Archaeological land evaluation
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Chapter 6
Pollen-analytical investigations in Late-Holocene Central and South Italy
(from the Neolithic until the Roman Age)

Examination of changes in vegetation, climate and landscape as a result of both natural and anthropogenic causes

6.1 Introduction

In the first chapter of this thesis (paragraph 1.2), two main research aims were described: to optimise land evaluation for archaeological purposes and to reconstruct the vegetation history of the Pontine Region (Central Italy). This chapter concerns with the second aim and shows the results from the pollen-analytical investigations in Central and South Italy, which were already done by others and it shows the new results from the Pontine Region.

From this latter area, three cores have been taken back to the Groningen University and have been analysed by dr. Stuivts, Woldring and myself. These include the Colle San Lorenzo-core in the west, the Lago di Fogliano-core in the south and the Laghi di Vescovo-core in the north (figure 6.2).

In the interpretation of the pollen diagrams, special attention is paid to the so-called anthropogenic indicators (6.1.2, table 6.1). These plant species (for example knapweed, barley and chestnut) occur only in the context of or are at least highly correlated with human activity (Behre 1986). The presence of anthropogenic indicators enables us to trace the history of habitation and its changing intensity with time and to elucidate the different forms of agricultural land use in the past (Behre 1986).

This reconstruction of the various land uses, which have existed in the Pontine Region, is necessary in order to be able to compare the results from the land evaluation with the results from the pollen analysis in the last chapter of this thesis.

6.1.1 Aims of the chapter

The aims of this chapter are fourfold:

- To provide independent information to test the results from the land evaluation for the three research periods (Bronze Age, Iron Age and Archaic/Roman Age).
- To provide additional information regarding the local and the regional vegetation changes in the Pontine region during the last four millennia. The causes of these changes are the result of climatic variations or anthropogenic interference with the landscape, or both.
- To decipher the start and the character of the human influences in the natural Pontine vegetation. The emergence of agricultural practices is looked upon, including relating activities, such as deforestation, ignicoltura (see chapter 4) and drainage.
- To present an up-to-date overview of all palynological information from researches, that took place in Central and South Italy, in order to obtain improved knowledge concerning the inter-regional climatic changes.

It is noteworthy to say that this chapter gives a first impulse into the reconstruction of the changes in the vegetation for the entire Pontine region. Due to many reasons the pretensions cannot be very high.
However, the premises of this chapter are that it was written so that it can be used as a test for the archaeological land evaluation (chapter 7). This inclusive aim was appropriately achieved.

### 6.1.2 Anthropogenic indicators of changes in vegetation

Houérou (1981) states that the degradation of the vegetation in the Mediterranean is essentially the result of human activity, climate does no more than provide favourable, though constant, conditions.

Kelly et al. (1991) describe (groups of) species or specific situations, which may prove human influence upon the vegetation development:

- Firstly, the occurrence of cereal pollen generally provides evidence for human activity. Pollen of *Secale cereale* (rye), *Triticum/Avena* (wheat/oats) and *Hordeum* (barley) can be recognised, however difficult to distinguish from the wild species. Kelly et al. (1991) indicate that the natural habit of many wild members of the cereal genera is a parkland with a discontinuous canopy. Reflection of human agricultural activity can be found in increased cereal pollen values.
- Arrival and increased abundance of *Castanea sativa* (chestnut), *Juglans regia* (walnut) and *Vitis vinifera* (vine) is generally considered to reflect human activity in the pollen record (Kelly et al. 1991). But an early arrival of these species in the Holocene can be a result from natural migration when environmental conditions changed. A later increase may reflect human influence or further progressive environmental change.
- Finally, indications for forest decline are supposed to be anthropogenic as a result of clearance, but environmental alterations must be considered as well.

The table below (table 6.1) shows an overview of European anthropogenic indicators, which are generally used in the literature (Accorsi et al. 1996, Behre 1981 and 1986, Eisner et al.1986, Houérou 1977, Hunt and Eisner 1991, Kelly and Huntly, Kuhnholz-Lordat 1938, Lowe et al. 1996, Veenman 1996). The table does not have the pretension to be complete, botanical experts can probably fill up the empty locations in the table easily. But we must bear in mind the overall aim of this chapter. Therefore, the table functions as an expedient for interested readers and is mainly focused on species which are described in this chapter. The table is based on the following hypothetical agricultural model:

When a farmer decided to cultivate crops in an area, which was not exploited before, he had to prepare the soil for cultivation. In other words, a suitable agricultural field had to be created. *Ignicoltura* (chapter 4, table 4.1) was a commonly used technique, in which trees were desiccated and burned. Possible indicators of this burning can be seen in relatively high percentages of charcoal in the pollen samples and the presence of pyrophytes (plants, whose propagation, multiplication or reproduction is stimulated by fire or which can resist fire by various mechanisms).

Subsequently, crops were sowed or planted. In table 6.1, pollen grains from these crops are categorised under primary agricultural or arboricultural (trees) indicators. Some examples were wheat and barley, walnut and grape. Species, which generate in a cultivated or fallow land, are shown in the table as secondary agricultural indicators, such as *Artemisia* and *Plantago*. The last column shows the shrub species, which are considered pioneers in a burned and cultivated field.

After the crops were harvested, sheep or goats grazed the fields. Houérou (1977) claims that an enrichment of gymnosperm species can be interpreted as the result of grazing. Livestock commonly ignores this vegetation, because of its spiny or thorny morphology. Also, some species, such as Euphorbiaceae, are poisonous and other species are adapted to be entered without being destroyed. Indicators for grazing are, for instance, *Urtica* and *Taxus*. 
Indicators of ignicoltura: pyrophytes

<table>
<thead>
<tr>
<th>Primary agricultural indicators</th>
<th>Primary arbori-cultural indicators</th>
<th>Secondary indicators: weeds</th>
<th>Indicators for grazing</th>
<th>Indicators of a rise of second growth shrub</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buxus</td>
<td>Avena group</td>
<td>Artemisia</td>
<td>Apiaceae</td>
<td>Erica arborea</td>
</tr>
<tr>
<td>Cistus</td>
<td>Cannabis</td>
<td>Atriplex</td>
<td>Asteraceae</td>
<td>Fraxinus</td>
</tr>
<tr>
<td>Erica arborea</td>
<td>Hordeum-group</td>
<td>Olea</td>
<td>Centaurea solstitialis</td>
<td>Brassicaceae</td>
</tr>
<tr>
<td>Quercus suber/coccifera</td>
<td>Triticum group</td>
<td>Vitis</td>
<td>Chenopodiaceae</td>
<td>Caryophyllaceae Quercus coccifera</td>
</tr>
<tr>
<td>Tamarix</td>
<td></td>
<td>Cistus</td>
<td>Cupressus</td>
<td></td>
</tr>
<tr>
<td>Urtica dioica</td>
<td>Compositae</td>
<td>Euphorbiaceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercurialis annua</td>
<td></td>
<td>Fabaceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plantago</td>
<td>Lamiaceae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polygonum persicaria</td>
<td>Liliaceae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ranunculus</td>
<td>Polygonum aviculare</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhus</td>
<td>Ranunculus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spergula arvensis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stellaria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vicia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6.1 Anthropogenic indicators, focused on the Mediterranean

6.1.3 Structure of the chapter

This chapter is divided into four parts:

1. The first part (6.2) portrays the locations of the cores, the lithology of the cores and the available radiocarbon dates. Related information, such as the local vegetation and a broad assessment of the genesis of the local circumstances from which the cores were taken, is also a component of this part.

2. The results and interpretations from the pollen analysis are described in the second part (6.3 and 6.4).

3. To achieve an understanding of the variations in vegetation in the entire Pontine region, several other cores were taken into account which were investigated by other researchers. A summary of the results is shown the third part (6.5). A detailed reconstruction of the climate and vegetation history is given in the same paragraph. It also shows the human influences on the historic landscape, such as caused by deforestation, agriculture and animal husbandry (grazing).

