Federico Cesi and his field studies on the origin of fossils between 1610 and 1630

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In 1603 Federico Cesi, along with four of his friends, founded the first Scientific Academy in Europe, the Accademia dei Lincei, which included Galileo Galillei as a member. Between 1611 and 1630 Cesi undertook an ambitious project to collect and record fossils from his lands around Acquasparta in Umbria. He had drawings and descriptions made of all the excavated fossils, fossil woods and their sites of origin. He died before his work could be published and it was left to his friend Francesco Stelluti to publish a monograph in which he claimed that evidence demonstrated that the fossil woods were formed from stone and were 'not once living'. The corpus of drawings, now in the Royal Collection at Windsor, has allowed the project to be reconstructed and fieldwork in Italy has shown that the complex nature of the fossil preservation could have easily confused the researchers and have led to misinterpretation of the fossils. This research by Cesi is the first to combine field and specimen data to interpret the origin of fossils and has been widely neglected by historians of Science.

Fossils were known for thousands of years before the Christian era and originally were probably collected either as curiosities or because of their presumed medicinal properties[1]. Fossils were known not only to the Greeks and Romans but also to the Chinese who had, by the 11th century, realised the true nature of fossil plants as 'once living' organisms and even used them to interpret climates of the past[2]. Aristotle and his disciples adopted a different view and believed that they were caused by spontaneous generation where earth forces had formed rocks to look like animals or plants[3]. Later the Fathers of the church adapted the Aristotelian view, which then became accepted by theologians. Although there are several important texts about fossils from before the 16th century, few of any significance survive, with the exception of the unpublished writings of Leonardo da Vinci (1452–1519), who believed in the organic nature of fossils[4]. The 16th century showed an increase in the study of natural history and, in particular, of fossils. In 1546 Agricola (Georg Bauer of Saxony, 1494–1555) published his observations on minerals and fossils in his 'De Natura Fossilium'[5]. It was the publication of the small book by Conrad Gesner (1516–1565) in 1565, however, which proved a turning point for the young science of palaeontology[6]. The collecting of natural history specimens and drawings was becoming more commonplace and the fascination with the subject seems to have been an important preoccupation with Italians, in particular, at this time. The Bolognese Ulisse Aldrovandi (1522–1605) wrote on many aspects of the subject although his collection of 'metals' (meaning all mineral materials) was not published until well after his death[7]. Gesner's drawings were produced as wood cuts which were rather coarse in contrast with later copper engravings, such as those of Fabio Colonna (1567–1650), a Neapolitan naturalist, which show exquisite detail[8].

Figure 1 Federico Cesi, attr. to Simon Vouet(?). Rome Accademia dei Lincei.

The organic nature of fossils had become the subject of wide debate. Among those who supported this view

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Figure 2 Symbol of the Accademia dei Lincei. Rome Accademia dei Lincei.

Figure 3 Galileo Galilei. Engraving by Ottavio Leoni, 1624, Rome, Gabinetto Nazionale delle Stampa. Accademia dei Lincei.

Figure 4 Title page of Galileo's 1613 monograph showing Lineo after his name and the Lincei symbol. Accademia dei Lincei.

were Gerolamo Cardano (1557–1650) and the French potter Bernard Palissy (?1510–1590). His collection contained many fossil woods which were unfortunately not described or illustrated, although some at least appear to be petrified, in his 'Discours Admirable' of 1580. It is not surprising, therefore, that in Italy in the 17th century there developed a scientific society devoted to Natural History[9].

The Accademia dei Lincei

The Cesi family originated in the town of Cesi near Rome. Federico Cesi (Figure 1) was born in Rome in 1585[10]. He was the son of Federico Cesi (who was the hereditary Marquis of Monticello and Duke of Acquasparta and made a prince by Pope Paul V). Cesi was privately educated and became interested in Natural History at an early age and whilst this interest was opposed by his father it was supported and encouraged by his mother (who came from the wealthy Orsini family of Rome). Federico Cesi (1585–1630), The Duke of Acquasparta, was only 18 when he formed the Accademia dei Lincei. The name for the academy was derived from the Greek mythological figure, the argoaut (Figure 2), which was famous for its sharpness of vision[11]. This first European Scientific Society comprised Cesi, Frecesco Stelluti (1577–1653) a mathematician from Fabriano, Johannes Heck (1576–?1618), a Physician from the Low Countries, and Anastasio de Filiis (1577–1608), a polymath[12]. It was established to study and understand all of nature and to classify all living and inanimate objects. For the first two years the four members of the Lincei, or 'clear sighted ones', lived together in Acquasparta. When the Accademia was first formed these members lived together in Cesi's house where they undertook their studies. By 1605 they agreed that the aim of the Accademia should be 'not only to acquire knowledge of things and wisdom, and living together justly and piously, but also peacefully to display them to men, orally and in writing, without any harm'[12].

