, that the pestilence which burst forth in the fifteenth year of Justinian [AD542] was not checked or alleviated by any difference of the seasons … but it was not until the end of a calamitous period of fifty-two years that mankind recovered their health, or the air resumed its pure and salubrious quality (Gibbon 1832).

We can see that Gildas' remarks appear to be part of a pattern. Taken all together, these scattered pieces of information raise the specter that the air around the globe was somehow corrupted in the immediate vicinity of AD 540. What is particularly interesting is that Gibbon's text actually reinforces the assertion: there was "universal corruption of the air," and later "the air resumed its pure and salubrious quality." This is hardly a slip of the pen; Gibbon seems to have been quite confident that the air was "corrupted." Moreover, Gibbon could not have known that the time period he chose to specify corresponds very closely to the "Maya Hiatus" of AD 534–593 (Robichaux 2000). Is this just a coincidence?

5.3 Mythology

Obviously scientists should not involve themselves with myth, unless there is a good reason to do so. However, the irony is that, in its own way, myth seems to contain a better description of what happened around 540 – and its causes – than any history book. There is not space here to go into myth in detail. The salient facts have been published elsewhere (Baillie 1999, 2002; McCafferty and Baillie 2005). What follows is a précis of a complex story.

In Britain King Arthur, probably the most famous Briton of the first Millennium, is said to have died around 540 (variously 537, 539 or 542). He is, without doubt, a Celtic god (scholars have known this for a long time but it is ignored by those who wish Arthur to be a flesh and blood hero). Arthur is cognate with a range of Celtic deities that include Cúchulainn, Mongan and Lugh. Of interest is the fact that Lugh is described in one text as "coming up in the west, as bright as the sun, with a long arm", he is also known for his "terrible blows" (Loomis 1927). As these descriptive elements only befit a comet (what else can be as bright as the Sun, can come up in the west, has a long arm and can deliver terrible blows?), myth is telling us that a 'comet god' died at the time of a global environmental disaster. Another major aspect of Arthurian romance is the "Wasteland" wherein three kingdoms are destroyed. In the stories, this destruction was caused by a "Dolorous Blow" that was delivered by Balin with a bleeding spear. Scholars have traced this Arthurian bleeding spear back to Lugh's spear (Christianized to the spear of Longinus) (Loomis 1927). Thus, mythology, by linking the death of Arthur to the period immediately around 540, tells us what conventional history does not, i.e. *a comet god caused a wasteland around 540*. To repeat, Arthur is cognate with Lugh who

is described as a comet, and it is Lugh's spear that causes the Wasteland in Arthurian romance.

I can imagine readers not familiar with such literature saying things like "he lost me when he jumped from King Arthur to Lugh; Arthur might have been around 540 but there is no evidence that Lugh was". It may concentrate the mind, therefore, to know that a document, *Vita s. Mochtaei De Hibernia*, relates to AD 535. Its content is described as follows:

> Mochteus; or Mochta Lugh, a Briton, is said to have been a disciple of St. Patrick, and became the first Bishop of Louth. He died in 535. The piece is, to a great extent, quite fabulous (Hardy 1862, p 117)

Now, Mochta in Old Irish means *great* or *mighty*. So, Mochta Lugh could, at its most simple, mean 'Great Lugh'. An entry to the same effect occurs in the Annals of Ulster and recent scholarship suggests that this basic statement about his death was written before 700 (Sharpe 1990). Sharpe also points out the exceptional nature of the quotation about Mochteus (Mauchteus or Mochta Lugh) in the Annals

> … the quotation from a document … to no annalistic purpose is without parallel in the Annals of Ulster (Sharpe 1990, p 88)

So the compiler of the Annals, sometime before 700, takes an unparalleled step in introducing a reference that could be to Lugh, with a date in the 530s. It might be quite reasonable to interpret this as another metaphor especially as County Louth is named after Lugh, thus, the first Bishop of Louth could also be a cryptic reference to Lugh. As we will see later, there are other uses of metaphor in the period around 540, including another link to Lugh.

