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The cultivation of *Castanea sativa* (Mill.) in Europe, from its origin to its diffusion on a continental scale

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Abstract The history of *Castanea sativa* (sweet chestnut) cultivation since medieval times has been well described on the basis of the very rich documentation available. Far fewer attempts have been made to give a historical synthesis of the events that led to the cultivation of sweet chestnut in much earlier times. In this article we attempt to reconstruct this part of the European history of chestnut cultivation and its early diffusion by use of different sources of information, such as pollen studies, archaeology, history and literature. Using this multidisciplinary approach, we have tried to identify the roles of the Greek and Roman civilizations in the dissemination of chestnut cultivation on a European scale. In particular, we show that use of the chestnut for food was not the primary driving force behind the introduction of the tree into Europe by the Romans. Apart from the Insubrian Region in the north of the Italian peninsula, no other centre of chestnut cultivation existed in Europe during the Roman period. The Romans may have introduced the idea of systematically cultivating and using chestnut. In certain cases they introduced the species itself; however no evidence of systematic planting of chestnut exists. The greatest interest in the management of chestnut for fruit production most probably developed after the Roman period and can be associated with the socio-economic structures of medieval times. It was then that self-sufficient cultures based on the cultivation of chestnut as a source of subsistence were formed.

Keywords Chestnut cultivation · Roman period · *Castanea sativa* · Palynology · Archaeology · Classical literature

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Introduction

The sweet chestnut (*Castanea sativa* Mill.) is a tree species that, perhaps more than any other in Europe, has attracted particular human attention. Its diffusion and active management, which make it difficult to trace its original range, have resulted in the establishment of chestnut at the limits of its potential ecological range (Pitte 1986; Bernetti 1995). During some historical periods, in various regions of Europe the cultivation of chestnut became so dominant and indispensable for the survival of mountain populations that some authors do not hesitate to identify these cultures as "chestnut civilizations" (Gabrielli 1994).

Many studies and monographs have been dedicated to the chestnut. Some of these concern purely botanical and economical aspects (for example, Lavialle 1906; Merz 1919; Piccioli 1922; Camus 1929; Fenaroli 1945; Bounous 1999; Berrocal del Brio et al. 1998; Bounous 2002). Others examine the ethnohistory of the species (Bruneton-Governatori 1984; Pitte 1986). Numerous publications are also concerned with chestnut cultivation at the regional level (for example Merz 1919; Rachewiltz 1992; Bounous 1999; Sauvezon et al. 2000). In most cases, however, the studies are based on the rich, even if only qualitative (that is, without any quantitative information on chestnut cultivation), written documentation available since medieval times (Quirós Castillo 1998); far fewer attempts have been made to describe the events which led to a chestnut culture in much earlier times (but compare the works of Hehn 1911 and Pitte 1986).

From the palynological point of view, the wealth of specific studies is in great contrast with a nearly total absence of thorough works of synthesis for the specific

theme of the chestnut culture. For instance, the recent work of Krebs et al. (2004) is limited to the Quaternary refugia of the species and does not deal with chestnut cultivation.

To the best of our knowledge, there has been no attempt at a multi-disciplinary approach to reconstructing the origin of chestnut cultivation and its spread throughout Europe in prehistoric times. In this article we make a first attempt to reconstruct the history of chestnut cultivation and its diffusion into most areas of central and southern Europe based on different sources of information, such as pollen studies, archaeology, history and classical literature.

Material and methods

Study area

For the definition of the study area, existing knowledge about the Quaternary refugia of the European chestnut was combined with information on the distribution of chestnut cultivation during the Middle Ages and today. Thus defined, the study area covers the greater part of Europe, extending as far east as the Caucasus Mountains and ranging in latitude from approx. 60°N to 30°N.

Palaeobotanical and palynological data

In searching for useful pollen records, we used the same approach and the same data sources as Krebs et al. (2004), which rely partly on existing databases on the internet (WDC 2003, EPD 2003, CiMPI 2003 and the Palaeoecological Atlas of Northern and Western Africa 2003). These sources of data have been combined with pollen diagrams published in scientific journals. In total 1471 sites in the study area were considered (Fig. 1). For the full list of the sites analysed see http://dx.doi.org/10.1007/s0034-004-0038-7.

Chronology

All the pollen profiles used were classified according to the quality of dating. For profiles providing a time axis or strong and coherent dating we proceeded to a linear interpolation between the dates. For profiles with mismatched radiocarbon datings or dated according to a comparison with sites with similar pollen stratigraphies, we adopted the dating proposed by the authors. For profiles without any dating, we proposed an approximate dating based on the expansions of representative taxa dated by radiometric methods at other neighbouring sites (for example, *Fagus*, *Corylus*, *Abies*, *Carpinus*, Lang 1994). If this was not possible, the profile was rejected. The use and presentation of data with doubtful dating will be taken up again in the discussion section.

Interpretation of pollen data

According to Behre (1990) *Castanea sativa* has to be considered a primary anthropogenic indicator in pollen diagrams. This is most certainly the case where the species did not survive the ice ages. In the presumed zones of natural shelter (refugia) of chestnut during the ice ages, its presence does not necessarily mean there was anthropogenic influence. The presence of the chestnut may indicate human activity, but this is likely only if there are other anthropogenic indicators as well. Only then can the presence of chestnut pollen be considered the direct result of human cultivation in the natural shelter zones of the species. In addition, the slope of the pollen curves may also reveal anthropogenic influence, since human influence usually manifests itself in a sudden rise in the slope of the curves and in the percentage values reached, which must sufficiently move away from the base values associated with the trees' natural presence. Moreover, the type of cultivation probably plays an important role, as the wild specimens produce pollen in abundance, while the cultivars selected for fruit tend to be male sterile (Rudow and Conedera 2001).

The analysis of the pollen data varied according to the quality of the data. Generally speaking, the studies conducted from the 1960's on were assigned greater importance, as they are based on core samples executed with modern drilling techniques. In the case of chestnut, an additional difficulty is the definition of the origin of the pollen used and therefore of the effective representation of the pollen curves. According to Huntley and Birks (1983), the presence of *Castanea* pollen can be regarded as a fairly reliable indication of

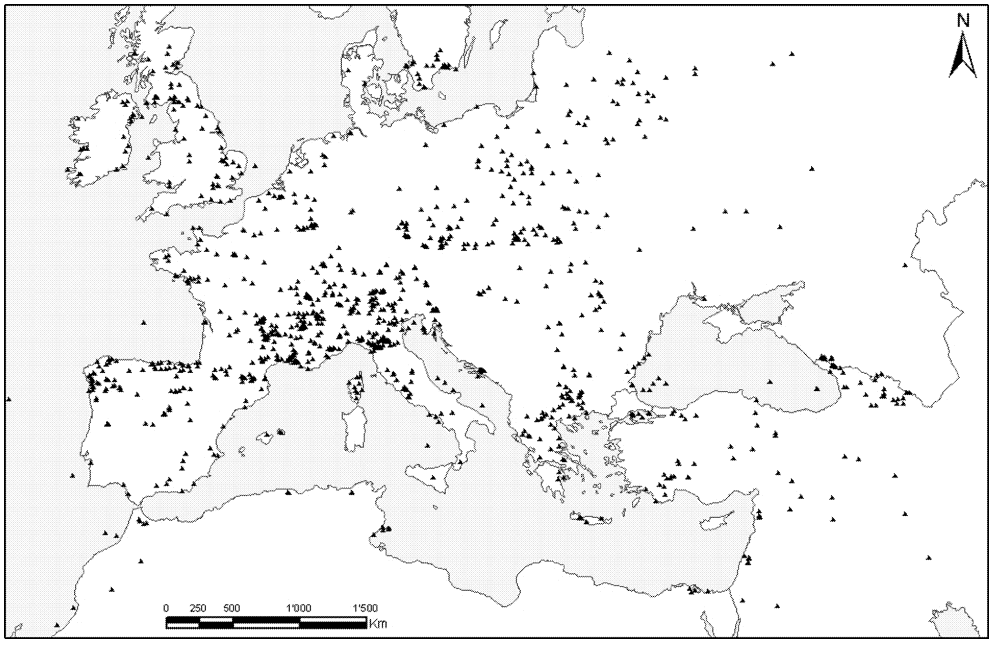


Fig. 1 Distribution of the pollen sites considered

the local presence of the species, and a pollen value greater than about 5% almost certainly reflects the widespread occurrence of chestnut woodland near the site. Other authors claim that the local topography combined with special meteorological conditions might cause transport of important amounts of chestnut pollen over long distances (up to more than 100 km) (Jochimsen 1986; Peeters and Zoller 1988) even along altitudinal transects (Brugiapaglia et al. 1998). Where chestnut pollen is less than 1–2%, it is difficult, as discussed in Krebs et al. (2004), to exclude confusion with pollen of *Lotus*, *Hypericum* or *Sedum*, which are morphologically very similar to *C. sativa* (Sanchez Goñi 1993). Palynologists today are usually aware of this problem, but it is not easy to solve (Mateus 1992). Finally, the interpretation of the presence or absence of *Castanea* pollen and its frequency in the diagrams must take into account the fact that the species does not grow readily on limestone soils (Gobet et al. 2000).

Given the large area covered in our study, we decided to consider as many profiles as possible, including sites at high altitude, even though these pollen records are likely to be affected by long-distance transport. Potential cases of misinterpretation of the data are then treated in the discussion.

Most of the pollen data is given in the form of maps. Where more detailed information is necessary, the specific source is indicated. In particularly significant cases, we also show selections from the original pollen diagrams.

Classical Greek and Roman literature

The study of the Roman and Greek classics was not conducted in a systematic way. The search for literary texts dealing with chestnut or its cultivation started with the authors who have already treated this problem (for example, Hehn 1911; Pitte 1986), and continued by cross-checking the references contained in several of the reports. We make no claim to have covered the literature exhaustively in our selection of authors and quotations. However, the historical-cultural contextual summaries of the references studied represent a very important aspect of our analysis (see Tables 1 and 2). The texts have been classified according to the background of the authors (historian, geographer, poet, agronomist, naturalist, etc.), the socio-historical context in which they worked and their motivations for writing (transmission of personal knowledge, compilation of previous authors, literary or poetic exercises, commissioned texts, etc). For the references cited, we have used the abbreviations listed in Tables 1 and 2.

An additional problem we faced is the lack of uniformity in the naming of the species in the classical literature in general, and in the Greek literature in particular. The lack of a commonly recognized scientific nomenclature forced the authors to either use generic expressions, or to employ denominations of local usage transmitted to them by people from different regions. The attribution of various names to the same species is therefore a recurrent and understandable practice in the ancient literature (Hehn 1911; Amigues 1988). In the case of the chestnut, the first reliable references are found in Theophrastus. Earlier possible references in the Greek literature are unreliable as the nomenclature used is too generic and of dubious value. Athenaeus indirectly confirmed this interpretation, asserting that “the Attics and the other writers call nuts all the fruits with a hard shell” (Deip. ii 52 a). A little later, Athenaeus, citing Heracleon of Ephesus, gives a more precise statement relating directly to chestnuts when he states that “almonds and today’s chestnuts were even called nuts” (Deip. ii 52 b). In Table 3, we describe the key used in this study for the interpretation of the Greek words potentially linked to chestnut (see also Tables 1 and 2).