4. Paragraph 6.6 shows an explanatory list of all plant species, which occur in the pollen diagrams, translated from Latin into, both English and Dutch.

6.2 Location and lithology of the cores

The geological, physiographical and climatic characteristics of Italy in general and of the research areas in specific were described in the introducing chapter and in chapter 3: landscape reconstruction.
and description of the research areas; Salento Isthmus, Pontine region and Sibaritide. This section describes in detail the location of and the lithology in the cores that were used in this chapter.

6.2.1 Location of previously published cores in Central and South Italy

**Pontine region**

In the Pontine region, five cores were previously analysed:

- In the north-west of the Pontine region, two crater lakes *Lago Albano* and *Lago di Nemi* were analysed by Lowe et al. (1996). They took a core for pollen analysis at a water depth of 70 m in Lago Albano and at a water depth of 30 m in Lago di Nemi.
- Further south, near Le Ferriere and *Campverde*, a core was taken in a dried-up lake, which lies in tuff deposits, surrounded by lagoonal deposits (Veenman 1996).
- Near *Monticchio*, Haagsma (1993) examined the vegetation history of the first millennium BC.
- In the north-eastern part of the Pontine plain, the *Mezzaluna*-core was analysed by Eisner et al. (1986) and Hunt and Eisner (1991).

**Other cores in Central Italy**

- Alessio et al. (1986) analysed a 10 m core for pollen from an artificially dried-up crater lake, *Valle di Castiglione* (east of Rome). The Castiglione crater lies about 20 km east of Rome at an elevation of 44 m above sea level. Lithologically, from downwards to upwards, the core consists of calcareous muds, tuffites, calcareous muds, peaty muds, peat and peaty muds, deposited in a sub-aqueous low-energy environment at a sedimentation rate of 0.3 mm/year.
- *Lago di Monterosi*, located north of Rome (Bonatti 1970) is a small lake in the Sabatinian volcanic centre, 40 km north of Rome, at 237 m above sea level, and a maximum water depth of 5 m. Lithologically the basin consists mainly of tufaceous rocks.
- *Lago di Vico* (north-north-west of Rome; Frank 1968) is a crater lake situated about 50 km north-northwest of Rome. Its surface lies 507 m above sea level and the surrounding crater wall reaches between 600 m and 963 m above sea level. The superficial area of the crater lake is ca. 12 km². A core was taken from this maar. From the bottom to the top, it consists of a 6 m thick layer of sandy clays and a 2 m layer of heavy clays.
- *Lago di Martignano* (north-west of Rome; Kelly et al. 1991) is a maar lake (2 x 1.5 km), situated 30 km north-west of Rome reaching 200 m above sea level. Lithology changes upwards from clay and coarser grained sediments to an alternation of silt and sand rich bands in the upper 11 cm.

**One core in South Italy**

- The surface of the maar lakes *Laghi di Monticchio* (Watts et al., 1996), in the Monte Vulture, lies at about 650 m above sea level. From the margin of one of the lakes, Lago Grande di Monticchio, a core was taken consisting lithologically, from the bottom to the top, of silt and clay, detritus mud and lake mud, and loose peat. From the middle of the lake, three additional cores were taken to complete the whole Holocene history, which turned out to be missing in the first core.

Figure 6.1 and 6.2 show the location of the all cores described above in Central and South Italy.
6.2.2 Location of and local vegetation around the three cores in the Pontine Region\

6.2.2.1 Colle San Lorenzo

In a fallow land, in the western part of the Agro Pontino, south of Ardea, near Colle San Lorenzo (figure 6.2), a core was taken to analyse the vegetation history of this area, of which little was known yet.

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1 The cores mentioned in this chapter are all situated in the plain and therefore have more or less the same elevation.
Lithologically, the surrounding environment comprises the Holocene Terracina beach ridges and clayey/peaty lagoonal deposits. Outside a 6 km radius in north-eastern direction, grey Pleistocene tuff from the Alban volcanoes occurs at the surface.

The local vegetation bordering the location of the core included Convolvulus, Euphorbia, Trifolium, Borago officinalis, Bellevalia romana, Anthriscus sylvestris, Arum, Taraxacam, various thistles, Ranunculaceae, Papilionaceae, Equisetum, two kinds of sedges (Carex otrubae and Carex hirta), Pulicaria dysenteraria and Gramineae. In the ditches at the borders of the field, Phragmites and Populus trees were present.

6.2.2.2 Lago di Fogliano

The Lago di Fogliano core was taken at the margins of the present-day lagoon, behind the dunes that border the Thyrrenean Sea (figure 6.3). Furthermore, the lagoon is surrounded by Borgo Ermada beach ridges and lagoonal deposits in the north-west, by Borgo Ermada beach ridges and aeolian deposits in the north-east and by Latina lagoonal deposits in the north.

Local vegetation bordering and in the vicinity of the lake of Fogliano included: Eucalyptus, Pinus pinea, Rubus, Phragmites, Urtica, Iris pseudacorus and Rumex hydrolapathum.

6.2.2.3 Laghi di Vescovo

In one of the sulphur-rich lakes of Vescovo (located in the former Pontine Marshes of the Terracina level, at the foothills of the Monti Lepini near Mezzaluna, for the location, see figure 6.2 and also 6.4), a core was taken for pollen analysis. Probably and hopefully, it fills up the gap from the Mezzaluna-pollen diagram of Eisner et al. (1986) and Hunt & Eisner (1991), from which the upper part lacks. This is an interesting part for my research, because it represents the vegetation history from about 3000 years before present.
Local vegetation in the vicinity and around the lakes of Vescovo included: *Euphorbia palustris*, *Typha latifolia*, *Veronica arvensis*, *Capsella bursa-pastoris*, *Ranunculaceae*, *Phragmites*, *Cerastium arvense*, *Carex* spp, *Plantago major*, *Stellaria media*, *Sonchus arvensis*, *Convolvulus*, *Lotus*, *Juncus* and *Lycopus*.

In the foothills of the Monti Lepini, watching over the lakes, the following vegetation was found: an abundance of *Pistacia*, *Rubus ulmifolius*, *Myrtus*, *Clematis*, *Smilax*, *Liguster*, *Anemone*, *Anagallis*, *Quercus ilex*, *Tordylium apulumium*, *Calendula*, *Pyrus* and *Ulmus minor/campestris*.

6.2.3 Lithology and radiocarbon dates

6.2.3.1 Colle San Lorenzo

In 1998, near Colle San Lorenzo, Delvigne, Woldring and myself took a core to a depth of 265 cm. The first 90 centimetres were thrown away because of clear indications of soil disturbance.

- The bottom layer (from the end of the core to 232 cm) shows sand with pebbles smaller than 1 cm.
- A peat layer (from 232 cm to 171 cm) is situated above this sand: humified peat incorporated with wood remains and organic material (from 232 cm to 190 cm) is succeeded by organic woody peat (from 190 cm to 185,5).
- From 183.5 cm to 171 cm, humified peat is repeated.
- The upper layer, from 171 centimetres to 90 cm, consists of very humic, sandy loam with remnants of wood. The percentage of sand in this layer varies: in the top (roughly from 90 cm to 100 cm) and in the bottom (from 145 cm to roughly 165 cm) the loam is mixed with coarse sand and occasionally with pebbles with a maximum diameter of 0.5 cm. Remnants of probably reed (*Phragmites*) are found at a depth of 145 cm.

In the tables below, radiocarbon dates have been calibrated by INTCAL98 (Stuiver et al. 1998).