Of necessity this is an extreme compression of an enormous amount of information. The simplest way to show that this Arthur/Lugh/540 idea has some substance is to show that there is another version of the myth that tells essentially the same story. Another deity cognate with Lugh is Mongan; in the stories he is Lugh's 'son' or more strictly Lugh's 're-birth', i.e. Lugh back again (MacKillop 1998). In the story *Mongan's Frenzy* (Stephens 1920) we read how Mongan is at a week-long festival at the Navel of Ireland in the year 538. Suddenly the skies go dark, with clouds coming from both east and west, and there is a horrendous shower of hail stones. In order to get away from this unusual phenomenon Mongan has to enter the Otherworld. Therefore, mythology not only tells us that one version of a comet god, Arthur, 'dies' around 540, but another aspect of the same deity 'goes to the Otherworld' at the same time associated with a darkened sky and an unusual hail-storm. Given the belief that Arthur did not die, but actually went to the Otherworld – Avalon – the similarities between the stories is striking. Both come with long-attributed dating within the environmental (tree-ring) window 536–545, and, if we imagine that the Otherworld is in all probability the sky, then both stories have the god going away into the sky to eventually return. Thus myth, when considered with the arguable 'comet' paradigm can be made to make sense where no viable interpretation existed before. The critical point is the placing of these sky-god myths in time, *precisely* at a global environmental downturn defined by dendrochronology.

5.4 What Actually Happened – the Global Consequences?

Let us, for the sake of argument, accept that the cause of the global environmental downturn in the window 536–545 (and running on even later if we accept Gibbon's comments) was a brush, or brushes, with a comet or its debris. We already know that the consequences were reduced tree-growth around the world and widespread famines implying reduced cereal production; should we be imagining reduced plant growth generally? We know that there was a serious plague after 540. We have hints that the primary vector – the cause of the dim-Sun condition – was dust loading of the atmosphere, through some combination of dust, gas and in all probability Tunguska-class impactors. We have direct written testimony that there was the 'dry fog' in 536–37. We also have Zachariah telling us that the "stars were dancing" from 533 to 540 (Hamilton and Brooks 1899); something that might imply atmospheric disturbance. As noted, we have Cassiodorus telling us that "something is coming on us from the stars" (Barnish 1992).

All of this must raise some concern about the plague at the time of Justinian. It has long been assumed that the Plague of Justinian was bubonic plague. But was it? The descriptions of the phenomenon reaching the British Isles in the 540s do not sound much like bubonic plague. There is the Yellow Plague recorded in Wales (Senior 1979), and there is a plague simply called 'Blefed' in Ireland (O'Donovan 1848); neither of these descriptions argue persuasively for the disease having been bubonic plague. Then we have Gibbon's comment about the "universal corruption of the air." Given the allusions to material – dust and showers (variously of stones and blood) – falling from the sky in the period immediately around 540, it has to be asked whether the plague might have included some sort of atmospheric pollution in addition to bubonic plague. We are at liberty to imagine that one of the two most widespread and severe 'plagues' of the last two millennia might have more than a single killing vector – why not bubonic plague and corrupted atmosphere? I want to look a bit further at this aspect of the devastation in the sixth century.

5.5 The Dust and Corrupted Air

There is another source that bears on this issue. Zachariah, the later volumes of whose history are largely missing, at least preserves Book 12, Chapter 5 (Hamilton and Brooks 1899). This section is entitled *The fifth chapter treats of the powder, consisting of ashes, which fell from heaven,* and dates to 556. In this bizarrely entitled chapter Zachariah tells us that:

> In addition to all the evil and fearful things described above and recorded below [mostly lost!], the earthquakes and famines and wars in divers places … there has also been fulfilled against us and against this last generation the curse of Moses in Deuteronomy … (Hamilton and Brooks 1899).

For someone writing in 556, "the last generation" would include those who had lived through the 536–545 events. So, the things that had been fulfilled against those who had lived across 540 could be identified in the writer's mind with Moses' curse

from soon after the Exodus. Might the curses in Deuteronomy give us a clue as to what may have been fulfilled against that past generation. What do they include? The key items are that you shall be cursed in the city and in the field and in your store.