Table 1 Greek authors considered in the analysis of the ancient literary sources

Author	Bibliographic notes	Texts with references of agricultural/chestnut interest and their reading keys	Relevance for chestnut cultivation[a]
Herodotus (Her.)	Historian. *490 B.C. in Halicarnassus (Caria), + probably before 420 B.C.	The *Histories* (His.) are a report on the Persian wars.	3
Hippocrates (Hip.)	The most famous Greek physician. *in Cos about 460 B.C., + probably in Larisa (Thessaly) 370 B.C.	The *Hippocratic Corpus* (H.C.) represents a collection of medical writings.	3
Xenophon (Xen.)	Historian and disciple of Socrates. *in Athens about 428 B.C., + 354 B.C.	He wrote on numerous subjects drawing on his varied experiences.	3
Theophrastus (Th.)	Philosopher and naturalist. *in Eresus (Island of Lesbos) about 370 B.C., + around 287 B.C. Pupil and friend of Aristotle and his successor as head of the Peripatetic School of Philosophy in Athens.	*Inquiry into plants* (Historia plantarum, H.P.), is divided into 6 books and deals with the classification and the description of the botanical world then known.	1
Nicander (Nic.)	Hellenistic didactic poet, *in Colophon, probably in the 2nd century B.C.	Of his numerous works only two have survived entirely: *Theriaca* (On poisonous animals) and *Alexipharmaca* (Antidotes to poisons, Alex.).	3
Strabo (Str.)	Geographer, *in Amasia (Pontus) 64 B.C., moved to Rome 44 B.C., + A.D. 24	The *Geography* (Geo.) describes the geography of the main countries in the Roman world	3
Dioskurides (Dios.)	Physician of the 1st century A.D. who served with the Roman army. His work was a standard textbook of pharmacy for many centuries.	In his five books of the *Pharmacopoeia* (Materia medica, Med.) the medicinal properties of some six hundred plants and nearly a thousand drugs are described.	3
Galenos (Gal.)	Greek physician, *in Pergamum A.D. 129, + in A.D. 199.	Galen’s writing formed the basis of all later medical works	3
Athenaeus (Ath.)	Writer from Naucratis (Egypt), around A.D. 200. His work is a fruitful source on the literature and practices of Ancient Greece.	The *Deipnosophistai* is about the conversations of 23 learned men on all aspects of food and other subjects.	2

[a] Levels of relevance
1: High. Proven and objective references to the agricultural techniques and to the products of the agriculture.
2: Medium. Indirect references or poetic descriptions of the agricultural reality and of the products of the earth.
3: Low. Occasional references to agricultural practices and to chestnut cultivation in particular.
Source: Howatson (1989).

Table 2 Latin authors considered in the analysis of the ancient literary sources

Author	Bibliographic note	Texts with references of agricultural/chestnut interest and their reading keys	Relevance for chestnut cultivation[a]
Cato (Cat.)	Military tribune, politician and orator, *in Tusculum (24 km SE of Rome) 234 B.C., + 149 B.C.	The *Liber de agricultura* (On farming, Agri.) was written between 164–154 B.C. and deals with the cultivation of wine, olives and cattle grazing for profit (latifundium).	1
Varro (Var.)	Poet, satirist, antiquarian, scientist, geographer, officer, and grammarian. *116 B.C. in Reate, in Sabine territory, + 27 B.C.	His work on farming (*De re rustica*, Rust.), dating from 36 B.C., is the only manuscript that entirely survived.	1
Vitruvius (Vitr.)	Roman engineer and architect of the 1st century B.C. Military service between 50 and 26 B.C. under Julius Caesar and the emperor Augustus.	He wrote a treatise in 10 books on architecture (*De architectura*, Arch.).	1
Virgil (Vir.)	Poet, *70 B.C. in *Andes,* near Mantua in Cisalpine Gaul. He was educated in Italy, +19 B.C.	*Eclogues* (*Bucolica,* Buc.) The Eclogues were written between 42 and 37 B.C. They became a model of pastoral poetry with allegoric components. *Georgics* (Related to agriculture, Geor.) are a didascalic poem presenting the life of the Italian small farmer as the ideal.	2
Ovid (Ov.)	Poet, * 43 B.C. in Sulmo (Abruzzi). He was educated in Rome and banished by Augustus to Tomis A.D. 8 where he died in A.D. 17.	*Ars amatoria* (Treatise on love, Ars) is a didactic poem about a classical Near Eastern legend with important historical and environmental references.	2
Martial (Mar.)	Roman poet, * A.D. 40 in Bilbilis (Spain), he moved to Rome in A.D. 64. In A.D. 98 he returned to Bilbilis, +around A.D. 103/04.	*Epigrams* (Epi.) are more then 1500 short satiric poems.	2
Columella (Col.)	Spaniard from Gades (Cadiz, Spain) who lived in the 1st century, tribune of the Roman army in Syria.	*De re rustica* (On farming, Rust.) was written between AD 60–65. It deals with the various aspects of farmer's life and work.	1
Pliny the Elder (Pl.)	Writer on natural history, *in Como (northern Italy) around A.D. 23/24. Probably educated in Rome, +A.D. 79, killed by the eruption of Vesuvius.	*Naturalis Historia* (Natural History, N.H.) is a compilation of the extant knowledge in 37 books about art, science and civilization.	1
Gargilius Martialis (Gar.Mar.)	Little is known about his life, *probably in Auzia around A.D. 200. Soldier and politician, +A.D. 260 during a battle.	From his *De Hortis* (On the garden, but also known as *De arboribus pomiferis*, Hort.) only 4 fragments survived. The fourth of them is on the chestnut (*de castaneis*). Unfortunately this chapter is not complete and only the first part concerning chestnut nurseries is present. But the citations of many lost authors make it very valuable.	1
Macrobio (Macr.)	Writer and philosopher, probably of African birth, lived around A.D. 400.	The *Saturnalia* (*Saturnaliorum convivia*, Sat.) are dialogues in 7 books supposed to represent a conversation at a banquet during the Saturnalian festival between a number of eminent Romans.	3
Palladius (Pal.)	Little is known about his life. He probably lived in the 4th century A.D. He is considered the last Latin writer on agriculture.	The treatise *Opus de agricoltura* (Agr.) represents a good compilation of the state of the art in agriculture.	1
Apicius (Ap.)	Marcus Gavius Apicius (A.D. 14–37), gourmet of the reign of Tiberius or Caelius Apicius (4th cent. A.D.)	The work *De re coquinaria* (On cookery (Cul.) is a collection of recipes that is thought to be a compilation of the fourth century.	3
Cassiodorus (Cas.)	Flavius Magnus Aurelius Cassiodorus (A.D. 490–583), son of a praetorian prefect of Theodoric, king of the Goths. Followed a political career until A.D. 514 and retired as a monk in Calabria.	The *Variae Epistolae* (Variae) is a collection of 12 letters he wrote for the Gothic kings to the most notable personages of the time. This work represents a valuable description of life and politics in the 6th century.	2

[a] Levels of relevance
1: High. Proven and objective references to the agricultural techniques and to the products of the agriculture.
2: Medium. Indirect references or poetic descriptions of the agricultural reality and of the products of the earth.
3: Low. Occasional references to agricultural practices and to chestnut cultivation in particular.
Sources: Howatson 1989; Sirago 1995; Carena 1982

Table 3 Interpretations of the various names probably linked to chestnut and used by the Greek authors considered

Expression	Literal translation	Source	Remarks
καρυα πλατεα	Broad nut	Hip., H.C. LV, 5 Xen. Ana. V. 5.4.32 Ath., Deip. ii 53 e Ath., Deip. ii 53 f	Expressions difficult to interpret and not kept in our analysis. We cannot completely exclude a reference to morphotypes of chestnut or to local varieties.
ευβοικον (*καρυον*)	Euboean nut	Th., H.P. I.11.3, IV.5.4, V.4.2, V.4.3, V.6.1, V.7.7, VI.9.2 Ath., Deip. ii 54 b	From the island of Euboia, perhaps refers to a morphotype or local variety.
διοσβαλανοζ	Zeus acorn	Th., H.P. III.3.1, III.3.8, III.4.2, III.4.4, III.5.5, III.10.1, IV.5.1, IV.5.4 Dyos., Med. I.145 Ath., Deip ii 53 d Ath., Deip ii 54 d	In Athenaeus the references to chestnut are dubious with the exception of the citation from Nicander (Ath., Deip ii 54 d).
καστανaικον (*καστανων*) *καρυον*	Chestnut	Th., H.P. IV.8.11 Dyos. Med. I.145 Ath., Deip. ii 54 b Gal., 6.621 (Kühn) Gal., 6.791 (Kühn)	In Theophrastus, used only in this passage, which makes us think it is a marginal annotation.
καστανεια	Chestnut	Ath., Deip. ii 52 b Ath., Deip. ii 54 d Gal., 6.777 (Kühn)	
καστηνον	Chestnut	Nic., Alex., 269	A variant of *καστανον* used only by Nicander (Ragozza, pers. com.).
Σαρδιανον καρυον	Sardis nut	Dyos. Med. I.145 Ath., Deip. ii 53 f Gal., 6.778 (Kühn)	From Sardi, a city in Anatolia. Perhaps refers to a morphotype or local variety.
λοπιμα or *λοπιμον καρυον*	Lopima	Dyos. Med. I.145 Ath., Deip. ii 54 d Gal., 6.621 (Kühn)	Literally: easy to peel. Used also in a scholium of Nicander (Hehn 1911). Probably refers to varieties. In Athenaeus, used also for other fruits.
μοτα or *αμοτα*	Mota	Dyos. Med. I.145 Ath., Deip. ii 52 b Ath., Deip. ii 54 d	Literally: wooly. In Athenaeus considered synonymous with nut of Sinope.
καρυα καρυστα	Nuts of Carystus	Ath., Deip. ii 52 b	From Carystus, city south of the Euboia; possibly referring to a morphotype or local variety.
καρυα Σινωτικα	Nuts of Sinope	Ath., Deip. ii 54 d	From Sinope, city of Pontus; possibly referring to a morphotype or local variety.
Ποντικων καριων	Pontic nut	Ath., Deip. ii 53 b Ath., Deip. ii 53 c	From the region of Pontus. In some cases used as a synonym for the *Zeus acorn*. Can mean a variety of chestnut. In other cases used for hazelnut.
λευκηναζ	Leukene	Gal., 6.778 (Kühn)	From a location in the Troad situated on the sides of Mount Ida; possibly referring to a morphotype or local variety.
μαλακον	Malaka		Literally: tender. Quoted in a scholium of Nicander (Hehn 1911). Probably referring to varieties.
γυμνοπον	Gymnolope		Literally: hairless. Quoted in a scholium of Nicander (Hehn 1911). Probably referring to varieties.