<table>
<thead>
<tr>
<th>Number</th>
<th>Depth (cm)</th>
<th>Radiocarbon dates (BP)</th>
<th>Calibrated dates (95.4 % confidence level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GrN-25582</td>
<td>155–157</td>
<td>2950 ± 60</td>
<td>1373 cal BC– 979 cal BC</td>
</tr>
<tr>
<td>GrN-25583</td>
<td>172–174</td>
<td>3040 ± 60</td>
<td>1431 cal BC–1091 cal BC</td>
</tr>
<tr>
<td>GrN-23943</td>
<td>207–210</td>
<td>4560 ± 60</td>
<td>3501 cal BC–3037 cal BC</td>
</tr>
</tbody>
</table>

Table 6.2 Radiocarbon dates from Colle San Lorenzo
6.2.3.2 Lago di Fogliano

In 1997, at the border of the lake of Fogliano, Woldring, Veenman and Haagsma took a core to a depth of 8 metres. The main constituent is clay, mixed with sand, peaty layers, and occasionally with shells.

- Directly on the bottom layer of sand, peaty and organic clay was deposited (from 805 cm to 712 cm).
- On top of this clay, a relatively thick layer of grey sandy clay was found (from 712 cm to 475 cm). In the top layer (530 cm to 475 cm), the clay is mixed with rests of shells.
- From 475 cm to 300 cm, the peaty clay is alternated with layers of sand and shells (at 440 cm), grey sandy clay and mixed with pieces of wood (375 cm to 325 cm).
- Peat was found at a depth of 300 cm to 275 cm, covered by an 8 cm thick layer of grey clay and followed by an organic clay to a depth of 150 cm. A piece of alder wood was hit upon (from 166 cm to 175 cm).
- The upper layers consist of peaty clay (from 150 cm to 127 cm), grey sandy clay (from 127 to 50 cm) and clay to the present surface.

<table>
<thead>
<tr>
<th>Number</th>
<th>Depth (cm)</th>
<th>Radiocarbon dates</th>
<th>Calibrated dates (95.4 % confidence level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GrN-25578</td>
<td>127–129</td>
<td>2360 ± 60</td>
<td>761 cal BC – 209 cal BC</td>
</tr>
<tr>
<td>GrN-25609</td>
<td>219.5–222</td>
<td>3400 ± 100</td>
<td>1940 cal BC–1455 cal BC</td>
</tr>
<tr>
<td>GrN-25579</td>
<td>270–278</td>
<td>3590 ± 160</td>
<td>2400 cal BC–1525 cal BC</td>
</tr>
</tbody>
</table>

Table 6.3 Radiocarbon dates from Lago di Fogliano

6.2.3.3 Laghi di Vescovo

The core, which was taken by Woldring and myself in 1998, measures 355 cm in length. The lower part of the core consists of organic peat with fragments of shells (355–125 cm), covered by humified peat with roots (from 125–20 cm) and again a coarsely organic peat to the surface. Pieces of wood were found at the depth of 134 cm (probably alder wood) and 112 cm. From 355 cm to 270 cm, the peat is darker and more compact than the peat layer above.

<table>
<thead>
<tr>
<th>Number</th>
<th>Depth (cm)</th>
<th>Radiocarbon dates (BP)</th>
<th>Calibrated dates (95.4 % confidence level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GrN-25580</td>
<td>227–229</td>
<td>2290 ± 100</td>
<td>760 cal BC – 60 cal BC</td>
</tr>
<tr>
<td>GrN-23941</td>
<td>240–243</td>
<td>2130 ± 70</td>
<td>377 cal BC – 1 cal AD</td>
</tr>
<tr>
<td>GrN-27076</td>
<td>261–264</td>
<td>2390 ± 70</td>
<td>763 cal BC – 263 cal BC</td>
</tr>
<tr>
<td>GrN-25581</td>
<td>292–294</td>
<td>2510 ± 180</td>
<td>1045 cal BC – 170 cal BC</td>
</tr>
<tr>
<td>GrN-27077</td>
<td>336–340</td>
<td>2680 ± 70</td>
<td>1003 cal BC – 599 cal BC</td>
</tr>
</tbody>
</table>

Table 6.4 Radiocarbon dates from Laghi di Vescovo

6.3 Results from the pollen analysis

In general, the samples contained a lot of organic material and were meagre in pollen numbers. Consequently, we tried to achieve a pollen sum of 200 arboreal pollen minimum, and frequently, more than one slide had to be counted. Taxa, which occur only once in the sequence and count one or two individual pollen, are omitted from the diagram. These are represented in appendix D.

The pollen sum is made up of all arboreal pollen (except for Alnus) and all non-arboreal (herbaceous) pollen. Local pollen from, for instance, water plants are also left out of the equation. For the reason
that *Alnus* (in this research) dominates the arboreal pollen, but in fact represents the local vegetation, the species is also left out of the pollen sum.

In the description and interpretation of the pollen diagrams, a distinction is made between the regional or upland pollen and the local pollen signals. *Local/extra local pollen is released from the anther and is fallen to the ground below the source or at a very short distance from the source. Regional pollen grains are transported over larger distances and mixed in the atmosphere into a homogeneous pollen assemblage* (Janssen 1986). Indications for human interference into the landscape are described in detail. Figure 6.5 shows the presence of local and regional vegetation during wet and dry periods.

![Figure 6.5 Schematic sketch showing the presence of local and regional vegetation during relatively wet and dry periods](image)

### 6.3.1 Colle San Lorenzo

Between a depth of 212.5 cm and 105.5 cm, 8 spectra were counted by dr. Stuijts. In general, the pollen was very corroded indicating unfavourable conservation circumstances (too dry). In the top, relatively large amounts of charcoal were present. The results are shown in figure 6.5: Colle San Lorenzo pollen diagram.

The diagram (figure 6.6) can be divided into the following pollen assemblage zones:

**Pollen assemblage zone I (spectra 1, 2 and 3): Vitis-Pinus-Quercus robur**

Zone I is mainly characterised by a significantly rise of tree pollen, especially *Vitis, Pinus,* and *Alnus* and is divided into two sub-zones:

**Pollen assemblage sub-zone Ia (spectra 1 and 2): Vitis-Pinus-Beta**

Starting some 4500 years before present, zone Ia shows a rise of *Pinus* and *Vitis. Quercus robur, Hedera* and *Ulmus* also increase.

Furthermore, the first half of this zone is characterised by a substantial decrease of *Beta*-type, in the second half this herb completely disappears, whereas *Artemisia-herba-alba-type, Plantago lanceolata-type, Urtica dioica-type* and *Rumex acetosella* increase. *Cyperaceae* and *Gramineae* are present in relatively small percentages.

The local and aquatic vegetation shows a rise of *Alnus* and *Osmunda,* while *Dryopteris*-type declines drastically.
Pollen assemblage sub-zone 1b (spectrum 3): Quercus robur-Alnus
In zone 1b, the regional pollen signal shows that Quercus robur increases to its highest value, the same goes for Quercus coccifera-type and Quercus cerris-type, Corylus and Ostrya/Carpinus orientalis.

The diagram shows a slight increase of Graminae, while herbaceous pollen, such as Ericaceae, Solanum dulcamara, Trifolium-type and Cerealia-type appear.

Locally, Alnus, Nymphaea and Pteridium reach their highest values. Osmunda almost disappears.

Pollen assemblage zone IIa (spectra 4 and 5): Graminae-Cerealia
Compared to the first zone, regionally, Hedera, Quercus robur-type, Pinus and Vitis decrease, Carpinus betulus and Corylus disappear entirely. Fagus shows a clear increase; it has its highest values in this zone only.

The zone is characterised by a significant increase of Beta-type, Cyperaceae, Graminae and Cerealia (Triticum). Furthermore, the diagram shows a slight increase of Atriplex, Senecio-type, Ericaceae, Compositae liguliflorae, leguminosae, Rumex acetosella and Ranunculus sceleratus-type.