> Cursed shall be the fruit of thy body and the fruit of thy land … The Lord shall make the pestilence cleave onto thee…The Lord shall smite thee with a consumption and with a fever, and with an inflammation, and with an extreme burning, and with the sword (or drought), and with blasting, and with mildew … The Lord shall make the rain of your land powder and dust: from heaven shall it come down upon thee … The Lord will smite you with the botch of Egypt, and with the emerods, and with the scab, and with the itch, whereof thou canst not be healed. The Lord shall smite you with madness, and blindness, and astonishment of heart: And you shall grope at noon-days as the blind gropeth in darkness. (Old Testament, Deuteronomy 28,18–28)

Here we see another contemporary writer, like Gildas (but almost certainly independent of Gildas), indulging in biblical metaphor to try to describe the happenings around 540. Again, it would seem that Zachariah is being quite accurate in his choice of metaphor; he is essentially using the Plagues of Egypt as an analogy. He is suggesting darkness at mid-day, dust from heaven, famine and pestilence, and he is talking *specifically* about the period around AD 540. While in this same time window, 536–545, we have historical evidence for a dry fog that renders the Sun dim, for famine, and for plague. A nice twist in Zachariah's metaphor is that there is one last key element in Moses' curse, as follows:

> … and the stranger that shall come from a far land, shall say, when they see the plagues of that land, and the sickness which the Lord has laid upon it; And that the whole land thereof is brimstone, and salt, and burning, that it is not sown, nor beareth, nor any grass groweth therein, like the overthrow of Sodom and Gomorrah, Admah and Zeboim, which the Lord overthrew in his anger and in his wrath. (Old Testament, Deuteronomy 29,22–23)

By using the Curse of Moses to describe the happenings around 540, Zachariah is incorporating Sodom and Gomorrah into the description, and, of course, those cities were destroyed by "brimstone and fire from the Lord out of heaven" (Old Testament; Genesis 19,24). So, Zachariah's choice of metaphor – with fire and brimstone, darkness at mid-day, famine and pestilence – would seem to be confirming the 540 scenario given by Gildas and Roger of Wendover.

It is apparent that there is a sub-text here. Gildas did not spell out what was happening around 540, nor did Zachariah; both used Old Testament extracts as metaphor. This is interesting in itself, and may well give rise to a whole field of study. But once sensitized to this concept, it seemed relevant to look for other examples. It turns out there is yet another, again in the Irish Annals, bearing the date 539. Here is the entry:

> The Age of Christ, 539. The decapitation of Abacuc at the fair of Tailltin [Teltown], through the miracles of God and Ciaran; that is, a false oath he took upon the hand of Ciaran, so that a gangrene took him in his neck (i.e. St. Ciaran put his hand upon his neck), so that it cut off his head (O'Donovan 1848).

In a sense it doesn't matter what the entry itself says (it reads at first sight like medieval gobbledegook). The important point is that Abacuc is not an Irish name, but here is someone called Abacuc being killed at *Lugh's Fair* at Tailltin in 539 (it was Lugh who traditionally founded the fair at Teltown).

Who, then, is Abacuc? The answer is that he is Habakkuk of the Old Testament. Hence, what the 'complier' of the Annals was doing by saying that Abacuc lost his head in 539 is that, embedded in Chapter 3 of the Book of Habakkuk is what we need to know. (It is in Chapter 3 that Habakkuk mentions 'Thou smotest down the head in the house of the ungodly, and discovered the foundations, even onto the neck of him.') In this case, again, we have an anonymous monk using Old Testament metaphor to describe what was going on around 540. So what does Habakkuk, Chapter 3 tell us? It includes:

> Before him went the pestilence and burning coals (or burning diseases): he … drove asunder the nations; and the everlasting mountains were scattered … The sun and moon stood still in their habitation … the fields shall yield no meat … and there shall be no herd in the stalls (Old Testament, Habakkuk 3:5–17)

Again this seems like a consistent description of what was going on around 540, with pestilence and burning coals from the sky and famine on the ground. In this case, the writer also provides the strong secondary link to Lugh's Fair – the Festival of the comet god Lugh. However, the links do not end there. In Habakkuk 3, the entity causing the havoc is described as: '… *his* brightness was as the light; he had horns *coming* out of his hand;' It is widely accepted that an alternative to the 'horns coming out of his hand' is 'bright beams out of his side' (Old Testament, Habakkuk 3,4). Given that consideration is being given here to a possible brush with a comet, around 540, how strange that an Irish monk would use an Old Testament metaphor for the happenings at 539 that could be interpreted as a description of some aspect of the dust/gas/ion tail(s) of a comet.