Results and discussion

Natural presence of the species

The reconstructed natural range of the sweet chestnut corresponds to the former refugia and to the subsequently colonized areas before the start of active human cultivation of the species. According to Krebs et al. (2004) the most likely natural range of the chestnut is delimited by six macroregions with scattered micro-environmentally favourable habitats probably allowing limited chestnut populations to survive during the main glacial events:

- an extended area around the southern coast of the Black Sea with a main centre on the southern slope of the Caucasus and a secondary centre in the Bosphorus, probably including south-east Bulgaria
- an area with a bipartite centre in southern and central Italy extending along a constricted hilly belt between the Tyrrhenian coast and the Apennine ridge, with a possible extension towards the north (Ligurian Apennine, Cuneo-region, the hilly region of Emilia-Romagna, and maybe even the French Département of Isère)
- the hills of the pre-Alps east from Lago di Garda (especially the Colli Euganei) in north-eastern Italy

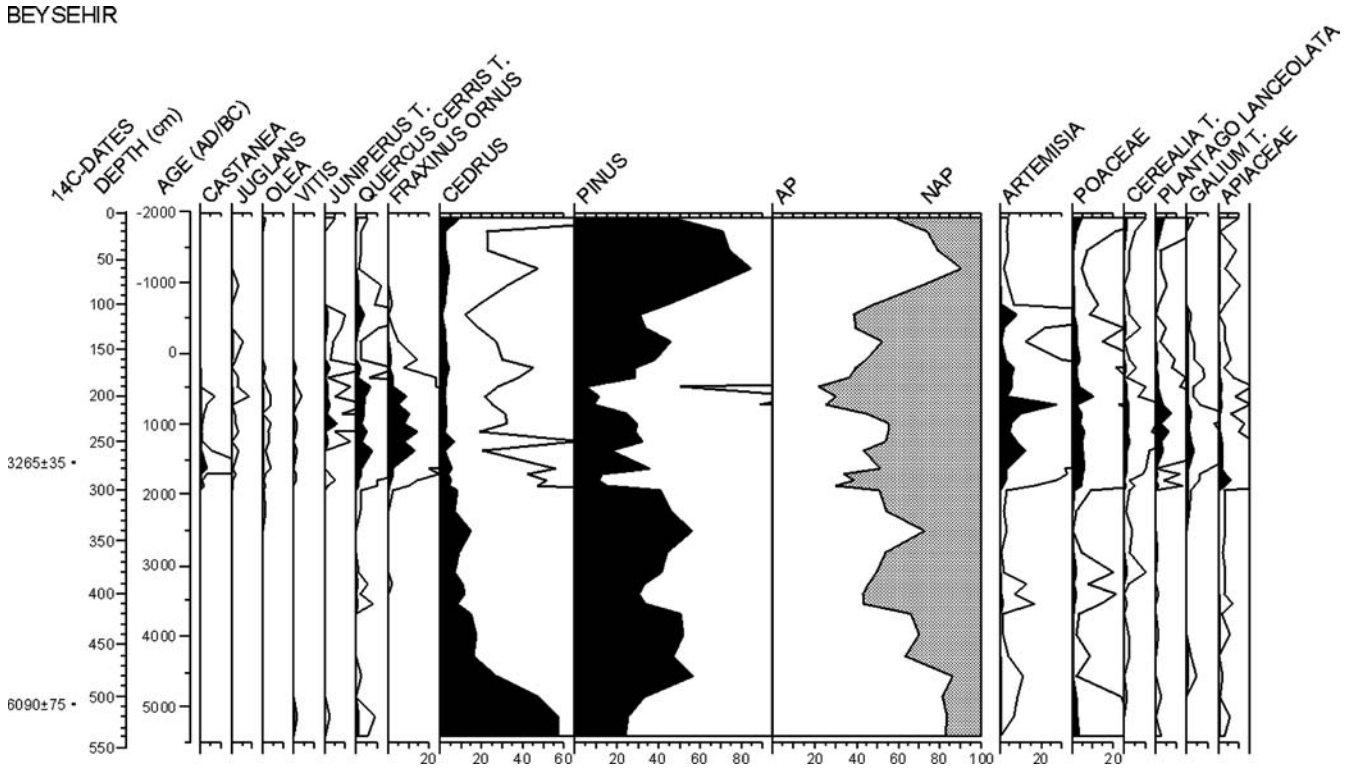


Fig. 2 Pollen percentage diagram of selected species for Beyşehir Gölü, southwestern Turkey (source: van Zeist et al. 1975)

- the area of northern Iberia centred on the hilly region of the Cantabrian coast, from the Picos de Europa in Asturias to the French side of the Basque region, with a secondary centre shared between southern Galicia and northern Portugal;
- the Balkan peninsula with a centre in southern Greece and a second one spread over Macedonia and south-western Bulgaria
- an area in the Near East centred over the hills of the Mediterranean coast in north-western Syria, and possibly extending to Lebanon.

First evidence of chestnut-human interaction

Around 8600 B.P., the presence of chestnut pollen (although <1%) in the Ghab Valley (northwest Syria) became constant (Yasuda et al. 2000). As interpreted by the authors, this is more likely to represent the indirect effect of a large-scale clearance of woodland for the cultivation of olive, wheat and barley than active cultivation of chestnut. Chestnut may have expanded into the new forest clearings, originating from the existing shelter zones. In Gălăbnik (Radomir Valley, south-east Bulgaria), chestnut wood was found among other timbers (mainly oak) in an archaeological site dating back to 7200–6900 B.P. (6000–5700 B.C.) (Marinova et al. 2002). Chestnut was probably used as many other tree species without any particular attention to it.

The first unambiguous pollen data showing evident indications of the chestnut tree spreading due to human activity are found in several regions in the Anatolian peninsula, northeastern Greece and southeastern Bulgaria dating back to around 3700 B.P. (2100–2050 B.C., van Zeist and Bottema 1991, Fig. 2). The shape of these pollen curves is characteristic of the so-called Beysehir Occupation Phase (van Zeist et al. 1975; Bottema and Woldring 1990; Eastwood et al. 1999). The pollen assemblages representing this phase point to an advanced form of agriculture, including fruit tree cultivation (Bottema and Woldring 1990). As seen in Fig. 2, we find along with chestnut other cultivated trees, such as *Olea* (olive), *Juglans regia* (walnut) and *Fraxinus ornus* (manna-ash), accompanied by an increase in non-arboreal pollen and Cerealia-type pollen. The pollen percentages of chestnut remain generally low during this phase, only exceptionally greater than 1–2% (van Zeist and Bottema 1991; Bottema and Woldring 1990; Eastwood et al. 1999). In some cases, chestnut pollen is even absent. Its heterogeneous distribution is related in all probability to the different climatic conditions and soils prevailing in different regions of this large geographic area (Bottema and Woldring 1990) (Fig. 3a).

Chestnut pollen percentages in central Italy also rise temporarily around 3600 B.P. (1900 B.C., Alessio et al. 1986; Allen et al. 2002), reaching 2% at Lago di Martignano (Kelly and Huntley 1991). This increase is probably related to local human activities, because there was also a corresponding rise in other human-related ar-

boreal pollen, such as *Juglans* and *Olea* and primary anthropogenic indicators (Cerealia-type pollen). It is more likely to be classified as indirect human influence on the spread of chestnut rather than active cultivation. Unfortunately, the inconsistency of the radiocarbon dates and the uniqueness of the pollen pattern of this profile make the timing of the spread of chestnut rather unreliable.

Taken together, the first consistent indications of chestnut-human interaction are found at the beginning of the 2nd millennium B.C. in the eastern Mediterranean area. The lack of further information makes it impossible to distinguish between direct human impact in the form of cultivation and indirect influence such as the freeing up of growing space for resprouting or regenerating chestnut trees. Archaeological finds are also scarce for this period. For the Italian peninsula, the only evidence is of chestnut charcoal macroremains dating from 2850±50 B.P. (900±50 B.C.) near Reggio Emilia (Bellodi et al. 1972), two macroremains from the Bronze Age in Monte Leoni near Parma (Ammerman et al. 1976; Pals and Voorrips 1979), and several charcoal macroremains from the late Bronze Age in Belmonte Canavese (Nisbet and Biagi 1987) and from the Iron Age in Montaldo di Mondovì (Nisbet 1991) (Fig. 4b). A noteworthy discovery was the finding of a chestnut shell fragment dating back to the late Bronze Age north of the Alps (from Greifensee near Zurich) (Küster 1991). According to the author, cultural exchanges across the Alps may have taken place during this period, judging from the number of cultivated species such as *Setaria italica* and *Vicia ervilia* present on the southern slopes of the Alps and found in northern archaeological sites (Küster pers. comm.). It is likely that this particular chestnut macroremain was transported as food or a gift, as there is no palynological evidence for such an early presence of chestnut in the Bronze Age north of the Alps.

Chestnut cultivation according to the Ancient Greek literature

Only the literary works of Ancient Greece can provide more precise and direct indications about the importance and origin of past chestnut cultivation in the eastern Mediterranean region. The most reliable and rich source is certainly Theophrastus' *Inquiry into plants* (H.P.), III century B.C. (see Table 2). In general terms, Theophrastus confirms the existence of developed techniques of silviculture and arboriculture. For example, the author dedicates many passages to the difference between cultivated trees and wild trees (H.P. I.14, II.2, III.2, IV.13, IV.14), propagation techniques (H.P. II.1–2), and the best time for tree cutting (H.P. V.I). Resprouting from stumps is often mentioned, which shows the importance of coppicing (H.P. I.5.1, II.2.2, III.7.1, IV.13.3, V.1.3).

References to chestnut are relatively numerous even though the author does not devote a specific chapter to it. From the analysis of the descriptions, we have the impression that chestnut was present above all in the mountainous (H.P. II.3.1) and northern regions (H.P. IV.5.1) of Greece and Anatolia. The principal zones that we presume to have had a chestnut tradition and cited expressly by Theophrastus (H.P. IV.5.4) are the Olympus of Misia (now Ulu Dag near Bursa), Mount Tmolos (today's Boz Dag near Sardi), the Region of Magnesia in general, the island of Evvoia and Mount Pelius (Fig. 4a). Unfortunately, we do not have any pollen data for most of these areas. Theophrastus' comments refer to the cultivation of chestnut as a wild tree (probably also coppiced) to produce timber (both for inside construction and for external use) and charcoal (H.P. V.4.2, V.4.3, V.6.1, V.7.7, V.9.2).

In all of his work, there is only a single indirect reference to the use of the fruit, when the author compares the taste and the sweetness of chestnuts to beechnuts (H.P. III.10.1). His comparison is not very positive about the sensory quality of chestnuts at that time. In fact, the authors of the classics were always rather cautious in commenting on the alimentary potential of hard-shell fruit. Chestnut was no exception. For example Athenaeus, reporting on earlier authors: "Mnesitheus of Athens, in his work on Edibles, says: in the case of the Euboean nuts or chestnuts (for they are known by both names) disintegration in the stomach is difficult, and the digestive process is accompanied by wind; but they fatten the system if one can tolerate them" (Ath. Deipn. ii 54 b) and "Diphilus calls the chestnuts Sardis-acorn, and says that they are nourishing and well-flavoured, but hard to assimilate because they remain for a long time in the stomach; and though when roasted they are less filling, they are more easily digested. But when boiled they not only inflate less, but also nourish more than roasted" (Ath. Deipn., ii 54 c-d). Only Galeno, in the passages about the nutritious quality of the acorns, makes an exception to this grim portrayal (Gal., 6.621; 6.777; 6.792 Kühn).