Locally, Alnus decreases drastically, while other local plants, such as Sparganium-type and aquatics, such as Nymphaea and Lemna increase or remain constant. The zone shows a considerable amount of “thecaspores” (van Geel type 143) at the bottom, but these decline in the upper spectra.

Pollen assemblage zone IIb (spectra 6, 7 and 8): Quercus robur-Cyperaceae-cerealia
The last biozone (which started somewhere between 1400 and 1000 BC) is characterised by an arboreal decline or disappearance, except for Quercus robur and Pinus (though only present in small percentages).

The diagram shows a substantial expansion of Cyperaceae and a decrease but also a gradually increase of Graminae to the top of the zone. Cerealia occur in relatively small percentages. At the bottom of the biozone, Trifolium and Polygonum aviculare reach their highest values.

Locally, Sparganium, Pteridium and Isoetes also increase. Osmunda reappears, though in small percentages only.

The upper layer contained an abundance of fine charcoal.
6.3.2 Lago di Fogliano

From the Lago di Fogliano core, 20 spectra were examined. The table below shows which spectra Stuijts, Woldring and myself counted.

<table>
<thead>
<tr>
<th>Person</th>
<th>Stuijts</th>
<th>Van Joolen</th>
<th>Woldring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectra in cm below the surface</td>
<td>107, 130, 155 (partly), 205 (partly), 251, 260, 270, 280</td>
<td>70, 155 (partly), 160, 185, 190, 205 (partly), 215, 236, 241, 545, 655, 670</td>
<td>325, 450</td>
</tr>
</tbody>
</table>

Table 6.5 Overview of all spectra, which were examined from the Lago di Fogliano-core and the three persons involved

The results are shown in figure 6.7: Lago di Fogliano pollen diagram. Although special attention is paid to the analysis of the upper part (from the top to a depth of 280 cm) of the Fogliano core (level 6 to 20), the lower part (to a depth of 660 cm) provides a glimpse upon the vegetation development before some 3500 years before present.

Therefore, the diagram is divided into three pollen assemblage zones, of which the second zone is divided into two different sub-zones:

Pollen assemblage zone I (spectra 1, 2, 3, 4, 5, 6): Quercus robur

The diagram shows forest vegetation of predominantly Quercus, along with Carpinus betulus, Fagus and Ostrya/ Carpinus orientalis. Chenopodiaceae, Cyperaceae and Gramineae dominate the non-arboreal pollen.
Pollen assemblage zone IIa (7, 8, 9, 10, 11, 12, 13): Quercus robur-Ostrya/Carpinus orientalis-Gramineae

Sub-zone IIa starts about 3600 BP (2400–1525 cal BC) and ends somewhere around 3400 BP (1940–1455 cal BC). This lower zone is characterised by forest vegetation of predominantly Quercus robur, accompanied by Fraxinus excelsior, Salix, Ostrya/Carpinus orientalis, Carpinus betulus, Corylus, Pinus and Ulmus. Vitis and Olea occur throughout the whole sequence, though in relatively small quantities, whereas Juglans, Quercus cerris and Quercus coccifera (ilex) abruptly disappear in the second half of the zone.

Gramineae, Ericaceae and Cyperaceae dominate the non-arboreal pollen. Anthropogenic indicators, such as Triticum (at a depth between 250 and 270 cm), Plantago lanceolata, Centaurea solstitialis and Urtica only occur in the lowest half of the zone in relatively small numbers.

Aquatic plants and green algae (Pediastrum boryanum, P. clathratum and P. kawsraisky) mark the local vegetation. Pteridium occurs in the first half of the zone, whereas Isoetes appears throughout the whole zone.

Generally, the samples include a lot of organic material, but low charcoal quantities. The pollen is well preserved.

Pollen assemblage zone IIb (spectra 14, 15, 16, 17, 18): Fraxinus excelsior-Osmunda-Dryopteris

Starting some 3400 years before present (1940–1455 cal BC), sub-zone IIb ends about 2400 years before present (761–209 cal BC). Despite principally showing a continuation of sub-zone IIa, sub-zone IIb is characterised by low and poorly preserved (especially Alnus) pollen percentages, an increasing amount of charcoal from the bottom to the top and varying quantities of organic material in the samples. Moreover, most aquatic species decrease or disappear throughout the sequence.

Tree pollen still dominate, particularly Quercus robur, Fraxinus excelsior and Salix. Vitis and Olea emerge and disappear repeatedly throughout the whole sequence, though in small percentages.

The herbaceous pollen does not differ significantly from the first sub-zone in that Gramineae, Cyperaceae and Ericaceae are the most prominent species. Indicators of agricultural activities (Plantago lanceolata, Artemisia vulgaris and Centaurea solstitialis) appear and disappear dispersed over the sequence. However, locally, the situation changes.
Locally, *Alnus* reaches its highest values in the first half of the sub-zone, but after that it decreases rapidly. *Nymphaea* and the green algae have disappeared. In the first half of the zone, *Osmunda* and type143 (van Geel 1996) dominate, whereas the second half shows a significant emergence of *Dryopteris* and *Typha latifolia*.

**Pollen assemblage zone III (spectra 19 and 20): Myrtus-Chenopodiaceae-Atriplex**

The lower boundary of zone III is dated around 2400 BP (761–209 cal BC). The regional pollen signal is characterised by *Quercus robur* with some *Carpinus betulus* and *Corylus*. *Vitis* gradually disappears, whereas *Olea* slightly increases to the upper boundary of zone III. *Juglans* once again emerges at a depth of 107 cm, but disappears later. The diagram also shows a remarkable presence of *Myrtus*.

Furthermore, zone III is characterised by an increase of non-arboreal pollen, especially Chenopodiaceae and *Atriplex*. Gramineae, Cyperaceae and Ericaceae still occur, though in relatively small percentages. *Triticum*, *Plantago lanceolata*, *Artemisia vulgaris* and *Artemisia herba-alba* suggest human environmental influence.

Locally, *Alnus*, *Sparganium*, *Typha latifolia* and aquatics such as *Nuphar*, *Nymphaea* and *Potamogeton* significantly decrease and/or disappear.

The samples contain a lot of relatively small particles of charcoal and little organic material. The pollen is severely corroded.

### 6.3.3 Laghi di Vescovo

In the peaty lithology, between 280 cm and 210 cm, eight levels were examined for pollen analysis by dr. Stuijts. The results are shown in figure 6.8: the Laghi di Vescovo diagram, which is divided into three pollen assemblage zones.

**Pollen assemblage zone I (spectra 1 and 2): Quercus-Cladium**

This zone starts somewhere after 2500 BP and is characterised by forest vegetation of predominantly oak (*Quercus coccifera, Q. robur-type* and *Q. cerris-type*), *Ostrya/Carpinus orientalis*, *Abies* and some low percentages of *Olea* and *Vitis*. 
Cladium, Graminae, Mercurialis annua, Sparganium-type and Dryopteris represent the most important local vegetation.

The samples contained low percentages of charcoal and the pollen only sporadically showed signs of corrosion. Especially Gloeotrichia fruit bodies (van Geel 1996: type 8) were found in these levels.

Pollen assemblage sub-zone IIa (spectrum 3): Ulmus-Ericaceae-Artemisia-vulgaris-type

Sub-zone IIa is characterised by a Quercus decrease and a Pistacia expansion. Vitis and Olea disappear.

The diagram shows a notable increase in non-arboreal pollen, especially Artemisia vulgaris-type, Senecia-type, Cyperaceae, Cladium, Ericaceae, Mercurialis annua Plantagolanceolata-type and Ranunculus repens-type. In the local vegetation, Alnus, Dryopteris-type and Sparganium-type prevail.

Again, the sample showed low charcoal percentages.