5.6 The Scientific Prior Hypothesis

On the basis of this accumulated evidence, and in the absence of any evidence for a volcano, it now seems reasonable to suggest that around AD 540 – in the window 536–545 – Earth had a brush with a close comet that dumped material into the atmosphere and caused a global environmental downturn. We have the scenario deduced scientifically from dendrochronology and ice-core work. We have several British and Irish recorders telling us essentially the same story, and we have an independent Mediterranean source repeating the same catastrophic elements – all with pre-existing dates.

But there is a scientific surprise. It turns out that there is a pre-existing scientific hypothesis, dating from the 1980s, wherein Clube and Napier (1990) elaborate their 'cosmic swarm' scenario. In this scenario, in a short period of months to years the Earth encounters a range of comet debris. The essential point is that Clube and Napier estimate, because of the more active sky, that running into a 'cosmic swarm' of small objects may have been likely and they make the following statement:

> Overall, it seems likely that during a period of a few thousand years, there is an expectation of an impact, possibly occurring as part of a swarm of material, sufficiently powerful to plunge us into a Dark Age.

Indeed they were even more specific:

> If large boulders do form in swarms, then during close encounters with the comet or its degassed remnant there is a risk of occasional bombardment on a scale comparable with that of a nuclear war…The occurrence of Tunguska-like swarms in recorded history is therefore expected … Thus we expect a Dark Age within the last two thousand years.

They reviewed the evidence and, in collaboration with Mark Bailey, went on to suggest:

> … it seems probable that the least biased measure of relative meteor activity during the Dark Age is now provided by the recorded incidence of meteor showers … There have probably been at least two significant surges in meteor shower activity [in the last two millennia], namely 400–600AD and 800–1000AD (Bailey et al. 1990).

Thus, scientists are confronted with the scientific case, from tree rings and ice cores, for a brush with a comet around 540. They are confronted with several independent suggestions, from history and mythology, that such a thing *did take place* around 540. Now it seems that there was even a prior hypothesis that a closely-related event involving comet debris might have occurred in the time window AD 400–600.

5.7 The AD 540 Symptoms

Tree-ring chronologies from around the world show that we had a global environmental event, involving reduced growth, in the time window 536–545. Mainstream history does not record the event in any thorough way. However, accumulation of marginal references, annals and mythology indicates that the events are recorded quite widely in non-conventional ways. These records hint strongly that a comet god was involved.

Given that the environmental event, coupled with plague, directly or indirectly killed one third of the population of Europe (there are reasons to assume that the rest of the world may have suffered similarly) it is surprising that the whole issue does not have a more conspicuous place in history. However, from the non-conventional records we see a consistent pattern of references that the atmosphere may have been corrupted – a situation stated by Gibbon but normally ignored for lack of context or corroboration. So, for the purpose of this discussion I am going to suggest that in the mid-sixth century the Earth's atmosphere may have been loaded with cosmic material to a level that was harmful to humans. Moreover, if this dust were indeed debris from a comet we could reasonably expect that it might include a volatile fraction, particularly an organic component.

With that in mind, and given the preceding interpretation of the use of biblical metaphor in the sixth century, Hoyle and Wickramasinghe make the following statement:

> By about the sixth centuryAD, Christian beliefs included the dogma that nothing that happens in the heavens could have any conceivable effect on the Earth (1993; 2–3).

Perhaps this is the reason why early medieval churchmen felt that they could only express themselves metaphorically; to talk about goings on in the sky overtly would have been to go against Church dogma. It would appear, however, that some felt sufficiently motivated by events to circumvent the dogma and to leave clues for anyone who, for whatever reason, might recognize the significance of the biblical quotations. Thus, when our interpretation of the tree-ring data indicated a sixth-century, global,

environmental event, and the ice cores indicated, by default, that it might have been extraterrestrial in origin, the metaphors finally make sense.

We can now reasonably re-ask the question prompted by Gibbon, Zacharaih, Gildas, Roger of Wendover and Cassiodorus – was the atmosphere compromized by extraterrestrial pathogens, 'dust' of some sort in the mid-sixth century? The answer is that people writing at the time seem to have been trying to tell us that it was so corrupted.