It became important to recruit new members to this exclusive society. In 1610 they persuaded the well respected Gioanni Batista della Porta (?1535–1615) to join and in 1611 Galileo (1564–1642) (Figure 3) also enrolled[12]. Galileo became a proud member of the group and the Accademia undertook to publish his research. Several of his publications were sponsored by the Lincei and bear their symbol (Figure 4)[10].

At their meeting in 1611 Galileo not only demonstrated a telescope to the group but also a microscope. Galileo provided a microscope for the use of the academy and Cesi used this to undertake a microscopic study of ferns, while Stelluti studied bees[12]. Other important members were Fabio Colonna (1566–1640) of Naples, Virginio Cesarini (1595–1624), Giovanni Ciampoli (1590–1643), Francesco Barbarini (1597–1679) (Figure 5) (the nephew of the future Pope Urban VIII, he became a Cardinal in 1623) and Cassiano dal Pozzo (1588–1657) (Figure 6) who was in service to Francesco Barbarini[12]. The election of Fabio Collona is of particular interest. He produced several significant studies of fossils, illustrated with detailed copper engravings, in which he asserted that the fossils he had observed had once been living plants or animals. In fact he went so far as to state that Glossopterae (fossil sharks' teeth) had belonged to sharks and attributed their occurrence as fossils to the biblical flood[13].

A major feature of the work of the Academy was the use of drawings. In 1622 another member Cassiano dal Pozzo joined the group. He was interested in a wide range of illustrative material and collected much of the group's illustrative material. When Cesi died in 1630, Cassiano incorporated the material of Cesi into his Paper Museum. This material was passed down through his family to the Albini family and in 1762 was purchased by George III. Although some material was evidently lost or was not included in the material destined for England a corpus of more that 7000 drawings and paintings was incorporated

Figure 5 Francesco Barberini. Engraving by Ottavio Leoni. Rome, Gabinetto Nazionale delle Stampa. Accademia dei Lincei.

Figure 6 Cassiano dal Pozzo. Pietro Anichini. Frontispiece to Dati's funerary oration, 1664. Accademia dei Lincei.

Figure 7 Front cover of Franceso Stelluti 1637 Trattato del Legno Fossile Minerale. ©Biblioteca Apostolica Vaticana.

into the Royal Collections and is now owned by Queen Elizabeth II and is housed at Windsor Castle[12].

A major publishing project is currently underway to publish catalogues of all of the drawings and watercolours. These have been divided into two series comprised of Series A: Antiquities and Architecture; and Series B: Natural History. To date, four of the projected 30 or so volumes have been published. A full catalogue of the fossil drawings referred to here has been published and the reader is referred to this volume for full documentation of the drawings[12].

The Fossils Project

Publication of Stelluti

When Cesi died in 1630 it was a fatal blow to the Accademia. Not only did Cesi have a restraining hand upon Galileo, which was suddenly removed with devastating consequences, but also few of his own researches were complete or published[12]. A large project that Cesi had undertaken was a study of the fossils and rocks in the area around Acquasparta in Umbria. Of particular significance were the number of fossil woods which Cesi collected in the areas between Dunarobba, Rosaro and Scismano (although not exclusively from here). It is evident from correspondence and from Stelluti himself that many in Europe who were interested in natural history knew of Cesi's studies of fossil woods[12]. Stelluti received numerous requests to supply information of the fossils and their interpretation. Having written a number of summaries of the research Stelluti decided that to publish a short summary of the work would be appreciated[14]. This short work appeared in 1637 and comprised a series of plates and their explanations together with a general statement on the origin of fossils (Figure 7). A facsimile edition of this work has been published[15] and a translation with notes in English (together with the Italian transcription) appears in the appendix of the Catalogue Raisonée[12]. Manuscript editions of the volume in Paris and Montpellier show several changes to the text before final publication, including the use of alternative figures[12]. Until the publication of the Catalogue Raisonée this slim volume was all that was known of the Cesi fossil woods project and a number of misunderstandings as to the depth of the project have been published[16] and in general it has been overlooked by historians of science[17].