Explicit references to the existence of different varieties of chestnuts are completely absent from the literary texts and thus make assessment difficult. But we cannot exclude that many of the names used in order to define chestnut (mota, lopima, sardis nut, nut of Carystus; see Table 3) refer in reality to the different locally cultivated varieties. Pliny the Elder provides indirect confirmation when he writes that the name *acorn of Zeus* (see also Table 4) was given to the chestnuts after improvement through cultivation (N.H. XV.94).

A medicinal reference to use of the chestnut was found in the Alexipharmaka of Nicander, the imaginative poem that talks of poisons and their antidotes. In the passage dedicated to lacerations of the lips and of the oesophagus provoked by the poison contained in *Colchicum autumnale* L., the poet suggests as one of several antidotes the use of the pulp of chestnuts (Nic, Alex. 268–271). This indication is also used by Dioscorides, who reports additionally on the astringent power of the episperma, the inner coating of the fruit that separates the pulp from the external peel (Dios., Med. I.145).

In conclusion, both the pollen data and the literary citations agree that the cultivation of chestnut played a

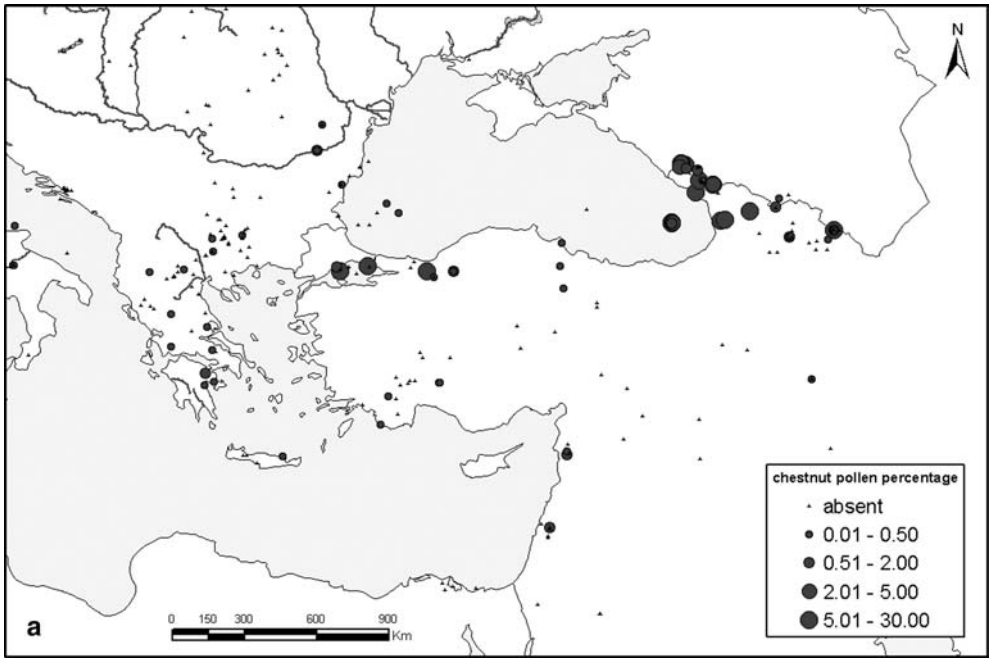


Fig. 3 Distribution map of chestnut pollen percentages 3500 B.P. (1820 B.C.). a) eastern Mediterranean area, b) western Mediterranean area

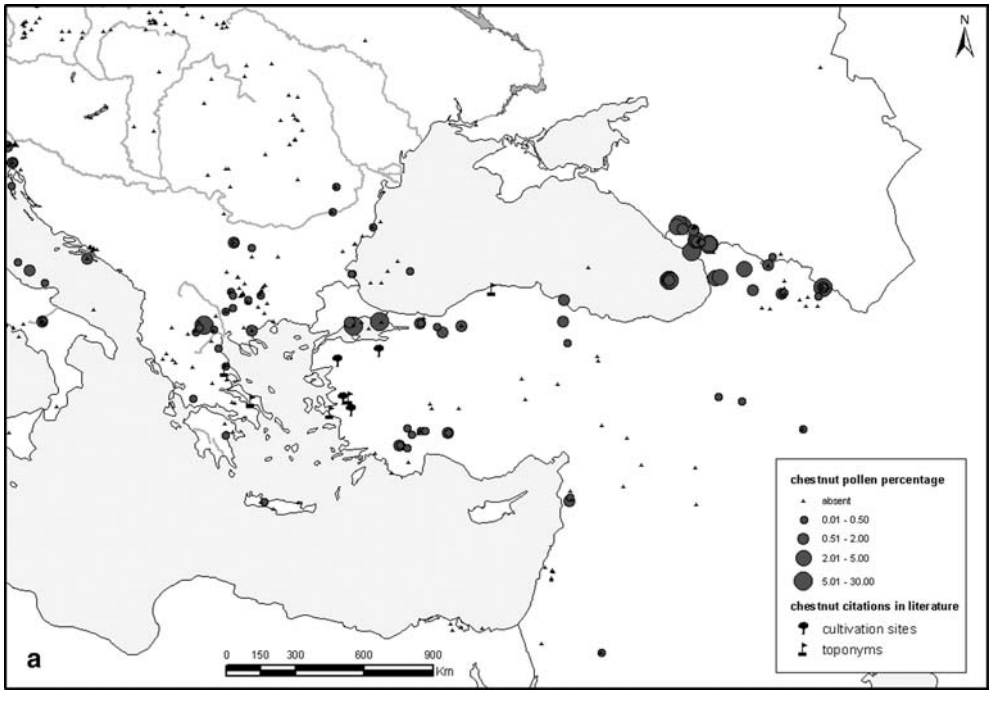
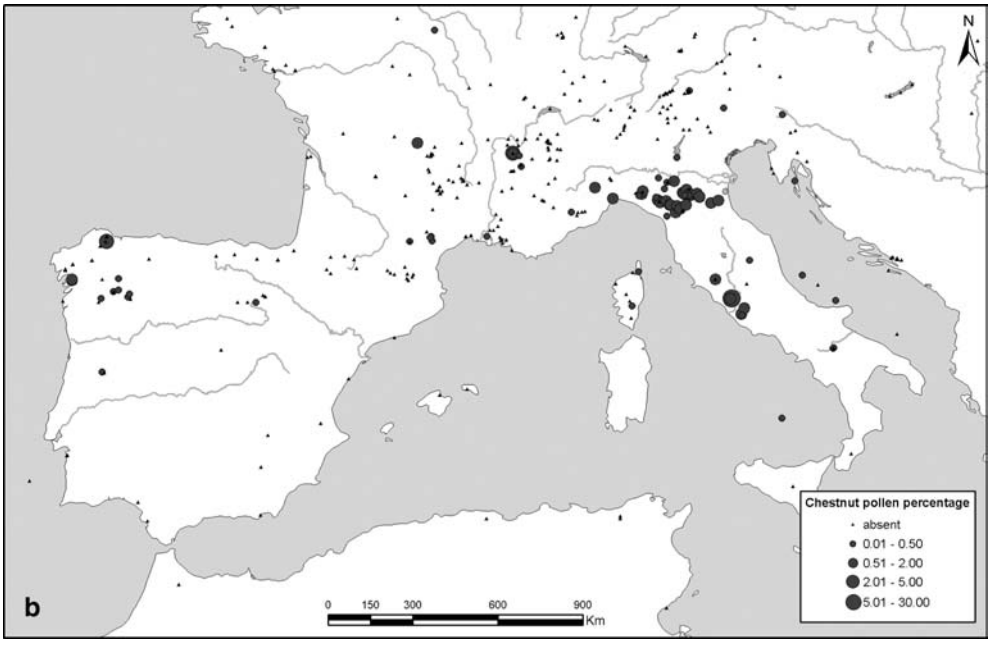


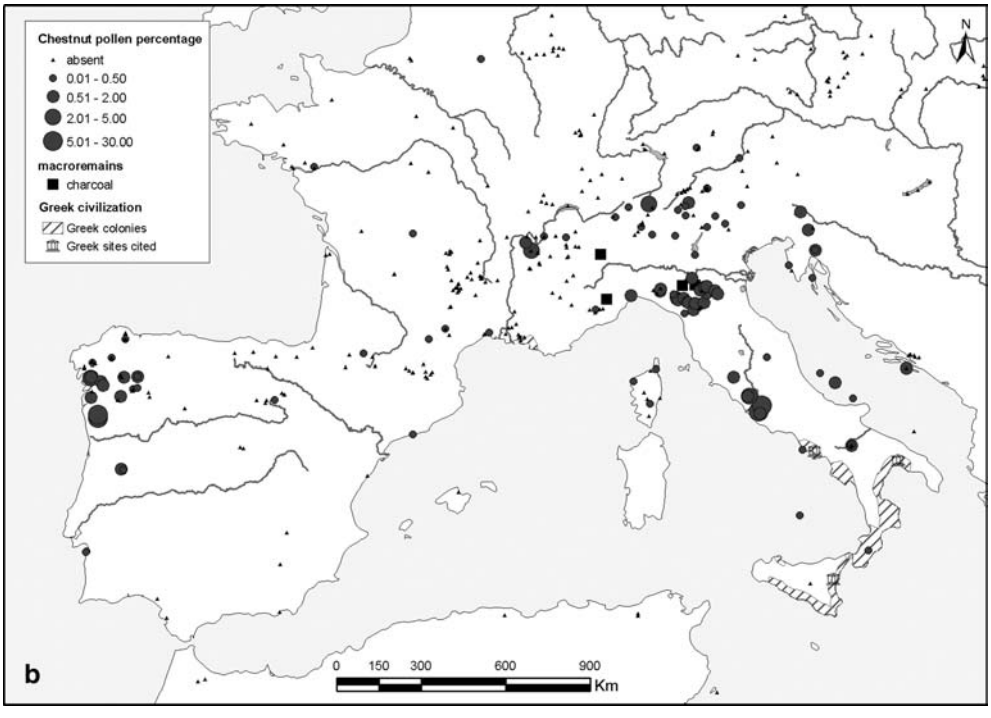
Fig. 4a,b Distribution map of chestnut pollen percentages 2300 B.P. (approx. 400 B.C.), including place names (toponyms) and areas of chestnut cultivation cited in the literature. **a** Eastern Mediterranean area, **b** western Mediterranean area

subsidiary role in ancient Greek civilization (Figs. 4a, 5a). However, it is certain that the Ancient Greeks were fundamental in developing the cultivation of chestnut, both for its wood and its fruits, even though they never required a large scale cultivation of the chestnut.