Pollen assemblage sub-zone IIb (spectra 4, 5 and 6): Pistacia-Quercus

This zone is characterised by its relatively small percentages of pollen and charcoal and severe corrosion of the organic material. In the pollen sequence, a regeneration of the forest is visible, starting with Pistacia, Carpinus betulus, Quercus (especially Q. cerris-type), Fraxinus excelsior and Abies. At first, Quercus coccifera and Q. robur increase, but later, their percentages decline.

Only Cyperaceae and Graminae flourish around the lake and Alnus and Dryopteris inhabit its borders. Gloeotrichia is scarcely present.

Pollen assemblage zone III (spectra 7 and 8): Castanea-Cladium

Anthropogenic indicators, such as Castanea and Olea emerge (again) during this zone, while a variety of trees increase: especially Ostrya/Carpinus orientalis, Fraxinus excelsior, Phillyrea-type and Ulmus, giving rise to a maquis-like forest.

Furthermore, the biozone is characterised by high percentages of Cladium and a rise or emergence of Atriplex-type, Compositae lugiliflorae, Artemisia herba-alba-type, Senecio-type and Ranunculus repens-type.

Locally, Alnus reaches its highest values. At a depth of 230 cm, Triticum and Trapa (water nut) have been found. Gloeotrichia increases to the top of this zone.

The sample contained relatively low values of charcoal.
6.4 Interpretation

Unless indicated, the ecological descriptions of the plant families and species have been derived from Sandro Pignatti’s *Flora d’Italia* (1982). Occasionally, Weeda et al. (1994) has been used as well.

6.4.1 Colle San Lorenzo

In general, the analysis of the pollen from the Colle San Lorenzo-core show the following results: from the bottom to the top the diagram reviews a transition from a pine-oak dominated forest to a more open landscape inhabited by herbs and particularly, cyper grasses. Anthropogenic influence is shown by the increase of cerealia from about 3000 BP onwards and the continuous decline of the forest until at least somewhere around the birth of Christ.

Figure 6.8 schematically shows the interpretation of the diagram. Some remarks concerning this (and the following) drawing(s) must be made. Firstly, because of the few radiocarbon dates and the variations in the calibration, the research periods could not be distinguished exactly from the diagrams. So the drawing of figure 6.7 should not be read without reading the text below first. Furthermore, the terms 'wet' and 'dry' must be considered to be relative and concern local circumstances.

**Pollen assemblage sub-zone Ia: Vitis-Pinus-Beta**

The zone starts somewhere between 3500 to 3000 BC with an open landscape, dominated by non-arboreal pollen, but gradually forest vegetation appears in the regional areas around the core. *Vitis* probably is wild, because of the large amount of pollen in the diagram (cross-or wind pollination versus self-pollination of the domesticated *Vitis* with low numbers of pollen grains; personal communication S. Bottema).

*Artemisia-herba-alba*, plantain, stinging nettle and *Rumex acetosella* indicate the emergence of agricultural activities, probably on the fertile tuff slopes of the Alban volcano. The increase of alder, *water lily* and royal fern, accompanied by the substantial decrease of *Dryopteris*, show progressively wet local circumstances.

**Pollen assemblage zone Ib: Quercus robur**

Regionally, the pine trees are replaced by mixed oak forest with some hazel and hophornbeam. Anthropogenic influence is more and more apparent by the increase of cereals and other grasses. A marshy area surrounds the Colle San Lorenzo location with some alder forest accompanied by undergrowth of bracken (*Pteridium*).

**Pollen assemblage zone IIa: Graminae-Cerealia**

More agricultural activities (probably on the tuff spurs of the Alban hills) are proved from the late Bronze Age, indicated by the significant increase of cereals (wheat) and the dramatically decrease of tree pollen. Obviously, more land was needed for farming practices and trees were cut, leaving behind a less dense oak-beech forest.

Lithologically (at a depth of 171 cm), the zone shows a transition from a low-energetic environment with peat development to a dynamic environment, in which sandy loam (though very humous) was deposited. At the top of this zone, even coarse sandy loam with pebbles was found. This may be the result of erosion of the deforested and cultivated soils of the Alban hills, leading to increased terrestrial sedimentation in the rather flat area between the volcanoes and the sea. This also explains the resemblance of the two radiocarbon dates at depth of 172 cm and 155 cm: a lot of sediment was deposited in a relatively short period of time. Penny grass (indicative for dynamic settings), duckweed and water lily indicate a local marshy area, surrounded by sedges.

**Pollen assemblage zone IIb Quercus robur-Cyperaceae-Cerealia**

The remarkable decline of all tree pollen except for *Quercus robur* and the increase of grasses demand explanation. The situation resembles biozone 9 in the Mezzaluna diagram (Hunt and Eisner 1991).
According to the authors, the increase of common oak and grasses may be an indication for a major dry phase or it is a local phenomenon. Signs of agricultural practices are still present: wheat, *Polygonum aviculare* and *Rumex* comprise some of the examples. The continuation of an open landscape can be interpreted as a result of human interference by deforestation, leaving common oak in peace. This may be justified by the fact that the fruits were highly praised as food for pigs. Moreover, oaks withstand grazing and fire and germinate quickly in open landscapes as opposed to many other trees.

Figure 6.9 Schematic overview of the local and regional changes in vegetation in the vicinity of Colle San Lorenzo in the western part of the Pontine Region

Conclusions

Summarising the above mentioned interpretations, it is concluded that:

- In the period between 3500 and 1000 cal BC, the area faced (at least locally) increased desiccation, especially somewhere between 1400 and 1000 cal BC. In this period, the local aquatics disappear.
- The diagram proves anthropogenic agricultural activities from at least the Neolithic period. Probably, the volcanic soils were taken into use (though marginally compared to the following periods).
- The arboreal pollen decline may be caused by a dry period, but deforestation with accompanying soil erosion cannot be excluded as well, as proved by the coarse sediment in the zone as a consequence of high deposition rates.

6.4.2 Lago di Fogliano

*Pollen assemblage zone I: Quercus robur*

Pollen assemblage zone 1a more or less resembles the starting period, in which some anthropogenic activities are present, in that *Quercus robur* is increasingly reduced. But more levels have to be analysed in order to obtain a better understanding of Neolithic human interference with the Fogliano landscape.
Pollen assemblage zone IIa: Quercus robur-Ostrya/Carpinus orientalis-Gramineae

Perhaps the foot slopes of the Monti Lepini were used for small-scale cultivation of olives and walnut. On the higher slopes of the Lepini mountains a mesophyllous deciduous forest grew with common oak, hornbeam, hophornbeam, beech and hazel.

The occurrence of wheat (*Triticum*), plantain, *Centaurea solstitialis* and stinging nettle are signs of agricultural activities in the neighbourhood of the lagoon. Probably the fertile aeolian area was used for small-scale farming, whereas grazing took place on and between the beach ridges. The lagoon may have functioned as watering place for cattle.

The Early and Middle Bronze Age climatic and vegetation history of the southern part of the Pontine region, as can be interpreted from the Lago di Fogliano diagram, starts with a relatively wet episode in which the rather deep mesothropic to eutrophic (indicated by occurrence of pondweed and milfoil) lagoon of Fogliano was surrounded by a marshy area of predominantly sedges, grasses and amphibious bur-reed. The deep-water reservoir is proved by the abundance of water lily and *Pediastrum*. The palaeoecological implications of the three *Pediastrum* species are explained below.

- According to Komárek and Jankovská (2001), *Pediastrum simplex* (var. *clathratum*) can be considered a thermophilic species, which thrives in deep, eutrophic water. According to Bottema (1974) *Pediastrum simplex* can be considered an indicator of human impact (fertilisation by cattle dung).
- At the contrary, *Pediastrum kawsraiskyi* indicates oligotrophic lakes with water plants and cold and clear water (Bottema 1974, Komárek and Jankovská 2001).
- *Pediastrum boryanum* var. *boryanum* distributes in mesotrophic and eutrophic waters (Komárek and Jankovská 2001).