Dating the field studies

It is clear that the fossils project was underway by at least 1611 if not earlier. The date 1611 is also mentioned on one of the drawings where it is stated that the wood was taken to Rome[12]. We have evidence from a letter from Cesi to Barbarini sent in 1624 where he comments on the fossil woods and sends several specimens[12,18]. It is clear that this was one of several letters over a period of time from Cesi to Barbarini. Indeed Cesi also sent him a table made of the fossil wood. By this date many of the fundamental observations had been made about the woods and their various preservation states. We are uncertain how quickly the project progressed or when the majority of the observations were made but it is clear that many had been made by 1624. There are several letters which attest to the continued interest in the fossil woods project at this time. In August 1624 Cesi wrote to Cassiano about the project and only a few days later Stelluti wrote to Galileo that Cesi had found 'very large pieces, up to eleven palms in diameter, and others with iron fibres in them, or similar metallic pieces within such woods, and others which secrete a kind of resin, like incense, even having a similar odour; and then too he has found a very large quantity of woods which have been turned in to stone or pyritized, of most extravagant forms; and if your excellency passes by on his return to Florence, he will see, both with amazement and pleasure, all these

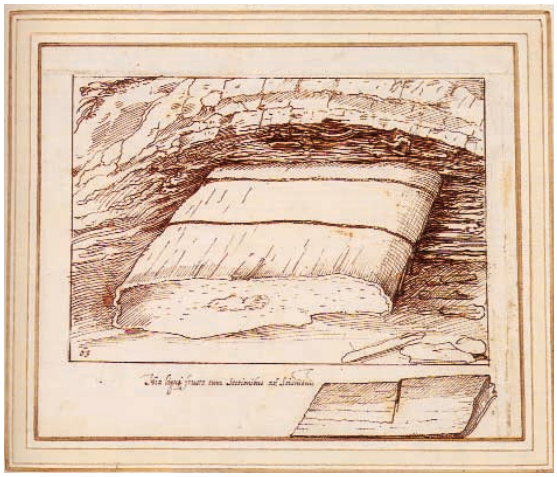

Figure 8 *In situ* fossil wood being excavated. Cat 8. RL.25601. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

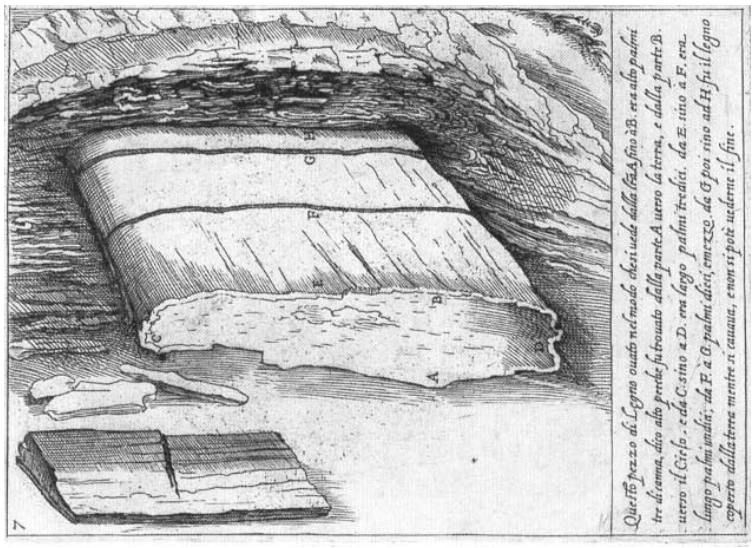

Figure 9 Plate 7 from Stelluti 1637 showing engraving of Figure 8. ©Biblioteca Apostolica Vaticana.

woods, and where they originated, as well as some of the underground fires that are here'[12]. However, it is clear that Cesi was preparing figures for publication as we have identified frame lines around several of the drawings as a guide to the engraver[12]. The style of the drawings is excellent and it lent itself to accurate engraving (albeit a mirror image) (Figures 8,9)[12].

The nature of the observations

Many of the drawings have annotations, originally in Cesi's own hand and later transcribed. Unfortunately we do not have any of the accompanying notes which must have existed. The field drawings usually have some indication of locality. It may be that those that currently do not have any locality data once did but have been trimmed and the data lost. Inscriptions on the drawings of the fossils vary considerably from simple measurements through to detailed descriptions. Many of the woods are drawn from several angles and appear on different drawing sheets. The descriptions usually include a note of colour, shape and weight or appearance. In addition, a number of new terms are employed which are designed to give a sense of the intermediate nature of the fossils. For example one inscription reads 'black woody fragment with a branch, on the inside heavy and stony', another 'Ferrous stone wood' (ligni lapiferreum), and another 'stone wood' (litoxilum)[12].