Transmission to the Latin world

Contacts and trade between East and West as long ago as the second half of the 16th century B.C. are documented through abundant archaeological finds dating back to the Mycenaean civilization in many parts of the Italian peninsula (Hase 1990). The colonisation of the Italian peninsula by the Greeks (*Magna Graecia*) may have contributed to the transfer of the techniques for chestnut cultivation to the Latin world as it did for the cultivation





of grape vine, olive and other species (Hehn 1911; Dion 1977; Forni 1990). The work of Pliny the Elder contains many such indications: the author claims that chestnuts "... were for the first time brought over from Sardi, which is why the Greeks called them Sardis nuts" (N.H. XV.93). The Italian regions which Pliny mentions in relation to the production of chestnuts are without exception areas which were under the influence of the Greek colonies (Fig. 4b): the preferred varieties of chestnut came, in fact, from Taranto and Naples. The *tarantina*, one of the varieties of chestnut known in the first century A.D., takes its name from Taranto, while the only other two varieties for which a geographical reference is given, the *corelliana* and the *tereiana*, were produced in the outskirts of Naples (Pl., N.H. XV.94). A precise reference to a method of cooking chestnuts typical of Naples is found in the Epigrams of Martial (Mar., Epi. V.78). We should not forget that the inhabitants of Euboea, a territory cited by Greek authors for its abundance of chestnuts (Th., H.P. IV.5.4) were among the pioneers of the Greek colonization in the west and the colony of Cuma near Naples in particular. Other sites cited in the Latin literature for the presence of

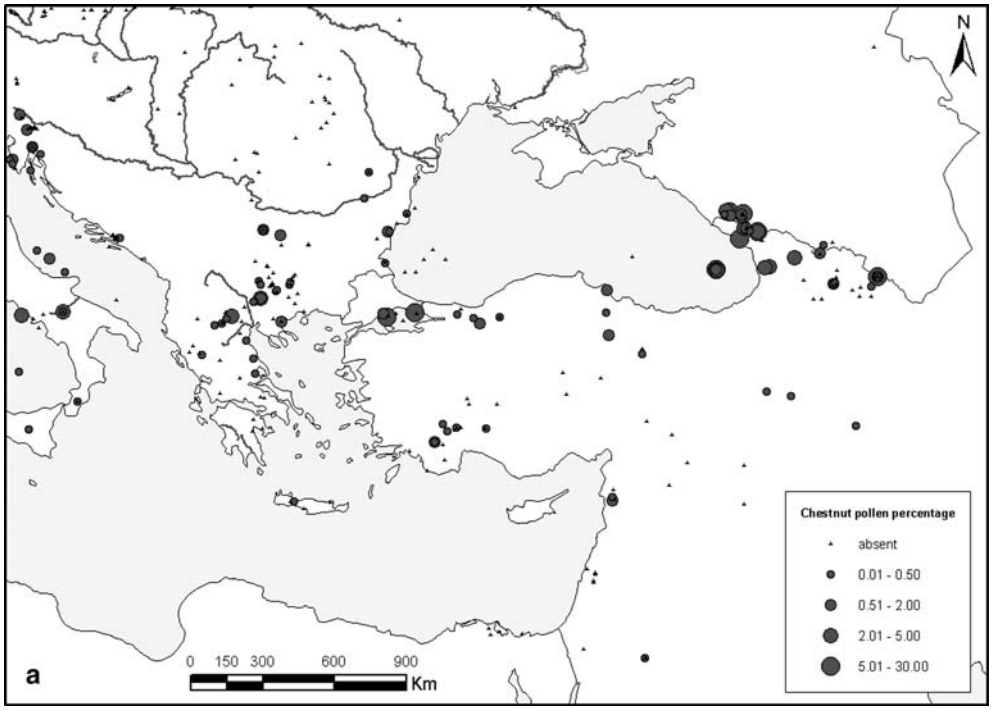


Fig. 5a,b Distribution map of chestnut pollen percentages 1900 B.P. (approx. A.D. 100). a) Eastern Mediterranean area. b) western Mediterranean area

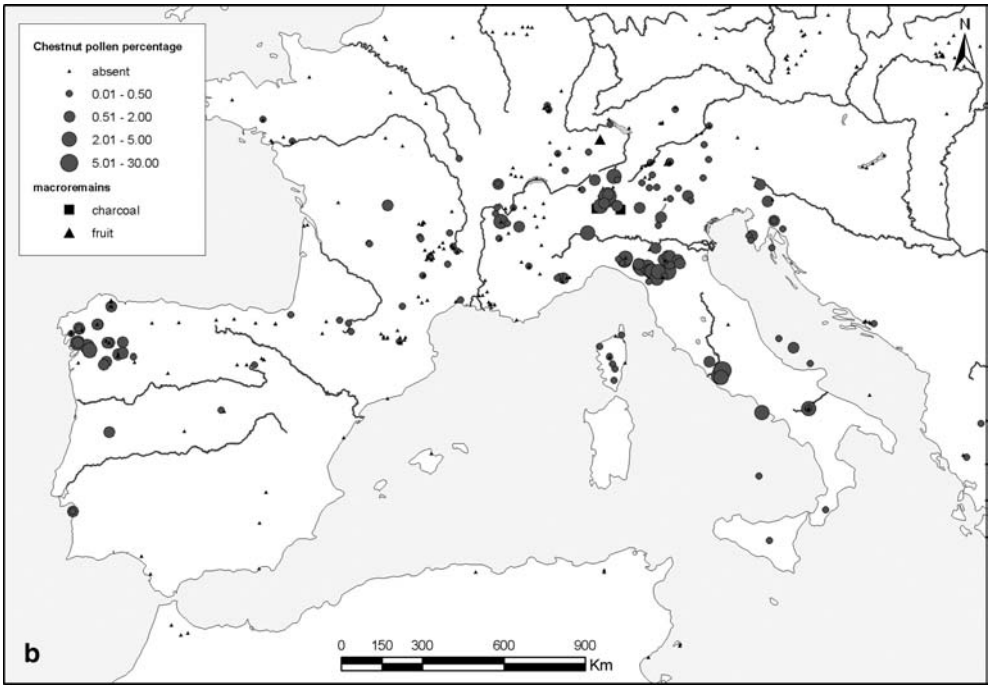
Table 4 Roman conquest and introduction of the chestnut into various European regions

Region	Start of the Roman influence or conquest	Increase in chestnut pollen percentages around 1900 B.P. (A.D. 100)		Maximum of chestnut during Roman time	Maximum chestnut pollen percentages in selected post-Roman periods (%)		
		%	Sites of occurrence / total sites	%	1500 B.P. (A.D. 600)	1000 B.P. (A.D. 1020)	400 B.P. (A.D. 1500)
Central Italy	570–300 B.C.	1.5–8.0	6 / 17	8.0	8.0	7.5	3.0
Southern Italy	260 B.C.	0.2–2.5	4 / 15	3.0	1.7	1.8	1.5
Po Plain	190 B.C.	0.2–0.5	5 / 62	12.0	17.0	18.0	18.0
Liguria and Tuscany	177 B.C. (?)	0.2–0.5 (?)	2 / 13 (?)	30.0 (?)	40.0 (?)	30.0 (?)	25.0 (?)
Mediterranean Spain	150 B.C.	0.2	3 / 51	0.2	0.6	0.3	2.0
Narbonne	Roman foundation 118 B.C.	0.2–0.5	14 / 95	0.5	1.5	1.0	7.0
Spanish Pyrenees	100 B.C.	0.5	1 / 19	0.5	0.1	0.3	1.8
French Pyrenees	100 B.C.	0.1–0.5	3 / 25	0.5	1.5	0.5	1.0
Croatia, Slovenia, Bosnia	100–30 B.C.	0.5–2.0	12 / 35	2.0	2.0	2.0	4.0
Great Britain and Ireland	55–50 B.C.	-	0 / 101	0.0	0.0	0.8	0.7
Mediterranean France	50 B.C.	0.2–1.8	15 / 127	4.0	1.7	3.2	3.3
Rest of France	50 B.C.	0.2–2.0	11 / 84	2.0	1.7	2.8	4.0
Rhaetia, Germany, Austria	50 B.C.	0.1–1.2	12 / 86	1.2	0.5	0.3	1.2
Insubria	40 B.C.	0.3–20.0	9 / 13	20.0	42.0	34.0	36.0
Hill tribes up to Veneto including Austrian Tyrol	40 B.C.	0.1–4.0	13 / 42	4.0	4.0	4.5	5.3
Belgium, Luxembourg and Netherlands	40–0 B.C.	0.1–0.2	1 / 47	0.2	0.0	0.0	0.0
Galicia and Portugal	A.D. 0	1.0–2.0	17 / 60	4.0	4.5	25.0	30.0

(?) Doubtful original data

chestnut and belonging to a Greek colony are the slopes of Mount Etna in Sicily. For instance,Ovid says chestnut was one of its many excellent agricultural products (Met. XIII 808–869).

There are indications that the flow of chestnut-related elements between Ancient Greece and the Latin world was not only cultural. It is probable that Greek colonists introduced chestnut cultivation to the Italian peninsula, making use of tree varieties from the main chestnut zones



of Ancient Greece, just as they did for grapevine (Dion 1977). This hypothesis is partly supported by the observation that the current chestnut populations of the western Anatolian peninsula are genetically more similar to Italian and French populations than to the chestnut groves of eastern Anatolia facing the Black Sea (Villani et al. 1999), even though the phylogenetic map of the chestnut in Europe is not fully understood yet (Fineschi et al. 2000).

There is indirect etymological evidence for the hypothesis that the first chestnut growing in the Italian peninsula had an early Greek origin and that the Latin world had early contact with chestnut cultivation. The Latin world adopted the expression *castanea* for the definitive denomination of the chestnut tree and its fruit, which is the Latinized form of *καστανικον καρυον* (chestnut) used by many Greek authors (see Table 3). The fact that in many Italian-speaking regions from the Alps to the Po (including northern Italy and the Italian-speaking part of Switzerland) the dialect names of chestnut are akin to an anomalous Latin word *castenea* could be indicative of an early contact of the Latin world with products of chestnut cultivation. According to Sganzini (1937) this linguistic anomaly implies that the assimilation of this word must have taken place before the evolution of *e* in a open syllable in Latin into an *i*, generating the change from *castenea* to *castinea*, an evolution taking place before the end of the third century B.C. Sganzini's interpretation is still considered valid (Petrini pers. comm.), making it likely that chestnut growing and the successive contact of the Latins with chestnut began earlier.

The archaeobotanical information available for the Italian peninsula is unfortunately not sufficiently detailed to give a precise picture of the geographical and temporal distribution and development of a possible increment of activities linked to chestnut in the Latin world. Whether the chestnut has really been present in the Apennine chain between Tuscany and Emilia Romagna since 3500 B.P. is an open question. Some of the palynological sites shown in Fig. 4b have limited dating and an imprecise chronology.

Generally speaking, we can say that the percentages of chestnut pollen before the beginning of the Christian era were low and remained at a low level throughout the territory of the peninsula. Exceptions to this are indicated by a slight change in the slope of the curve of chestnut pollen around 300 B.C. in the profile of the Lago di Monticchio in the Province of Basilicata (Watts et al. 1996) and by a more pronounced increase (up to 10%), although not radiocarbon-dated with precision (5th century B.C. or 1st century A.D.?), in the profiles of Lago di Albano and Lago di Nemi, in the outskirts of Rome (Lowe et al. 1996; Oldfield 1996). In conclusion, the information available for the pre-Christian centuries from the pollen profiles seems to indicate a much-limited influence of the Greek cultivation techniques on the Latin and subsequent Roman civilization (Fig. 4b and 5b). Nevertheless, where present, chestnut was utilized as was any other suitable tree, for building, as firewood and for its fruit, as indicated by archaeological macroremains dating back to the Bronze Age (Fig. 5b).