However, we have access to records they could not have dreamed of. If we go to the Greenland ice cores and look at the ammonium record (Fuhrer et al. 1993) we find that the two highest values in the last two millennia are 46 ppb and 35 ppb ammonium at depths of 238 and 336 meters respectively. These depths correspond to calendar years at or close to AD 1014 and AD539 (see Fig. 5.4). So, an unusual ammonium layer in the GRIP ice core coincides with records of a corrupted atmosphere.

Obviously, given the thrust of this discussion, this is a quite remarkable observation. However, from the point of view of the reliability of some of these ancient records it is hard to improve on the 1014 ammonium signal. If we go to Britton's (1937) meteorological compilation we find the following:

> 1014
> Short refers to a remarkable calamity in this year. He says 'a heap of cloud fell and smothered thousands'. He adduces the Anglo-Saxon Chronicle as authority for this phenomenon, a work in which there is certainly no mention of it. It might conceivably be a poetic distortion for a heavy rainstorm in which many people were drowned (Britton 1937, p 39).

We now have evidence that this reference to a smothering heap of cloud coincides with the largest atmospheric concentration of ammonium in this era (Fuhrer et al. 1996). This raises the question as to the source of such unusual – once in a thousand years – concentrations of ammonium. Conventional wisdom *suggests* that ammonium may be attributable to forest fires (Legrand et al. 1992), however, the authors of that paper display their uncertainty by the insertion of a question mark in the title. Am-

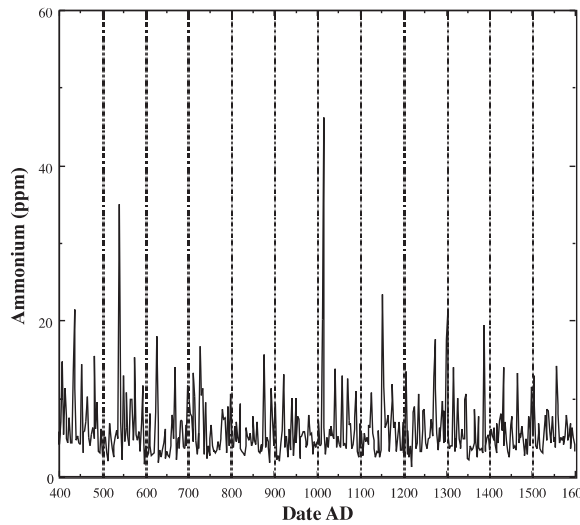

Fig. 5.4.
The ammonium record from AD 400 to 1600 derived from the Greenland GRIP ice core (Furher et al. 1993) [Data provided by the National Snow and Ice Data Center, University of Colorado at Boulder, and the WDC-A for Paleoclimatology, National Geophysical Data Center, Boulder, Colorado]

monium could also come from ocean-bed clathrates, for example, and it is surmised to occur in comets (Sagan and Druyan 1997). What makes 1014 particularly interesting is that it is listed by Sekanina and Yeomans (1984) as a year when a comet made a relatively close approach of the Earth. Thus, the two highest ammonium spikes in the last two millennia both have some comet association.

With respect to the 540 event, we can also ask – how long did its effects endure? The answer in this case is that we don't know, but Gibbon's corrupted air, when combined with the duration of the Maya Hiatus suggests that it could have been prolonged. In Fig. 5.5 we see a notable depression in the envelope of Irish oak growth that lasts from 540 to 590. Could this be a symptom?

The trouble is that more and more pieces of information can be added to this story. Once we accept the duration of corrupted air in the sixth century we find that there is another relevant Irish story. The story involves a sea monster called the Rosault. It washes up on the Atlantic coast in the mid-sixth century. The dating is determined by the story being set at the time of St Columcille (traditional dates 518–597). The monster is described as follows:

> … he was able to vomit in three different ways three years in succession. One year he turned up his tail, and with his head buried deep down, he spewed the contents of his stomach into the water, in consequence of which all the fish died in that part of the sea … Next year he sank his tail into the water, and rearing his head high up in the air, belched out such noisome fumes that all the birds fell dead. In the third year he turned his head shoreward and vomited towards the land, causing a pestilential vapour to creep over the country that killed men and four-footed animals (Joyce 1913).