The problem of classification

Cesi was interested in classification. In particular those objects which were of intermediate nature, i.e. part animal part plant, part plant and part mineral[12]. The fossil woods fascinated him and he spent much time considering how to describe woods which appeared part wood and part metal or part stone. He classified these in to Metallophyta and defined informally a number of categories, such as Cretilignum (Clay wood)[12] and litoxilum (stone wood)[12]. The range of preservation types in the area around Acquasparta made this study particularly important.

Uncovering the field sites

Stelluti map

A useful start in unravelling the woods project, as none of the fossils themselves survive, is a study of the published Stelluti map. Here Stulluti in plate 1 (Figure 10) illustrates the geography of the region studied and an indication of some, but not all, of the fossil sites. We have no material from two of the indicated sites or drawings from the sites not indicated. None of the sites are described in the Stelluti volume.

Drawings of the field sites

In the corpus of drawings at Windsor there are 17 drawings of field sites. These show the general landscape of the sites where woods had been collected, the horizons of the woods, and the excavation of one of the large logs, two of which were published by Stelluti (pl. 7,8)[12]. The field sites with names include Dunarobba, Rosaro and Scismano, all of which can be identified on the Stelluti map and which are geographically close by (Figure 11).

Modern geological evidence

Observations on a modern geological map indicate a major north–south fault running through Acquasparta separating earlier Mesozoic sediments, predominantly limestones, from softer, younger, Tertiary and Quaternary clastic sediments[12]. These sediments to the west of Acquasparta were deposited in the late Tertiary Tiberino Basin. This was a large freshwater lake which was bordered by a swampy floodplain upon which grew coniferous forests[19]. The area around Dunarobba and Rosaro include sediments of the Fosso Bianco Formation, of late Pliocene age (around two million years ago). It is in these sediments that most of the fossil woods were derived (Figure 12)[12].

Modern field studies

In 1980 working of a clay pit in sediments of the Pliocene Fosso Bianco Formation at Dunarobba uncovered a notable fossil forest[20]. In all more than 40 upright trees were uncovered and are now preserved in a protected site. The trees were large, up to 2 m in diameter and 8 m high, belonging to a taxodiaceous conifer, believed to be

Glyptostrobus by some and *Sequoia* by others[21]. The site has featured on a recent Italian postage stamp and application is being made for its designation as a world heritage site[22]. A visit in 1995 by the author indicated that the level of the fossil forest was below the likely level studied by Cesi at Dunarobba. The forest level contained predominantly upright trees, which was not noted by either Cesi or Stelluti and caused some problems in the interpretation of the fossil woods. (The observation that the trunks were compressed led Stelluti to conclude that the weight of the earth prevented them from growing upwards rather than being buried and compressed and confirms Stelluti's belief that 'the raw material of this wood is nothing other than clay-rich earth'.)[12] However, levels higher in the section corresponded very much to those illustrated by Cesi. These beds contained wood of a variety of shapes and sizes, matching well with the descriptions of Cesi. Subsequent fieldwork in 1998 and 1999 located several field sites in the Rosaro area which bear a striking similarity to those described by Cesi, including the occurrence of large logs over 1 m in diameter. A comparison of the modern sites with the field drawings commissioned by Cesi indicate that these were excellent renditions of the areas where the fossils were found and may be regarded as excellent records of scientific data. This was over 200 years ahead of its time as the field visualisation of geological strata was not commonplace until the 19th century[23].

Perhaps the fact that none of the woods had been found upright was of importance to his understanding, as was the large size of the woods, larger than any tree currently growing in the area. This was noted by Periisac writing to Ferrier in 1635 describing the fossils and their field sites 'One must therefore infer that this is no local tree as in this part of the world we don't have trees of this diameter.'[12]

Modern field collections

Many of the sites excavated in Umbria were found to contain abundant fossil woods. A representative collection of the woods was made and comparisons undertaken with the Cesi drawings (Figures 13–18). Immediately obvious was the similarity of many of the wood specimens to the drawings. Secondly the quality of the drawings could be appreciated. Indeed many were as good as photographs, if not better. We can have confidence of the accuracy of the drawings. More important were the observations that could be made on the preservation of the fossils (Figures 20–28).

The fossil woods included some that might be confused with modern wood through to those which were permineralised and petrified with iron oxides and calcium carbonate (Figure 19). Many specimens showed a variety of preservation types within one specimen.