Evidence of an increasing importance of chestnut before the Christian era (A.D. 1) is scarce not only in the pollen profiles (Figs. 4b, 5b), but also in pre-Christian Latin texts referring to chestnut cultivation. The *latifundium*, the entrepreneurial management of agricultural estates with groups of slaves, started after the 2nd century B.C. in the fertile plains of Lazio and Campania and then became largely diffused under the Roman dominion (Carandini 1988; Sirago 1995). In Cato's (234–149 B.C.) *De agricultura* there is no explicit mention of chestnut cultivation in the *latifundium*. In his list of the more profitable items grown on the agricultural farm, Cato places *silva caedua* (coppice) in seventh place and *glandaria silva* (forest producing acorns for pigs) in the ninth and last place (Cat., Agri. I.7). In neither case is reference made to chestnut. We also do not find any description of chestnut cultivation in Varro (116–27 B.C.). Chestnuts are referred to once, as an alternative to oak acorns for dormice (Var., Rust. III.15). In his manual on architecture, Vitruvio says nothing about chestnut timber in farm buildings.

The fact that chestnut was neither used nor produced before the Christian era according to the sources mentioned above does not mean that all forms of chestnut cultivation were completely absent from the Italian territory during the last centuries B.C. Unfortunately, there are no detailed descriptions in the classical Latin literature prior to the first century B.C. of the practices of this marginal agriculture aimed more at self-sufficiency than at large-scale agricultural production. In the poetic texts of Virgil, Ovid and Martial, the chestnut is mentioned in a mountainous context, often in association with pastoral activities and in frugal meals based on rustic ingredients, such as cheese and fruit (Vir., Buc. I.81, Buc. II.45–54, Buc. VII.53–57; Ov. Ars II.261–280; Ov., Met. XIII.808–869; Mar., Epi V.78). Virgil says that chestnut was refined through human selection and the practice of grafting (Vir., Geor II.9–73), although, as is often the case in ancient literature, the proposals (grafting chestnut on beech, walnut on arbutus, etc.) are not realistic (Vir., Geor. II.69–73).

Chestnut cultivation techniques for fruit production conquered the Roman world slowly. At the latest by the end of the pre-Christian era there were varieties of chestnut of good quality being commercialized and cultivated for ease of peeling and a variety of uses (Pl., N.H. XV 93–94; Ov., Ars II.261–280). As well as fresh consumption (boiled or roasted), drying and transforming the chestnuts into flour was also known, but the only reference to chestnut flour seems to be in the production of a bread substitute consumed by women when fasting (Pl., N.H. XV.92). That chestnuts were part of the diet of the Romans, at least in the areas of the Greek colonies, is confirmed by the remains of carbonized chestnuts at the Roman Villa Torre Annunziata, destroyed by Mount Vesuvius' eruption in A.D. 79 (Meyer 1980).

LXXIX.

Ad lapidem Torquatus habet praetoria quartum;
ad quartum breve rus emit Otacilius.
Torquatus nitidas vario de marmore thermas
extruxit; cucumam fecit Otacilius.
Disposuit daphnona suo Torquatus in agro;
castaneas centum sevit Otacilius.
Consule Torquato vici fuit ille magister,
non minor in tanto visus honore sibi.
Grandis ut exiguam bos ranam ruperat olim,
sic, puto, Torquatus rumpet Otacilium.

Fig. 6 Martial, Epigrams, X. Torquatus has a palace at the fourth milestone: Otacilius bought a small farm at the fourth. Torquatus constructed splendid warm baths of varied marble: Otacilius made a cooking pot. Torquatus laid out a laurel grove on his land; Otacilius planted a hundred chestnuts. When Torquatus was consul, Otacilius was wardmaster, in which high office he felt himself not inferior. As once the bulky ox ruptured the tiny frog, so methinks, Torquatus will rupture Otacilius

In spite of the increase of references to chestnut in the Latin literature between the last century B.C. and the first century A.D., we have the impression that this fruit was never favoured by the Roman aristocracy. An epigram of Martial in which chestnut is used as a symbol of inferiority in aristocratic Roman circles illustrates this: the one hundred chestnut trees of Otacilio are compared to the laurel grove of Torquato, like a farm house to a splendid villa, a small bath to marble thermal baths, a head of a district to that of a consul, or the stature of a small frog to that of the ox (Mar., Epi X 79, Fig. 6). The allegorical interpretation of the text by Virgil where Amaryllis is said not to like chestnuts anymore (Vir., Buc. II.51–52, a concept also found in Ov., Ars II.267–268 and Gar. Mar. Hort. IV.1) can be considered symbolic of the rural association the Romans had with chestnuts: *Amaryllis* was in fact the figure of a shepherd frequently evoked by the classical poets and considered by some the allegorical personification of the Roman aristocracy (Carena 1982). The presence of a recipe for chestnuts (*lenticulam de castaneis*) in the 5th book of the *De re coquinaria* (the art of cooking) of Apicius only partially softens this not so positive image. However, there are well-founded suspicions that this book is just a compilation of several successive authors expert in the culinary arts (Vesco 1990). We might find among them Marcus Gavius Apicius (A.D. 14–37), but more probably Caelius Apicius (4th century A.D.?).

References in the Latin literature to alimentary or medicinal uses of the chestnut are also relatively rare. The most exhaustive information is supplied by Pliny, who, beside the text already referred to about chestnut varieties and baking (N.H. XV.92–94), describes the laxative and regulating effect of chestnuts on the stomach and their use in treating haemoptysis (N.H. XXIII.150). Latin authors, like Greek ones, tend not to praise the properties of chestnuts as food. Indeed, at a certain point, Pliny even admires how nature has so zealously hidden a fruit of such little value (N.H. XV.92).

Increasing acceptance of chestnut as timber

The role of chestnut in the Italian territory may have changed at the beginning of the Christian era when people realized that the wood produced from chestnut coppices was so useful and versatile. Signs of this change are found first in literary texts. Post-Christian Latin literature provides a striking amount of detail about the ecological needs of chestnut (Col., Rust. IV.33.1; Pl., N.H. XVI.74, XVI.76, XVI.98, XVI.138, XVII.147; Gar.Mar., Hort. IV.5–6; Pal., Rust. XII.7), nursery techniques (Col., Rust. IV.33.1–6, V.10.17; Pl., N.H. XVII.59, XVII.148–149; Gar.Mar., Hort. IV.1–4; Pal., Rust. XII.7) and coppice management (in particular Col., Rust. IV.30.1–2, IV.33.3–5; Pl., N.H. XVII.148–150, XVII.174). The text by Columella (Rust. IV.30–33; updated later by Pliny, N.H. XVII.147–150) deals above all with the agricultural aspects of chestnut coppicing, emphasizing the supremacy of the chestnut in the production of poles to support vines. It is quite difficult to give a quantitative judgment of the effects of this innovation on the dissemination of chestnut in the great *latifundia*. The systems of vine support were in fact multiple (live support with running branches, low stock without support, low stock with dry support, trellis, etc., see also Var., Rust. I.VIII.1–6 and Pl., N.H. XIV.10–14) and varied according to local traditions, the degree of influence of external elements (that is, of the Greek colonies) and the type of land and vine (Hehn 1911; Sereni 1981).

The pollen profiles from the Italian peninsula fall short of contradicting an increase in chestnut presence, with the exception of the previously cited case of the Lago di Albano and Lago di Nemi (Lowe et al. 1996; Oldfield 1996). There is some archaeological evidence of chestnut wood used as piers in rural constructions in the 1st century A.D. in the Apennine part of Tuscany (settlement of Filattiera-Sorano, Rottoli and Negri 1998). On the other hand, the presence of chestnut pollen in northern Italy generally increased from around A.D. 100 to A.D. 600, especially along the southern slope of the Alps from Piedmont to Croatia (Figs. 5b and 7b). In some areas of the Italian peninsula, chestnut appears for the first time in the profiles from the first centuries of the Christian period, probably in connection with the Roman conquest (Table 4), for instance in the Insubrian Region (Fig. 8, Tinner et al. 1999, Gobet et al. 2000) and in Calabria (Schneider 1984).

Insubrian Region: the first centre of chestnut cultivation

Table 4 highlights the low pollen percentages for chestnut in most European countries during the Roman period. The Insubrian Region, the region of the southern Alpine lakes across the Swiss-Italian border, is an exception. Chestnut pollen became significant here within a few centuries of its first appearance (Fig. 8). The slope of the *Castanea* pollen curve varies a great deal as a function of local conditions, even though chestnut was cultivated in a systematic way in the hills and mountains of the region from the 1st century A.D. with percentages up to 40% (Fig. 9). In areas with limestone in the bedrock, the pollen curves of chestnut increase with a slight delay and with smaller maximum percentages (Gobet et al. 2000).

The introduction of chestnut coincided with a radical change in local use of land. Fire was no longer used systematically to clear open spaces in forests. Instead, many wooded areas were actively managed as chestnut groves (Tinner and Conedera 1995; Tinner et al. 1999; Fig. 9). The rapid increase in chestnut pollen percentages leads us to hypothesize that chestnut was introduced as a monoculture, and probably managed in coppices for pole production and not just for fruit cultivation.

The Insubrian region represents, in all probability, a privileged centre of chestnut cultivation not only because of favourable climatic and site conditions, but also because the network of lakes and rivers allowed easy transport between the pre-Alpine area and the Po Plain (Tozzi 1982; Vedaldi Iasbez 2000; Fig. 9). The well-documented archaeological cases of Angera (southern part of Lago Maggiore, Italy) and of Muralto (northern part of Lago Maggiore, Switzerland) confirm the intensity of commercial exchange between the pre-Alpine zone and the Po plain in the first centuries of the Christian era. The water routes allowed the transport of heavy goods (timber, building stone etc.) from the pre-Alpine valleys, while consumer goods (wine, oil) and other lightweight goods were carried from the plain towards the Alps, and also beyond (Senna Chiesa 1995; Biaggio Simona 2000).

Unfortunately, no written documents have been found which describe how this new form of cultivation was introduced into the region. There are, however, archaeological findings showing that chestnut wood was used for building and domestic purposes during the Roman period. Carbonized chestnut carpentry dating back to the 3rd-4th century A.D. was found during the excavations in Angera (Lago Maggiore, Italy) (Rottoli 1995). Pieces of carbonized chestnut wood were found in a 2nd-4th century Roman villa in Monte Lambro, near Como (Madella 1991). Similarly, while digging in Monte Barro (Como, Italy), wood works, supporting structures and even floor boards made exclusively of chestnut were uncovered in buildings dating back to the 5th-6th century A.D. The timber came from small-size trees (20 cm in diameter), most probably from a coppice (Castelletti et al. 1988; Castelletti and Castiglioni 1991; Castiglioni et al. 2001). In the archaeological site of via Alberto di Mario in Brescia dating from the same period, chestnut was the dominant wood in the supporting structures. At both sites abundant chestnut fruit remains were also found, probably from wild trees (Castiglioni et al. 2001; Castelletti and Maspero 1988). Other archaeological evidence like the two chestnuts found in the Roman cemetery of Tenero (Lago Maggiore near Locarno, Switzerland) from the 2nd century A.D. (Sordelli 1883), suggest that both forms of utilisation, both for timber and fruits, may have coexisted.