Figure 6.10 Pollen of *Pediastrum kawsraiskyi*

Obviously, the lagoon showed fluctuations in the nutrients supply (probably from local eutrophic water because of agricultural activities).

Pollen assemblage zone IIb: Fraxinus excelsior-Osmunda-Dryopteris

The remarkable change in pollen conservation and low pollen percentage can be interpreted to be the result of local drier circumstances rather than different sedimentation mechanisms, because the lithology resembles that of sub-zone Ia (organic clay). The disappearance of aquatics, such as water-lily, pondweed (*Potamogeton*) and water milfoil (*Myriophyllum*) and green algae confirm this.

The predominantly oak forest of zone Ia is gradually replaced by a more heliotropic mixed forest. However, the diagram does not show an increase of xeric forest vegetation, so different agents must have caused the drying-up phase. Perhaps the mountains were partly deforested (for wood, or to create small spots for a modest olive cultivation), thereby increasing soil erosion in the hinterland. Or parts of the lagoon were deliberately drained in order to diminish mosquito’s habitats.

Unpretentious human activities took place in the vicinity of the lagoon, proved by the occurrence of plantain, mugwort and knapweed.
An alder (probably with wild *Vitis*, because of its low percentages)- willow-ashtree forest, accompanied by undergrowth of royal ferns, grasses and sedges covered the swampy area surrounding the lagoon. Alder wood was found at a depth between 175 and 166 cm. The typical increase of the marsh plant *Typha latifolia* (bulrush) points to an environment, which has been disturbed by fire or by other causes (such as drainage or increased deposition of fine clayey sediments or organic material). Favourable areas for bulrush are sheltered spots at the edge of shallow waters or almost dried-up marshes.

*Pollen assemblage zone III: Myrtus-Chenopodiaceae-Atriplex*

Regionally, the common oak-hornbeam-hazel forest regenerates, but the variety of trees is diminished. Preparing land for olive cultivation (the percentage of *Olea* increases to the top of the zone) with accompanying deforestation may cause this phenomenon.

The diagram clearly shows intensified farming activities in the neighbourhood of Lago di Fogliano, as is concluded from the increasing numbers of herbaceous pollen (including pollen of wheat, *Artemisia* and plantain). The lagoon itself seems to have been dried-up even more: all aquatics vanish or at least decrease significantly throughout the zone. The surrounding alder-willow forest is replaced by an open landscape of mirte, grasses, heath and sedges.

The characteristic severe corrosion of the pollen in zone II may be caused by fluvial transportation, which can also be proved lithologically. The transition from peaty clay (from 150 cm to 127 cm) to grey sandy clay (from 127 to 50 cm) indicates an increasingly dynamic environment, possibly also influenced by marine floods, in which sandy sediments were deposited in the predominantly low-energetic lagoon. This marine influence can be deduced from the increase of Chenopodiaceae (under which also *Atriplex*). The goosefoot family and particularly orache generally are well adapted to saline circumstances.

Figure 6.11 visually shows these interpretations.
Conclusions

Two main conclusions can be drawn from the Lago di Fogliano diagram:

- The diagram unmistakably shows agricultural activities in the surrounding area from at least the early Bronze Age (probably even starting in the Neolithic), although there is no question of flourishing large farms. More probably, here and there, farmers cultivated some wheat for their own husbandry, using probably the fertile aeolian soils or the moist flanks of the beach ridges. However, somewhere between 761 and 209 cal BC, farming activities intensified, but still the area within a radius of 5 km (maximum airborne travel distance of wheat) could have been used only marginally.

- From the end of the Bronze Age or the start of the Iron Age, the lake of Fogliano shows local drying-up of the water-body as can be concluded from the disappearance of aquatics, low pollen conservation quality and low pollen percentages. However, the diagram does not prove a regional desiccation phase, since the arboreal pollen sum continues to be constant throughout the zone, although the forest composition changes.

6.4.3 Laghi di Vescovo

Figure 6.12 schematically shows the variations in vegetation in the Vescovo-region.

Pollen assemblage zone I: Quercus-Cladium

During and somewhere after 2500 BP, the Monti Lepini were covered by mixed oak forest. It is uncertain whether (probably cultivated) *Vitis* and *Olea* grew at the footslopes of the mountains (because of their relatively low percentages), but colonists of cultivated soils, such as *Rumex acetosella*, *Mercurialis annua* and *Artemisia vulgaris* affirm this assumption.
The Vescovo diagram suggests rather dry circumstances by the absence of aquatic plants. Furthermore, *Cladium*, *Sparganium* and *Dryopteris* suggest moist or shallow water conditions.

**Pollen assemblage sub-zone IIa: Ulmus-Ericaceae-Artemisia-vulgaris-type**

The arboreal pollen decrease is caused by further human interference within the landscape (deforestation), especially *Quercus coccifera* declines rapidly. This phenomenon has also been shown in the Monticchio-pollen diagram of Haagsma (1993). The woods probably were cut for fuel, building material and for the creating of open spaces for grazing. The rise of open ground species, such as *Artemisia vulgaris*-type, *Senecio*-type, *Cyperaceae*, *Ericaceae*, *Mercurialis annua*, *Plantago lanceolata*-type and *Ranunculus repens*-type indicate anthropogenic environmental influence for this purpose too. Human influence is progressively more visible by the appearance of a wide variety of anthropogenic indicators.

**Pollen assemblage sub-zone IIb: Pistacia-Quercus**

The significant rise of sclerophyllous species such as *Pistacia lentiscus* indicates the regeneration of an open forest (Burnie 1995) on the mountain slopes, accompanied by hornbeam (*Carpinus betulus*) and heliotropic taxa such as ashtree (*Fraxinus excelsior*).

The disappearance of aquatic plants and most non-arboreal pollen (except for *Cyperaceae* and *Gramineae*) and the significant rise of *Dryopteris* suggest a drier phase in the pollen record. The exceptionally small pollen percentages and the severe corrosion of all organic material indicate the water body was dried-up and oxidation took place. Alder (*Alnus*) is present throughout the whole zone, though in small percentages only.

**Pollen assemblage zone III: Castanea-Cladium**

The emergence and significant rise of *Castanea* together with a slight appearance of *Olea* suggest that the trees were planted, probably at the footslopes of the mountains, which were more and more covered by deciduous forests of predominantly oak (*Quercus cerris* and *Quercus coccifera*). *Gramineae* increase rapidly, but no rise of agricultural indicators (except for the two pollen grains of wheat found at a depth of 230 cm) could be distinguished and the diagram shows no important increase of colonists, such as *Plantago*, *Rumex* or *Urtica*.

From the diagram, at least locally, a gradually wetter environment can be inferred because of the considerable rise of alder, bur-reed, water nut and water milfoil and the increase of local herbs, grasses and *Cladium*.