Several important facts emerge from the recent field studies of the fossil wood localities and from subsequent laboratory investigations:

1. Most of the localities contain several horizons of fossil woods.
2. Apart from at the recently excavated 'Dunarobba fossil forest' all the woods have been transported and occur in a horizontal position.
3. The woods predominantly occur in a clay matrix.
4. Leaf fossils appear generally absent.
5. The size of specimens range from less than 1 cm to more than 1 m in diameter and from less than 1 cm to more than 2 m in length.
6. Specimens may appear unflattened, though are oval in cross section.

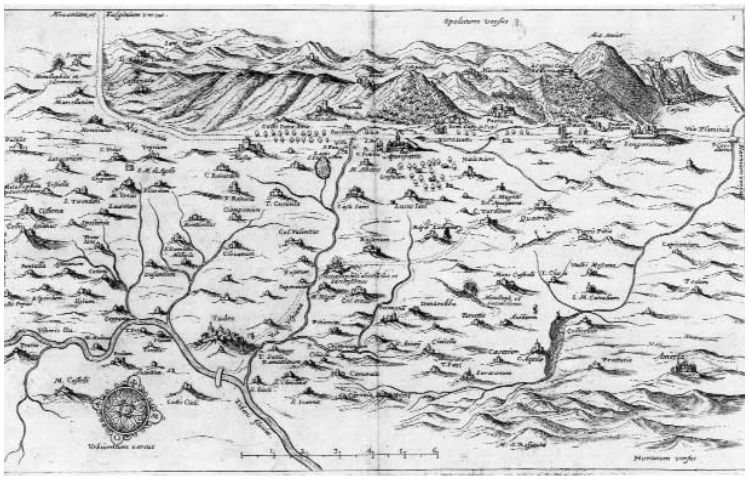

Figure 10 Map (Plate 1) from Stelluti 1637. ©Biblioteca Apostolica Vaticana.

Figure 11 Detail of Stelluti map illustrated in Fig. 10, showing the area around Dunarobba, Rosaro and Scismano. Note the location of fossil sites. ©The author.

Figure 12 Modern view looking across Rosaro and the late Tertiary Tiberino Basin towards the hills (of harder Mesozoic rocks) behind Acquasparta. ©The author.

Figure 13 Drawing of the Field site at Dunarobba. Cat. 1. RL.25681. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

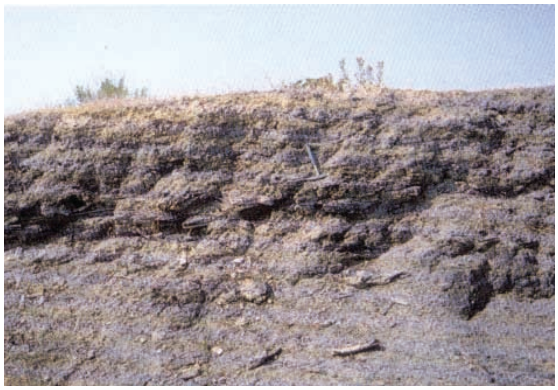

Figure 14 Photograph of 1995 exposure of a fossil wood site at Dunarobba above the fossil forest. ©The author.

7. A range of preservation states exist at each locality from woods with good organic preservation through to woods which have both organic cell walls preserved with mineral infilling cell lumina to specimens showing complete mineral replacements.
8. A single specimen of wood may exhibit a wide range of preservation states.

Baked clays

Amongst the drawings are a series of coloured paintings which show multicoloured rocks, generally shades of reds, yellow and purple (Figures 33–35). Their link with the main corpus of wood drawings originally appeared unclear. However, it was recognised that these may represent baked clays from underground fires. Original support for this view came from the letter of Ferrière. Here he mentioned Cesi's observations of a fire being started and burning underground for ten years. He also mentions the occurrence of 'terracotta' – like shards present in the fields. 'My guide did show me a place where, he said, a fire had burnt for seven years and that shepherds had set fire to the soil… I suddenly remembered the discourse, of which you have a copy, that the late Prince Cesi had written about this fossil wood, which stated that there was a place where, the earth being naturally sulphurous, it had burnt for ten years and there is no doubt that this was the place my guide had shown me. I found that the soil broke off in what looked like terracotta scales like potsherds or broken bricks.'[12] Rising smoke is seen both in the only field painting (Figure 29) and also in Stelluti's composite field image (his plate 2).

Recent fieldwork confirmed the observation of underground fires. These occur regularly in the area burning wood and lignite horizons. The effect of the heat is to bake the grey clays from grey to various shades of purple, yellow and red. Ploughed fields and landslips in the area around Rosaro often show such material, which is also often close to wood-bearing horizons (Figures 30–32).