The existence of chestnut woods in the region is furthermore documented for the beginning of the 6th century

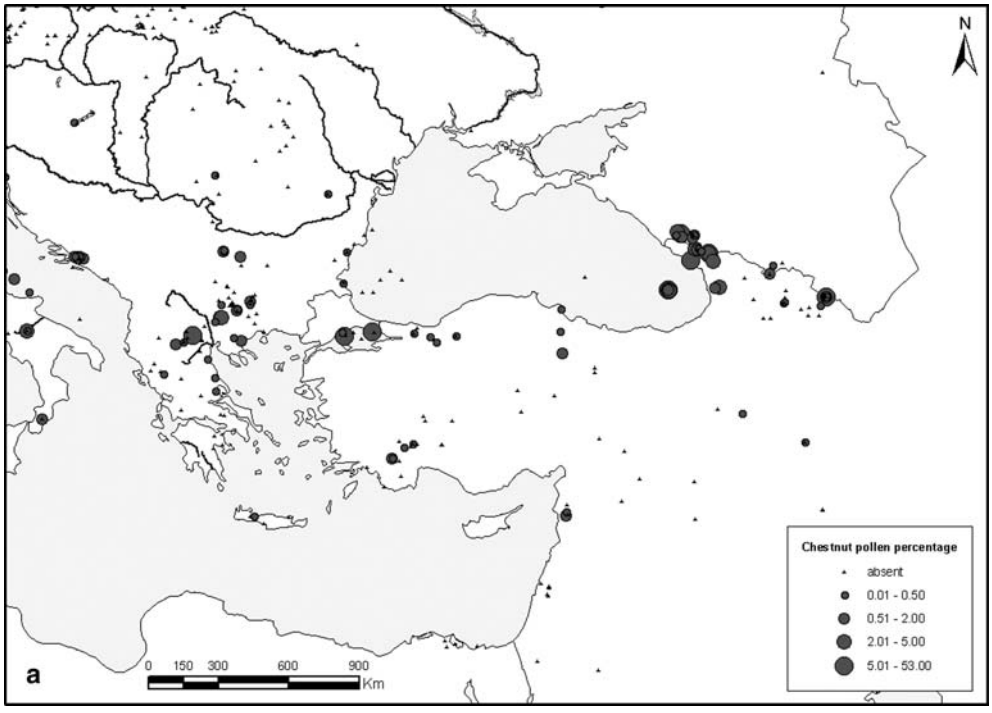


Fig. 7a,b Distribution map of chestnut pollen percentages 1500 B.P. (approx. A.D. 570). a) Eastern Mediterranean area. b) western Mediterranean area

A.D. by Cassiodorus, who described in *Variae epistulae* (various letters), the mountains around Lago di Como as "being covered by vineyards along the slopes and by dense chestnut forests looking like a natural curly head of hair on the top" (Cas., *Variae*, XI, 14; see also in Castelletti and Castiglioni 1991).

Chestnut cultivation outside the Italian peninsula during the Roman period

The generally increasing percentages of chestnut pollen found from the 1st century A.D. onwards have also been observed in the southern parts of France and Germany, in northern Switzerland and, partially, in the Iberian peninsula (Figs. 5b,7b). This suggests that the use of chestnut was spread throughout the empire by the Romans (van Mourik 1985; Aira Rodriguez et al. 1992; Santos et al. 2000). In most of these regions, chestnut appears in the

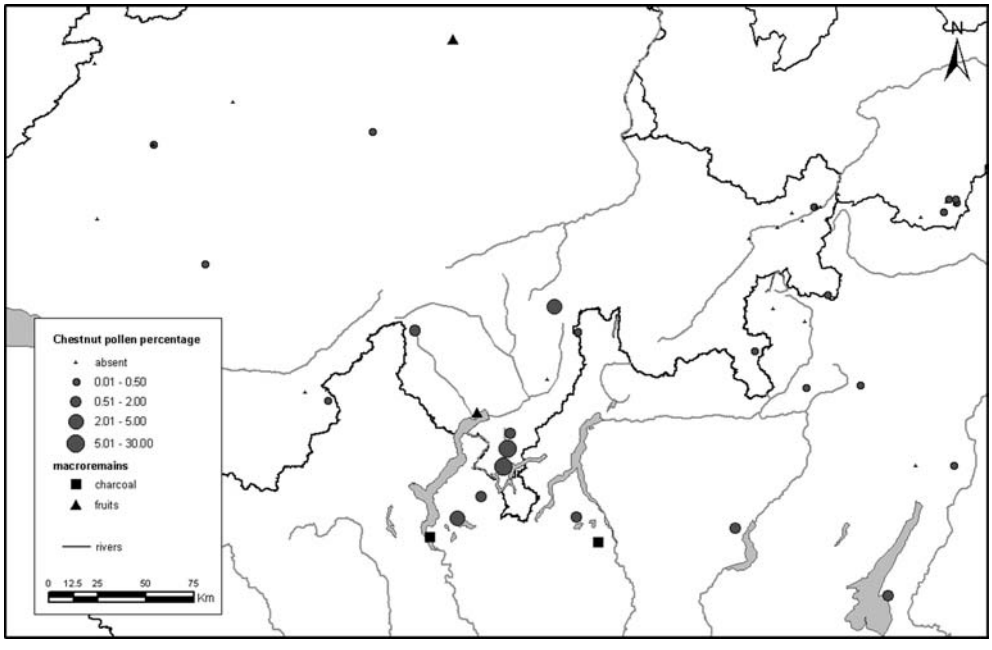
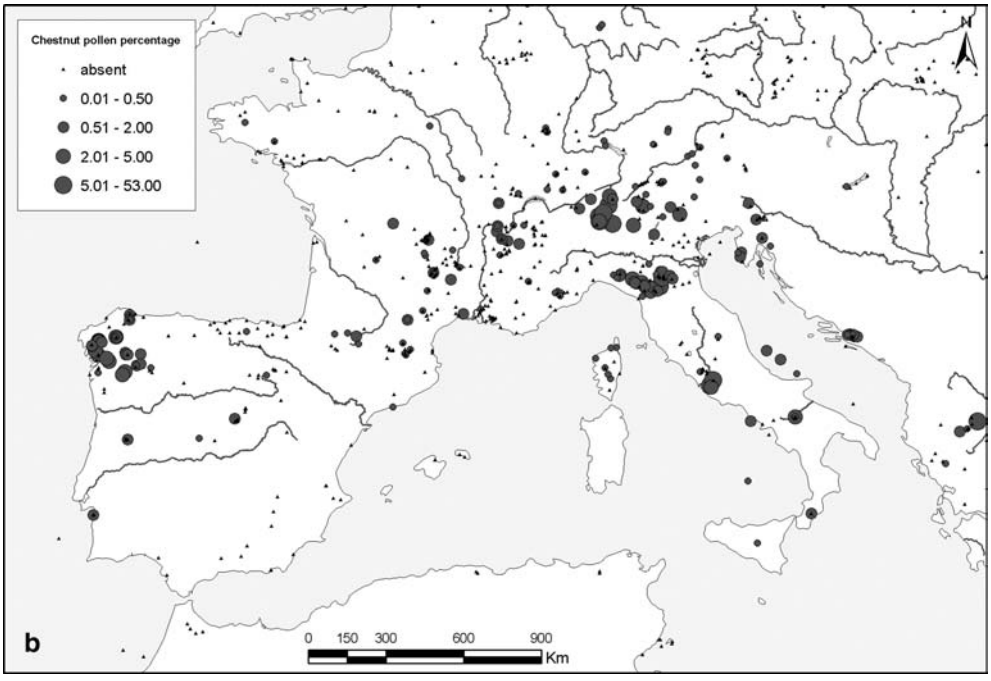


Fig. 8 Distribution map of chestnut pollen percentage 1500 B.P. (approx. A.D. 570) for the Insubrian Region, including archaeological sites with chestnut macroremains



profiles for the first time in the first centuries of the Christian period (Edelman 1985; Jolly 1988; Clerc 1988; Visset 1994; Ammann 1989; Eusterhues et al. 2002), probably in connection with the Roman conquest (Fig. 10 and Table 4). According to Frascaria et al. (1993) the generally slight genetic differentiation among chestnut populations in southern France could also be interpreted as the effect of the Roman campaign to introduce chestnut.

In general, the presence of chestnut increases by only a few percent, but it is evident throughout all profiles, even at high altitudes where we assume that chestnut pollen is of extra-local to regional origin. Despite the slight yet distinct increase of chestnut, archaeological finds are very scarce north of the Alps and little is known about its use during the Roman period. In the mine of Saint-Pierre-Montlimart (Loire valley, France) chestnut wood vessels were found dating back to the 2nd-3rd century A.D. (Provost 1993). These conical containers were also used in the Iberian mines (where they were called *cuncos*). Those tools served mainly to separate the sands of the riverbed using a rotating movement, leaving heavy metals

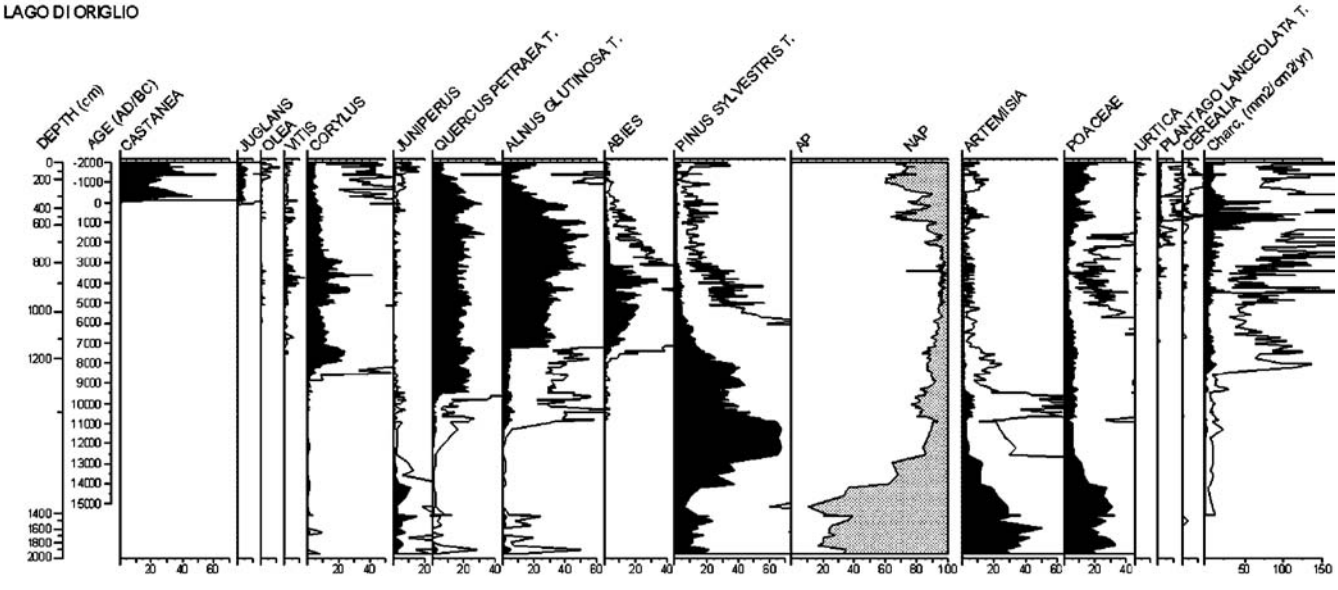


Fig. 9 Pollen percentage diagram of selected trees and shrubs and charcoal influx, Lago di Origlio, southern Switzerland (source: Tinner et al. 1999)