**Conclusions**

- It can be concluded that the local area in the vicinity of the lakes of Vescovo was unsuitable for agriculture, probably because of the wet soil conditions most of the time or maybe because of the sulphurous underground. At least from the Roman period onwards, human activities took place at the foothills of the Lepini, probably sweet chestnut cultivation and in small quantities, olives. Evidence for vine cultivation cannot be proven from the Vescovo pollen core.
- Somewhere during the Roman Age, the Laghi di Vescovo area became progressively dry, probably by Roman drainage activities to improve cultivation areas and to stop malaria (Attema 1993).
- Unfortunately, the Laghi di Vescovo core cannot be linked to the Mezzaluna core (Eisner et al. 1986 and Hunt & Eisner 1991). The oldest date of around 2700 years before present at a depth of 340 cm (table 6.4) does not correspond with the top layers of the Mezzaluna core. The Vescovo core describes the vegetation history between roughly 800 BC and the birth year of Christ, whereas the Mezzaluna core probably ends somewhere around 1100 BC with a dry phase. If this last assumption is correct, this may explain a hiatus between the Mezzaluna core and the Vescovo core, for in a dry period oxidation of organic material destroys the linear vegetation history. Therefore, a deeper core in the Vescovo lakes is necessary in order to solve this mystery.
6.5 Reconstruction of the Late-Holocene climate and vegetation history in Central Italy and especially, the Pontine region in the last three millennia

This paragraph gives an overview of all pollen analytical research executed in Central and South Italy, especially concentrated on the period roughly between 5000 and 2000 years before present. Next, combined with the results from my research in the Pontine plain (Colle San Lorenzo, Laghi di Fogliano, Laghi di Vescovo), I have tried to provide a detailed description of the climatic circumstances in the Bronze Age, Iron Age and Archaic/Roman Age. Also, the anthropogenic influences on the natural vegetation and possible agricultural activities in the Pontine region, as can be derived from the various pollen diagrams, are shown below.

6.5.1 Climate and vegetation history in Central and South Italy, focused especially on the Pontine region

6.5.1.1 Subboreal-Bronze Age (3000–1000 BC)

Early Subboreal (Calcolitico) climate is interpreted as temperate and wet accompanied by an expansion of the forest, with deciduous oaks, hazel, beech, elm and birch (Alessio et al. (1986). Locally, alder carr and willow replaced the mixed oak forests (Eisner et al 1986, Hunt and Eisner 1991).

Starting from the early Bronze Age, Frank (1968) interprets the low values of Artemisia in the open vegetation in this period and the disappearance of pine, juniper-tree, Ephedra and Chenopodiaceae to be the result of human influence on the natural vegetation. The diagram of Martignano (Kelly et al. 1991) also shows clearance activities, in that the woods progressively decline. Furthermore, the rise of wild grasses, several ruderal taxa (for instance Plantago major/media, Plantain and Rosaceae) and arable crops indicate pastoral and agricultural activities in the crater. Alnus is present, probably growing around the lake throughout the whole episode. Because of the establishment of the mixed mesophyllous forest dominated by deciduous oaks, hophornbeam, beech, hornbeam, alder, hazel and sweet chestnut, climate is depicted as relatively warm, but possibly slightly drier than the previous period (Frank 1968, Kelly et al. 1991).

South Italy

According to Watts et al. (1996), from 2800 BP onwards, vegetation is distinguished by an evergreen woodland and shrubs of Pistacia, Ericaceae and olive. Fir and yew disappear, whereas hophornbeam and beech reach high values. Anthropogenic influences are indicated by the presence of sweet chestnut and walnut, a peak of olive and probably by the invasion of weeds (Plantago spp, Rumex and Pteridium) after forest cutting, shown also in the increase of the sum of herbs. But, according to the authors, this extensive forest clearance cannot be linked to any known archaeological events. Appearance of fir with Taxus as an understorey tree can be the result of clearance or because of a climatic change (for example increasing summer dryness). Presence of water-lily and pondweed macrofossils suggests a brief rise of the water-table of the lake.

Human interference in the Pontine region during the Bronze Age

From the Albano and Nemi-cores (Lowe et al. 1996), the Colle San Lorenzo core and the Campoverde-core (Veenman 1996), it is evident that cereals (certainly wheat) were already cultivated in the Bronze Age, most probably on the volcanic soils in the north-western part of the Pontine region. In order to gain more land for farming, deforestation practices were common, resulting in (severe) erosion of the vulnerable volcanic soils. Polygonum aviculare and Urtica indicate local grazing. In the Campoverde-core, Linum usitatissimum-type (flax) was found (Veenman 1996), indicating that this crop was locally cultivated.

In the southern part of the Pontine region, small-scale wheat cultivation was demonstrated in the vicinity of Lago di Fogliano, probably on the aeolian deposits east of the lagoon, whereas on the foot slopes
of the Monti Lepini grew olives and walnuts in small quantities. The surrounding beach ridges may have been used for grazing.

In the north-eastern area, anthropogenic indicators, such as *Artemisia*, goosefoot, *Vicia*, *Cistus* and plantain indicate agricultural and pastoral activities in the neighbourhood of Mezzaluna (Hunt and Eisner 1991).

6.5.1.2 Early Subatlantic-Iron Age (1000–600 BC)

The Subatlantic (since 3000 BP) may have started with a major dry phase around 1100 BC (Eisner et al. 1986; Hunt and Eisner 1991). It is characterised by a decline of alder and a rise of oak and grasses (as indicated before). According to Hunt and Eisner (1991), this could be a sign of a dry period or it could be a local phenomenon. Alessio et al. (1986) argue that the change of vegetation in this period is the result of the climatic shift to less humid conditions, rather than the effect of anthropogenic influences, notwithstanding the diffusion of chestnut. They claim that Iron Age climate can be considered as Mediterranean, as confirmed by the presence of *Quercus ilex*, *Viburnum*, *Ericaceae* and *Oleaceae*. In this period humidity decreased, while temperature increased. Paleontologically, climate can be interpreted to be less humid too.

From the Colle San Lorenzo diagram it is evident that somewhere between 1400 and 1000 BC, the arboreal vegetation declines to almost negligible values. This may reflect the above-described dry phase, but the top of the core has not been dated yet, so whether we deal with a phase at all is uncertain. The decline can also be interpreted as the result of severe deforestation practices in order to obtain agricultural fields, as can be proved by the significant rise of cereals in this period.

**Human interference in the Pontine region during the Iron Age**

The volcanic area in the north-west was used for cereal farming (Lowe et al. 1996), with the accompanying down cutting of trees. Further expansion of barley and wheat/rye and the decline of trees (mainly deciduous oaks) are the result of human interference, which is also evident from the Colle San Lorenzo core.

More south, the Fogliano area shows signs of disturbance of the local vegetation and a lowering of the water level in the lagoon. Herbs and weeds indicate that some farming activities took place in the neighbourhood.

For the eastern area in the Pontine region, the vegetation history still remains unsolved.

6.5.1.3 Archaic and Roman Age

According to Bonatti (1970), the sudden increased sedimentation rate detected in the core at a depth of 150 cm corresponds to the Roman period (2200 BP, Stuiver and Deevey 1962). This is also reflected by the increase of *Myriophyllum* and the decrease of *Sphagnum*, indicating an (artificially) increase of the water level as result of Roman activity. Increase of Urticaceae, cultivated cereals and sweet chestnut indicate human interference by agriculture and grazing.

**Human interference in the Pontine region during the Archaic and Roman Age**

Both from the Colli Albani-cores (Lowe et al. 1996) and the Colle San Lorenzo-core, human activities endure in the western and south-western Pontine area during the Roman Age, indicated by the large expansion of chestnut, walnut and olive and the continuing presence of cerealia. The Colli Albani cores contain material and pollen dating modern times, because of the presence of maize (*Zea mays*) at a depth of 10 cm. This New World crop has been introduced only recently. From the Campoverde-core (Veenman 1996), deforestation activities can be inferred starting somewhere around 1910 BP.
According to Haagsma (1993), most of the lower parts of the Pontine region had wet conditions during the whole of the first millennium BC. So the area surrounding Monticchio (alluvial sheet; see chapter 4) was probably used for extensive grazing indicated by open landscape types as grasses, *Compositae tubuliflorae* and *Caryophyllaceae*.

Haagsma (1993) and the Vesvoco-core prove cutting activities in the oak-dominated forest starting somewhere before 400 BC, probably in the Archaic period. Subsequently, olive, chestnut and walnut were probably cultivated on the elevated and terraced foothills of the Monti Lepini. The Pontine plain remained wet, useable only for extensive grazing.