Reconsidering the observations of Cesi and the conclusions of Stelluti

Conclusions of Stelluti

Most of our knowledge of the views of Cesi came from the short Trattato of Stelluti (Trattato del Legno Fossile

Figure 15 Drawing of field site at Scismano showing large trunks of wood. Cat. 3. RL.25684. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

Figure 16 Large coniferous trunks from the Dunarobba Fossil forest. Note typical features of drying out and splitting once exposed (1995). ©The author.

Figure 17 Drawing of field site at Rosaro showing gully erosion and the accumulation of fossil woods. Cat. 15. RL.25600. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

Figure 18 Landslipped area between Rosaro and Scismano with large trunks of fossil wood (1999). ©The author.

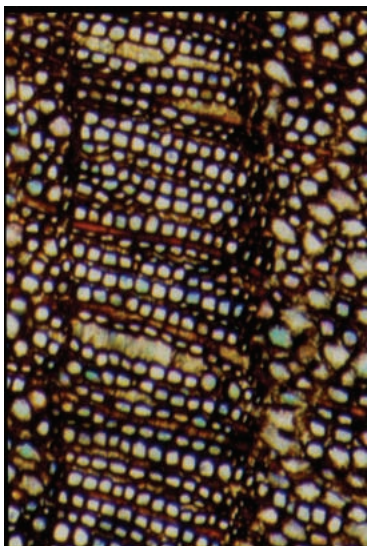

Figure 19 Thin section of permineralized wood from Dunarobba showing well preserved anatomical structures. The cell spaces are filled with the mineral Calcite (Calcium carbonate) which give the wood an appearance of stone. ©The author.

Figure 20 Large fossil conifer trunk from between Rosaro and Scismano (1999). ©The author.

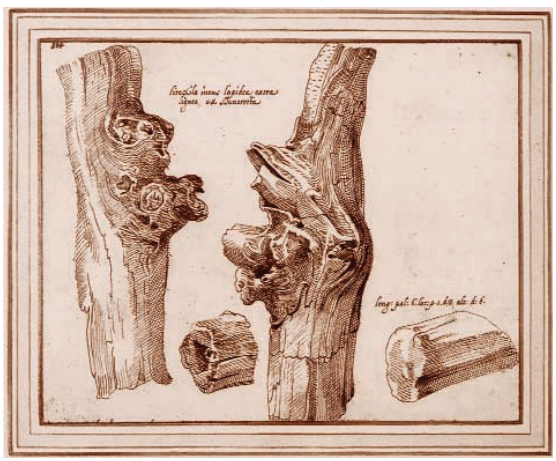

Figure 21 Drawings of fossil woods from Dunarobba. Inscription states 'Litoxila intus lapidea extra/lignea, ex Dunarobba'. Cat. 20. RL.25653. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

Minerale)[12]. Whilst Stelluti claims to be representing the views of Cesi, we cannot be sure. Stelluti first makes a number of critical observations before making his conclusion. He notes that none of the woods have been found upright in the position of growth that might be expected if these had been 'once living' plants. Secondly he notes that some specimens were like wood whilst others were like stone and many showed the transition between the two. Two alternatives existed, therefore. Either these were 'once living' trees which had been transformed to stone or stone which had been transformed to wood. The occurrence of underground fires were considered as a possible mechanism but dismissed. Note that the underground fires envisaged by Stelluti were not related to volcanic activity as considered by some[17]. The fact that none of the trees had been found upright and many were flattened led Stelluti to conclude that these could not have been 'once living'.

In early manuscript versions of the Trattato this appeared sufficient evidence. However, for whatever reason, in the final printed version an additional story appears. To perhaps emphasise that this was also Cesi's view he relates the following story: 'We have now only to pass to an explanation of the illustrations which follow; but first we must declare that, while any proof as to the origins of this wood is lacking, this may suffice: that, a quantity of damp earth having been removed from around a piece of wood, and placed in a room in the Palace of Acquasparta, belonging to His Lordship Duke Cesi, it was found after some months to be wholly converted into wood, to the great wonder of the afore-mentioned Lord, and all others who saw it: whence he is without doubt that the earth itself is seed and mother of this wood, the earth of these parts being most suitable for its generation.'[12]

Can we be sure that this would have been Cesi's view if he had published the project or was uncertainty a cause of delay in publication?