Yet again, we see a story set in the sixth century that specifically refers to noisome fumes and pestilential vapour creeping over the country. This ancient Irish story parallels Gibbon's comment on corruption, as does Gildas' metaphorical note 'For from the prophets of Jerusalem pollution has gone out over all the Earth' (Winterbotham 1978, 82:3).

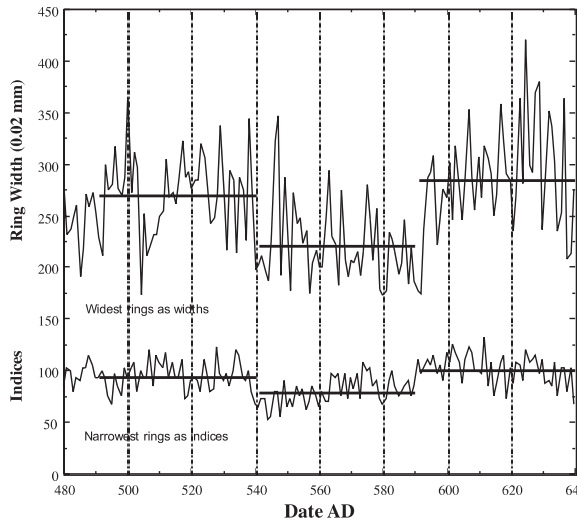

Fig. 5.5.
Widest and narrowest growth rings in each year of the sixth century in Irish oak (widest rings plotted as ring widths; narrowest rings plotted as indices [normalised departures around a value of 100] for clarity) showing the systematic reduction in the envelope of oak growth from AD 540 to 590. *Black bars* represent average values for the periods indicated

Here is another story:

> In 550 [sic] the Yellow Plague was said to be roaming through the land in the guise of a loathly monster. This was in Wales but in Ireland too the plague was regarded as a living thing that roamed the land. The power of prayer against this creature was amply demonstrated when, at the prayer of St MacCreiche in Kerry, a fiery bolt from heaven fell upon it and reduced it to dust and ashes in the presence of the people (Twigg 1984).

A yellow plague monster roaming the land, with fire from heaven reducing it to dust and ashes! Overall, there is enough information out there to allow the suggestion that the event(s) in the sixth century that triggered the Plague of Justinian (or Yellow plague, or, in Ireland, the plague called Belfed) and the Maya Hiatus included corruption of the atmosphere due to a close brush with a comet. Finally, it is important to realize that there appear to be no equivalent clusters of dated information on atmospheric corruption in the other centuries of the first millennium. The mid-sixth century stands out in this respect; just as the global tree-ring event stands out; just as the cluster of dated myths stands out.

5.8 Linkages to Other Events

Having highlighted the 'strangeness' of the literature relating to the period around the AD 540 global tree-ring event, it seems reasonable to look briefly at the other events high-lighted by the Irish oaks. We have already touched on 207 BC with its Chinese environmental trauma and dynastic change, and Livy's references to 'stones from the sky'. Below are some brief coincidences involving other dated environmental events wherein Irish trees exhibited catastrophic growth reductions. The tree-ring dates are given in bold.

- *2354–2345 BC*. This date marks the transition from the Neolithic to the Bronze Age in the British Isles. This occurred at about the same time as a widespread societal collapse in the Near East (Weiss 1996; Courty 1998; Peiser 1998). It coincides uneasily with Archbishop Ussher's date for the Biblical Flood (2349 BC). Curiously, Isaac Newton, no less, suggested that the biblical Flood of 2349 BC might have been due to a comet (Schechner Genuth 1997).
- *1159–1141 BC*. This event in the middle of the 12th century BC falls close (there being no precisely-dated history at this time) to both the traditional date for the fall of Troy and the end of the Chinese Shang Dynasty. In both cases, the Trojan war and the mythical battle of Mu, it is observed that the battles involve humans *and* sky gods. In the case of Troy it is the god Apollo who brings plague. The 12th century BC sees the start of the four century long Greek Dark Age.

So, these dates, derived purely from tree-rings, provide curious resonances to two of the major events in ancient history, namely the Flood and the Fall of Troy. Now let us rehearse the rest of the Chinese story.