Although the Fogliano-core shows signs of agriculture, the coastal zone was used for cereal cultivation only marginally.

### 6.6 Appendix

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<td></td>
</tr>
<tr>
<td><em>Olea</em></td>
<td>Olijf</td>
<td>Olive</td>
</tr>
<tr>
<td><em>Ostrya/Carpinus orientalis</em></td>
<td>Hopbeuk</td>
<td>Hophornbeam</td>
</tr>
<tr>
<td><em>Phillyrea</em></td>
<td>–</td>
<td></td>
</tr>
<tr>
<td><em>Pinus</em></td>
<td>Den</td>
<td>Pine</td>
</tr>
<tr>
<td><em>Pistacia</em></td>
<td>–</td>
<td>Mastic tree, Lentisc</td>
</tr>
<tr>
<td><em>Quercus cerris</em></td>
<td>Moseik</td>
<td>Turkey Oak</td>
</tr>
<tr>
<td><em>Quercus coccifera/ Q. ilex</em></td>
<td>Steeneik/--</td>
<td>Kermes or Holly Oak  Holm Oak</td>
</tr>
<tr>
<td><em>Quercus robur</em></td>
<td>Zomereik</td>
<td>Common Oak</td>
</tr>
<tr>
<td><em>Salix</em></td>
<td>Wilg</td>
<td>Willow</td>
</tr>
<tr>
<td><em>Ulmus</em></td>
<td>Iep</td>
<td>Elm</td>
</tr>
<tr>
<td><em>Vitis</em></td>
<td>Druif</td>
<td>Grape</td>
</tr>
</tbody>
</table>

*Table 6.6 List of Arboreal Pollen (AP)*
<table>
<thead>
<tr>
<th>Latin</th>
<th>Dutch</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artemisia herba-alba</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Artemisia vulgaris</td>
<td>Bijvoet</td>
<td>Mugwort</td>
</tr>
<tr>
<td>Atriplex</td>
<td>Melde</td>
<td>Orache</td>
</tr>
<tr>
<td>Beta</td>
<td>Biet</td>
<td>Beet</td>
</tr>
<tr>
<td>Caryophyllaceae</td>
<td>Anjerfamilie</td>
<td>–</td>
</tr>
<tr>
<td>Centaurea solstitialis</td>
<td>Zomercentaurie</td>
<td>Knapweed</td>
</tr>
<tr>
<td>Chenopodiaceae</td>
<td>Ganzevoetfamilie</td>
<td>Goosefoot</td>
</tr>
<tr>
<td>Cladium</td>
<td>Galigaan</td>
<td>Galigane</td>
</tr>
<tr>
<td>Compositae</td>
<td>Composietenfamilie</td>
<td>–</td>
</tr>
<tr>
<td>Cyperaceae</td>
<td>Cypergrassenfamilie</td>
<td>–</td>
</tr>
<tr>
<td>Ericaceae</td>
<td>Heidefamilie</td>
<td>Heath family</td>
</tr>
<tr>
<td>Eryngium</td>
<td>Kruisdistel</td>
<td>Holly</td>
</tr>
<tr>
<td>Gramineae</td>
<td>Grassenfamilie</td>
<td>Grasses</td>
</tr>
<tr>
<td>Leguminosae</td>
<td>Vlinderbloemenfamilie</td>
<td>Leguminosae</td>
</tr>
<tr>
<td>Lythrum</td>
<td>Kattestaart</td>
<td>Purple Loosestrife</td>
</tr>
<tr>
<td>Mercurialis annua</td>
<td>Tuinbingelkruid</td>
<td>Mercury</td>
</tr>
<tr>
<td>Plantago lanceolata</td>
<td>Smalle weegbree</td>
<td>Plantain</td>
</tr>
<tr>
<td>Polygonum aviculare</td>
<td>Varkensgras</td>
<td>Knottgrass</td>
</tr>
<tr>
<td>Ranunculus repens</td>
<td>Kruipende boterbloem</td>
<td>Buttercup</td>
</tr>
<tr>
<td>Ranunculus sceleratus</td>
<td>Blaartrekkende boterbloem</td>
<td>–</td>
</tr>
<tr>
<td>Rumex acetosella</td>
<td>Schapezuring</td>
<td>Sheepsorrel</td>
</tr>
<tr>
<td>Senecio</td>
<td>Kruiskruid</td>
<td>Ragwort</td>
</tr>
<tr>
<td>Solanum dulcamara</td>
<td>Bitterzoet</td>
<td>Bittersweet</td>
</tr>
<tr>
<td>Spergula arvensis</td>
<td>Gewone spurrie</td>
<td>Spurrey</td>
</tr>
<tr>
<td>Thalictrum</td>
<td>Ruit</td>
<td>Meadow Rue</td>
</tr>
<tr>
<td>Trifolium</td>
<td>Klaver</td>
<td>Clover</td>
</tr>
<tr>
<td>Umbelliferae</td>
<td>Schermbloemenfamilie</td>
<td>Umbelliferae</td>
</tr>
<tr>
<td>Urtica dioica</td>
<td>Grote brandnetel</td>
<td>Nettle</td>
</tr>
<tr>
<td>Urticaceae</td>
<td>Brandnetelfamilie</td>
<td>Nettle family</td>
</tr>
</tbody>
</table>

*Table 6.7  List of Non Arboreal Pollen (NAP)*
<table>
<thead>
<tr>
<th>Latin</th>
<th>Dutch</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Dryopteris</em></td>
<td>Niervaren</td>
<td>–</td>
</tr>
<tr>
<td><em>Hydrocotyle</em></td>
<td>Waterlavel</td>
<td>Penny or shilling grass</td>
</tr>
<tr>
<td><em>Isoetes</em></td>
<td>Biesvaren</td>
<td>Quillwort</td>
</tr>
<tr>
<td><em>Lemna</em></td>
<td>Eendekroos</td>
<td>Duckweed</td>
</tr>
<tr>
<td><em>Lemnaceae</em></td>
<td>Eendekroosfamilie</td>
<td>Duckweed</td>
</tr>
<tr>
<td><em>Myriophyllum spic./vert.</em></td>
<td>Vederkruid</td>
<td>Water milfoil</td>
</tr>
<tr>
<td><em>Nuphar</em></td>
<td>Gele plomp</td>
<td>Yellow water-lily</td>
</tr>
<tr>
<td><em>Nymphaea</em></td>
<td>Waterlelie</td>
<td>Water-lily</td>
</tr>
<tr>
<td><em>Osmunda</em></td>
<td>Koningsvaren</td>
<td>Royal fern</td>
</tr>
<tr>
<td><em>Pediastrum boryanum</em></td>
<td>Groene alg</td>
<td>–</td>
</tr>
<tr>
<td><em>Pediastrum clathratum</em></td>
<td>Groene alg</td>
<td>–</td>
</tr>
<tr>
<td><em>Pediastrum kawraisky</em></td>
<td>Groene alg</td>
<td>–</td>
</tr>
<tr>
<td><em>Polypodium vulgare</em></td>
<td>Gewone eikvaren</td>
<td>–</td>
</tr>
<tr>
<td><em>Potamogeton</em></td>
<td>Fonteinkruid</td>
<td>Pondweed</td>
</tr>
<tr>
<td><em>Pteridium</em></td>
<td>Adelaarsvaren</td>
<td>Bracken</td>
</tr>
<tr>
<td><em>Sparganium</em></td>
<td>Egelskop</td>
<td>Bur-reed</td>
</tr>
<tr>
<td><em>Typha latifolia</em></td>
<td>Lisdodde</td>
<td>Reedmace, Bulrush</td>
</tr>
</tbody>
</table>

Table 6.8  List of local pollen