Thoughts of Cesi

There are some lines of evidence which suggest that Cesi did, at least at one time, hold to the view that the fossil woods were 'not once living'. In his letter to Barbarni in 1624 he talks of the woods as being part of the 'middle nature' and being derived from the earth[12]. In addition, he mentions the possible role of underground fires in the process. However, we also know that others used Cesi's observations to make rather different conclusions. For

Figure 22 Drawing of wood with branches. Cat. 21. RL.25634. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

Figure 23 Wood with branches from the Dunarobba site collected 1995. ©The author.

example, Ferrière comments on the size of the trunks, a feature recognised by Cesi. Ferrière concludes that the trees must have come from trees no longer living in the area, as they are much larger than any of the local trees. This clearly implies the belief that they were 'once living'[12].

Not all members of the Lincei held that fossils were 'not once living'. For example, Fabio Collona published his important 'Observations on aquatic and terrestrial animals' (1616) where he asserts the organic origin of some fossils[13]. Surely Cesi would have discussed this topic with so distinguished a naturalist. Clearly Stelluti was not impressed by his arguments, and was at pains to nail Cesi's colours to the mast of 'not once living'. These facts cannot be considered in isolation of the events following Cesi's death.

The death of Cesi, Galileo's trial and the Barbarini family

The influence of Cesi upon other members of the Lincei should not be underestimated. Although he was an enthusiast he was also a cautious politician. It is clear that he kept Galileo under a particularly careful watch to curb his excesses[12,16]. It can be no coincidence that Galileo's Discourses (1632) appeared shortly after Cesi's death in 1630. Surely Cesi would have cautioned Galileo on his method of presentation and warned him of the dangers. The subsequent trial of Galileo and his recantation would have sent a clear warning to other members of the Lincei. Stelluti's 'over the top' dedication to Cardinal Barbarini in the Trattato and his conclusion that the fossil woods were not derived from living plants can be considered to be strong evidence that the conclusions reached by both him (and Cesi?) were because of pressure from the Vatican.

However, it can also be argued that the conclusions reached were entirely consistent with the data as understood at the time. Maybe this was politically convenient but it can be argued that the approach was 'scientific'.

Geological background as a prerequisite to data interpretation

The recent geological fieldwork has confirmed a number of the key observations of Cesi:

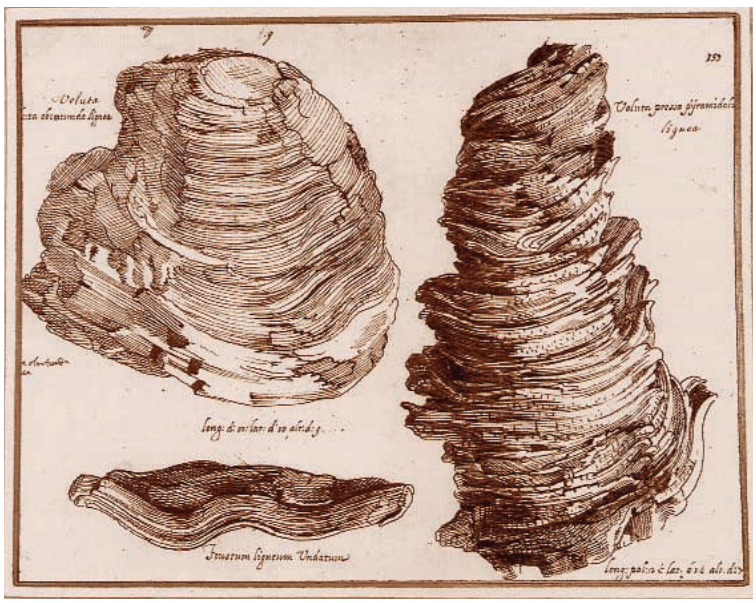

Figure 24 Woods described as 'round woody volutes'. Cat. 76. RL.25696. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

Figure 25 Fossil wood showing branch insertion with spiral character, Dunarobba (1999). ©The author.

Figure 26 Decaying pyritised wood (inscription refers to flowers of vitriol). Cat. 48. RL.25661. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

Figure 27 Partly permineralised wood with decay products from between Rosaro and Scismano (1999). ©The author.

- It is true that the woods are found predominantly prostrate and not upright.
- It is true that some fossil woods appear to be wood and others stone.
- It is true that many wood specimens show a range of preservation states.

Figure 28 Collection of woods from the Dunarobba site in 1995 showing range of preservation states including iron impregnated and permineralized (petrified) woods. ©The author.

- It is true that there have been underground fires and that these have changed the rocks.

What we have to appreciate is the lack of knowledge of sedimentological and geological processes and the lack of appreciation of geological time. We are able to use our extensive knowledge of this to identify at least four stages in the transformation of the living tree to a fossil wood.