In the 12th year of his reign (trad. 2346 BC) the first Chinese emperor, Yao, meets the Divine Archer Shên I (clearly a version of Apollo). At the time there are terrible catas-

trophes including *ten suns in the sky*, famines, floods etc. The Divine Archer, having shot down nine of the ten suns, sets out to seek the cause of these catastrophic events and finds that they are due to the activities of one Fei Lien (a wind spirit) (Werner 1995). Now, noting the tree-ring dates, let us look at the associations of this story. In the Chinese story Fei Lien who was responsible for the calamities in the 24th century BC was later a minister of King Chòu, the last emperor of the Shang dynasty who was defeated at the battle of Mu. The Shang dynasty ends by tradition in the 12th century BC. Hence, preserved in a Chinese story is *a link* from the 24th to the 12th century BC, something that implies that some observers in China recognized the similar causes of the two events; such recognition might best be explained by people having seen things in the sky.

By tradition it is at the Fall of Troy that the Greek god Apollo shoots plague arrows, while in China at the time of Chòu (also 12th century BC) a Zeus-like character, No-cha, finds a wonderful bow and three magic arrows. No-Cha shoots an arrow towards the south-west "a red trail indicated the path of the arrow, which hissed as it flew". Subsequently it was observed that the arrow bore the inscription 'Arrow which shakes the heavens' (Werner 1995). Again, in case this seems far fetched, there is an accepted reference to a comet at the fall of the Shang, *viz*:

> When King Wu-wang waged a punitive war against King Chòu [the last king of the Shang dynasty], a comet appeared with its tail pointing towards the people of Yin … (Sagan and Druyan 1997, p 15)

So, close to two of the early tree-ring dated environmental events (2350 BC and 1150 BC) we have associations with Apollo-like gods. Then, with Arthur's death (542), Mongán's frenzy (538), and possibly with the death of Mochta Lugh (535), we have characters cognate with Lugh, the Celtic Apollo, recorded just around the time that plague breaks out, arriving into Constantinople in AD 542.

5.9 Conclusion

Given that the tree-ring dates are derived scientifically and are well replicated, they cannot easily be moved in time. Thus dated growth departures in these tree-ring records are fully equivalent with any other precisely dated records. It is therefore interesting that both mythical stories and normally disregarded historical records, with dates, should sit so comfortably with the tree-ring dates. In each case there appears to be some reason to invoke a link to comets, or comet debris, or meteorites, whether it is a reference to ten suns in the sky, or Cybele – a goddess manifest as a meteorite – or a suggestion of Isaac Newton, or direct historical references as noted from Roger of Wendover, Gibbon, etc. To these can be added the consistent appearance of comet-associated sky gods, be it the Divine Archer or Apollo or Lugh at the events described in dated myths. More surprising is the consistent use of biblical metaphor to describe happenings in the sixth century. None of this ancient information need exist; but, not only does it exist, it has mostly been treasured from antiquity.

The historian Gibbon tells us that there was a comet in 539 and that the atmosphere was corrupted from 542 to 594, but, while his comet record is accepted, his assertion about corruption has previously been disregarded for lack of corroboration. As shown,

there are clear indications that some other ancient writers – writing in the 6th century, and using biblical metaphor – were attempting to convey this same concept of a corrupted atmosphere. Now, relevant to the tree-ring event bracketing AD 540, there is direct scientific information, from the Greenland ice record, showing unusually elevated levels of atmospheric ammonium at the time. It is hard to imagine that this extended package – including information from the written record, from tree rings and from ice cores – is just a coincidence. Rather, it should be an important clue as to the true nature of the 540 event, stated by the normally disregarded medieval historian, Roger of Wendover, as involving "a comet seen from Gaul so vast that the whole sky appeared to be on fire" in 540/541. It is time for a more concerted look to be taken at what is hidden in ancient records and indeed what else is present in the ice cores.

Note: A question to atmospheric scientists. Pentti Zetterberg informs me (pers. comm., 6 April 1999) that the AD 535 growth ring in Finnish pine was the *widest* in his whole 7000-year record. It is suggested that in Japan the year 535 was 'perfectly wonderful' (Aston 1956), while Cassiodorus (Barnish 1992) notes that the year before the dry-fog 'such was last year's [presumably 535] fortunate abundance.' What mechanism might induce a *widespread fertilization effect* in the run up to a dry-fog catastrophe? Could it have been something involving nitrogen fertilization?

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