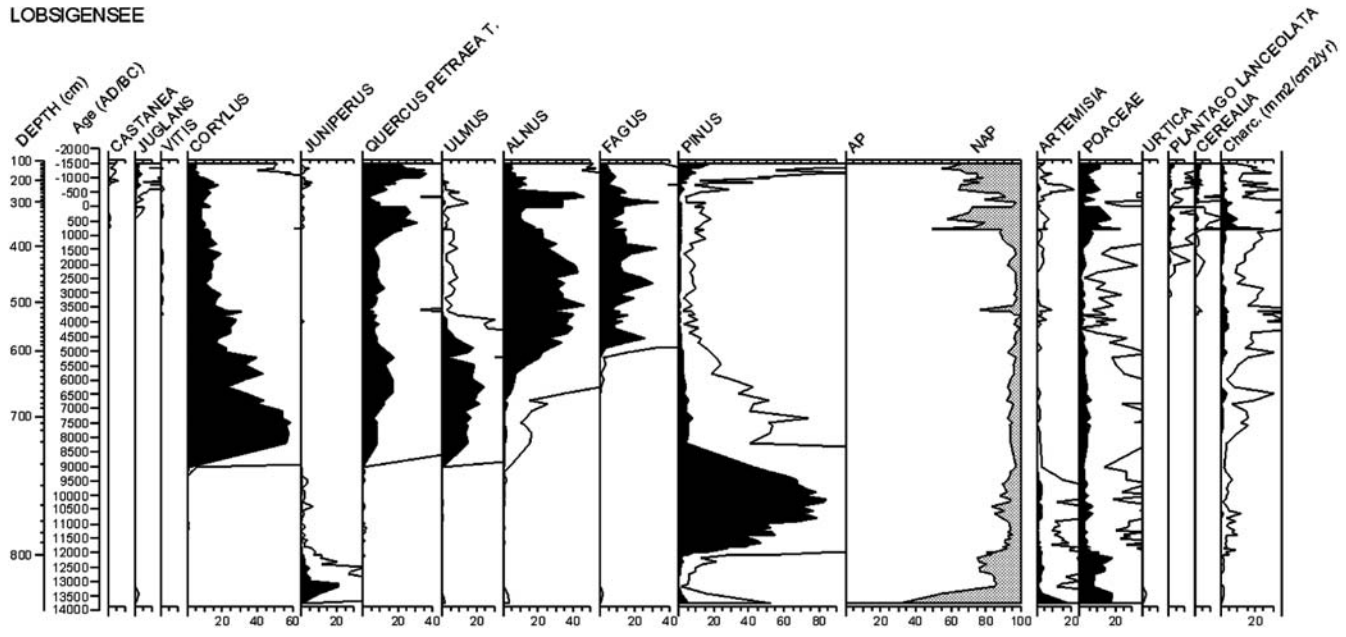


Fig. 10 Pollen percentage diagram of selected trees and shrubs for Lobsigensee (source: Ammann 1989)

including gold at the bottom (Perez-Garcia and Sanchez-Palencia Ramos 1985). Chestnut was probably favoured because it can endure prolonged contact with water. It may be, then, that chestnut wood was widely used in the mining industry. According to Pliny the Elder, the use of the correct timber quality was very important in the different uses to which it was put in gold mining (that is, beams to hold up the galleries, water distribution channels, etc., Pl., N.H. XXXIII.66–79). In the Iberian region (Asturias, Galicia and northern Portugal) during the Roman period, there were more than 600 mining sites that handled an estimated total of 600 million m^3 of soil (Perez-Garcia and Sanchez-Palencia Ramos 1985). Nevertheless no large increase in chestnut pollen concentration occurred, which seems to exclude its systematic use in the Iberian mining industry. It is important to note that in these regions chestnut was already present at a great number of sites at 3500 B.P., although the quality of some pollen profiles is poor. Furthermore we are not aware of any archaeological records of chestnut fruit.

There was very little rise in the chestnut pollen percentages in some regions, such as England, northern Germany and Corsica (Figs. 5b, 7b and Table 4) and for most of the eastern Mediterranean area (Fig. 5a, 7a). The case of Corsica is historically well documented: Pitte (1986) describes how chestnut cultivation was introduced in Corsica by the Genoese in the 18th century. Other situations are much more difficult to interpret, such as the pollen profiles around the ancient town of Ragusa (Dubrovnik). Figures 5a (1900 B.P.) and 8a (1500 B.P.) suggest a simultaneous chestnut introduction at six sites near Mostar somewhere between 1900 B.P. and 1500 B.P., probably reflecting the increased power of the Byzantine Empire. These sites were studied in the early 1970's (Brande 1973) and only in one case was radiocarbon-dating performed. All other profiles were dated biostratigraphically, which considerably limits the usefulness of the information. The nearby profiles of Malo Jezero and Veliko Jezero located in the Island of Mljet first studied by Beug (1961) and then by Jahns and van den Bogaard (1998) and Jahns (2002) help only partially to solve the dating problem of chestnut introduction.

In conclusion, no centre of chestnut cultivation has been detected outside the Italian peninsula during the Roman period. The Romans may have introduced the idea of systematically cultivating and using chestnut and in certain cases the tree itself, but no evidence of systematic chestnut planting exists. Widespread use of chestnut in coppices and in orchards for staple food production (the proper chestnut civilization) took place in western Europe starting in the early Middle Ages (for example in Tuscany, Quirós Castillo 1998) and flourished further in the later Middle Ages (11^{th}-16^{th} centuries, Pitte 1986, Fig. 11). It was probably not introduced by the Romans, if our analysis of chestnut terminology in the modern European languages is correct. The name for the tree and the fruit is uniform, with all names derived from one common Latin root. But the terminology for the other parts of the tree, for example the spiny cupule surrounding the fruit or for some methods of baking, varies with some words having pre-Roman origins (Käser 1932). Their etymology is probably linked to the cultivation of the fruit of other species before the introduction of chestnut. Pliny even asserted that some populations nourished themselves regularly with acorns (Pl. N.H. XIV.16 and ff.). Where the interest in the cultivation of chestnut fruit introduced by the Romans continued in successive phases, the locals probably adopted the terminology already in use from pre-Roman time for other species for describing the cultivation of chestnut.

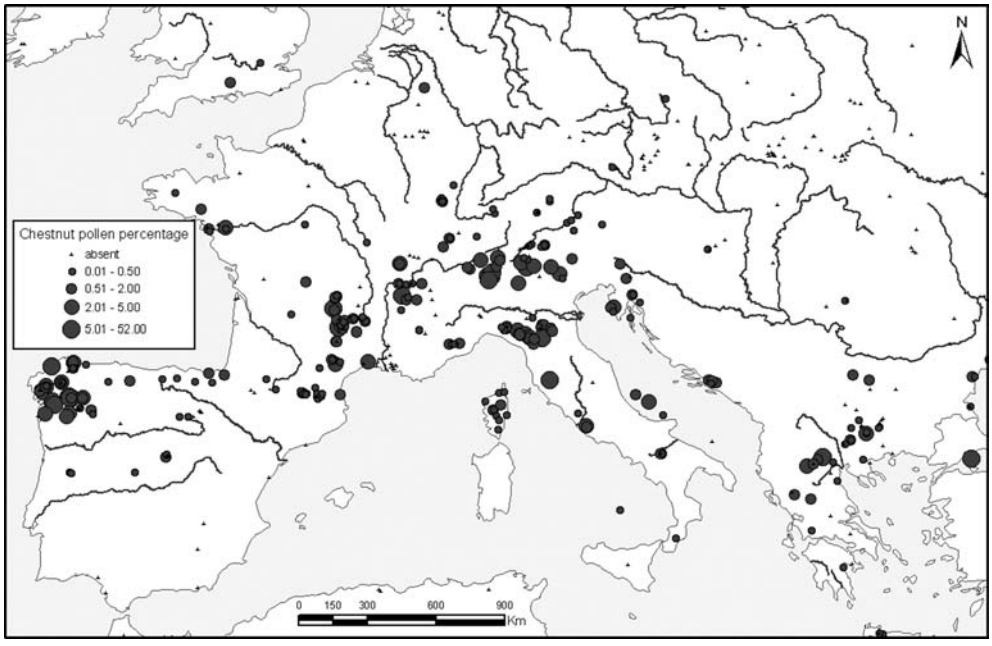


Fig. 11 Distribution map of chestnut pollen percentages 400 B.P. (approx. A.D. 1460) in Europe

Conclusion

Castanea sativa is a tree the occurrence of which is closely tied to human activity. As for most plants affected by human activities, pollen data alone are often not enough to assess the time of, and the means and motivation for its dissemination. In this article we have tried to reconstruct the history of chestnut cultivation by comparing pollen data with information from literature, classical historiography, linguistics, and archaeology. As a result of this multidisciplinary approach, we have given a more complete picture of the role of the Greek and Roman civilizations in spreading the cultivation of chestnut on a European scale. In particular we show that its use as food was not the primary driving force behind the introduction of chestnut into Europe by the Romans.

A major interest in managing chestnut for fruit production as well as in cultivation for self-sufficiency more probably developed after the Roman period and can be associated with the socio-economic structures of medieval times. During the Roman period, the Insubrian Region constituted the first major centre of chestnut cultivation in western Europe, while in eastern Europe the decrease in chestnut pollen percentages suggests that there was also a decline in chestnut cultivation.

There are clearly limits to our approach that are mostly due to lack of information. Some European regions, such as southern Italy, western Turkey, central and southern Spain, etc., have still not been sufficiently studied palynologically. Radiocarbon dating is limited or completely absent, and old literary texts are either absent or are not easily interpretable from a botanical point of view. However, our approach presents another perspective for reconstructing the history of the impact of humans on the vegetation of the European continent, which could be extended to other trees and combined with other disciplines. In particular, the latest developments in genetics and the possibility of using different molecular markers for ecological studies including past distribution, genetic variation and re-colonisation patterns of the species (Comes and Kadereit 1998; Hewitt 1999; Newton et al. 1999) open new perspectives for understanding the gene flow associated with the origin of chestnut cultivation in Europe.

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