1. The tree dies and branches/trunks fall into a river or lake. Alternatively they may fall into a waterlogged area (for example: marginal to a lake) or become inundated by sediment from, for example, river flooding.

Figure 29 Field watercolour of the area between Rosaro and Scismano. The plumes of smoke show position of underground fire. Cat. 14. RL.25683. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

Figure 30 Ploughed fields at Podere Cassonova showing red baked clays after underground fire (1998). ©The author.

Figure 31 Landslip between Rosaro and Cassanova (1999) showing red baked clays from underground fires. ©The author.

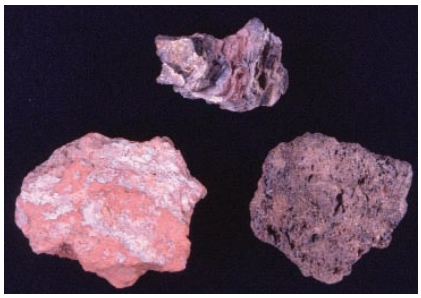

Figure 32 Collection of baked clays (1998) from underground fire at Podere Cassanova. ©The author.

Figure 33 Watercolour of baked clay. Cat. 163. RL.25716. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

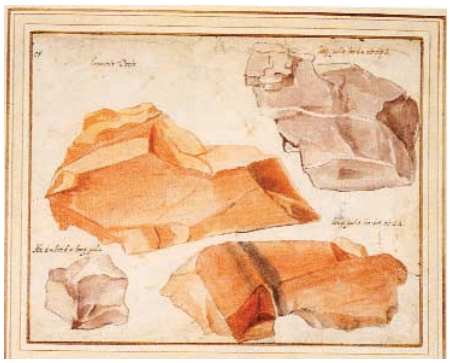

Figure 34 Red baked clays (lateritia). Cat. 168. RL.25721. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

Figure 35 Multicoloured baked clay. Described as 'lateritium mixed with violet'. Cat. 169. RL.25722. The Royal Collection ©2001, Her Majesty Queen Elizabeth II.

2. The woods may be transported by water away from their original site of growth.
3. The woods may be incorporated into sediment, for example in a river or lake.
4. The wood may undergo decay and compaction by the weight of the overlying sediment.
5. Minerals in the water may precipitate in cell spaces or replace the organic matter in the cell walls.
6. The sediment may be further buried.
7. The fossil-bearing rocks are uplifted, eroded and exposed.
8. Recent underground fires may alter both the sediment and woods.
9. Recent erosion will expose the fossil woods.

Given the above complexity of process and the need for background knowledge for each interpretation, it is not surprising that understanding the nature of the Acquasparta woods was not easy. From the limited background knowledge and the data at hand it would have been possible to take the view that the woods were 'not once living' or the opposite conclusion that they were.

If, however, upright trunks, such as those now exposed in the Dunarobba fossil forest had been found, it would have added weight to the view that these were 'once living'. What if Cesi and Stelluti had championed this idea?

The legacy of Cesi

First geological field study

Whilst many had shown considerable interest in geology and indeed had discussed and illustrated geological materials, the work of Cesi was the first, at least in the West, to represent an integrated field and specimen investigation to help solve a problem – that of the origin of fossils. There is no doubt that many were interested in all aspects of geology, from the Greeks, Etruscans and later through works by Gesner and Aldrovandi for example, even Leonardo made many geological and palaeontological observations. Cesi's contribution is exceptional for this time in that it examines a wide range of material from one place and links a number of observations together over several years to come to a conclusion.

First western palaeobotanical study

Traditionally the origins of Palaeobotany in the West are considered to be in the 18th century, although several authors describe fossil plants at the end of the 17th century[24]. In the book by Andrews on the history of Palaeobotany the work of Cesi and the Lincei is not mentioned[25]. We may suspect that the error of Stelluti in his interpretations on the origins of the fossil woods meant that few later researchers referred to this work. It is also likely that its obscurity resulted from the fact that it contained fossil woods and not fossil leaves. It is possible to identify fossil leaves from drawings of their morphology whereas this is not the case with fossil woods where microscopic observations are needed. This would have resulted in there being little practical use in referring to this work for later researchers.

History of palaeontology

The achievements of Cesi and Stelluti have not figured in any comprehensive history of Palaeontology[17]. Neither Cesi

nor Stelluti had students to carry on with their work. The material was lost so no later researchers could make use of it. All that remained was the relatively thin and unsatisfactory Trattato and a large number of unpublished manuscript drawings. Publication of the corpus of drawings of the fossils project may well help to raise the profile of Cesi and the Accademia dei Lincei in the history of Palaeontology.

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