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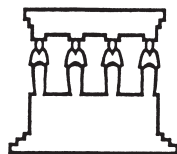
INVESTIGATIONS IN THE SANCTUARY OF ATHENA ALEA 1990–94 AND 2004

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Anne E. Bjune, Knut Krzywinski and Anette Overland: PALYNOLOGICAL INVESTIGATIONS IN THE SANCTUARY OF ATHENA ALEA

Introduction and background

The Norwegian excavation project in the sanctuary of Athena Alea (1990–94) extended its objectives towards a broader understanding of the cultural landscape development outside the sanctuary itself by taking into account regional and local social and economic development, as reflected by changes in vegetation types and land cover. The expected rewards for implementing archaeopalynology at this site were: valuable insights into human activity at various levels, and an understanding of landscape change as reflections of the dynamic relations between culture and nature through time. Integration of the material from the site with geobotanical evidence was expected to facilitate the interpretation of the archaeological artefacts from the sanctuary, aspects concerning the development of the site, and interpretations of the polis state as a whole. The intentions were not only that palynological studies should provide a better understanding of activities and development of the sanctuary, but also, in a wider context, of activities in the city's environment and, on landscape scale, of the cultural factors of mutual influence between the city and the surrounding plains.

Although well established in other fields of archaeology, interdisciplinary cooperation between palaeoecologists and archaeologists has not been much developed in Classical archaeology. In particular, the palaeoecological research community has so far paid little interest to potentially important research collaboration in this field, and to relevant sources of data regarding the specific periods. For this reason we know little about the effects that the growth of Greek polis states, changes in population densities, and agricultural activities had on land-cover in the Mediterranean lowland.

One reason could be that few if any pollen grains can be expected to be preserved in the dry and well-aerated soils which are regularly found at Classical sites (see *e.g.* Greig and Turner 1974; Rackham 1982; Jahns 2003). It is difficult to perform a meaningful analysis when pollen concentrations are too low, whether this happens because the actual residual pollen concentration is too low, or because less suitable concentration techniques have been applied. Other problems arise when inappropriate

interpretations and models for pollen deposition are used. For on-site pollen analysis an understanding of both the pollen source area and the cultural significance of each sample is required. This is also valid for palaeoecological studies at Classical archaeological sites.

Fortunately the temple site of Athena Alea was better suited for palynological studies than most others similar contexts. Silt layers with a high organic content retain moisture in the otherwise dry soil and counteract the oxidation of pollen. This has created fairly good conditions for pollen preservation at the site. Safely dated layers of primary refuse between silt layers guide contextual interpretations and make the temple site particularly well suited as a reference site for palynological investigations. The study also provided an opportunity to develop laboratory routines adapted to the silty, aerated soils with a relatively low pollen concentration.

Since the turn of the last century, Scandinavia has held a leading position in the development of pollen analysis and the use of pollen preserved in deposits for research at archaeological sites, as well as the development of methods and interdisciplinary application of archaeopalynology (see *e.g.* Krzywinski *et al.* 1983; Krzywinski and Kaland 1984; Kaland 1986; Krzywinski and Soltvedt 1988; Fægri and Iversen 1989; Berglund 1991; Kvamme *et al.* 1992; Hjelle *et al.* 1992). The analysis undertaken at the temple site of Athena Alea is in line with the research traditions developed in particular since the mid-1970s, which view research on cultural landscape development as an integrated effort where natural sciences such as geology, botany, and zoology cooperate with the humanities. Its potential at this site is mainly due to 1) good preservation of the pollen, and 2) the origin of the deposits at the temple site. It opens up possibilities for obtaining first-hand data on landscape development in the surrounding area, in addition to information on conditions at, and activities on, the site itself.

In 1993 soil samples were collected from a number of strata in one of the excavation profiles within the temple of Athena Alea, in order to 1) test the pollen preservation and pollen concentration; 2) develop a sampling strategy and laboratory procedures; and 3) select a framework for the interpretation of the pollen source area and the vegetation surrounding the site.

The project was funded by the University of Bergen, Norway, and included a campaign of systematic sampling during the last excavation season in 1994. The pollen profile from 1994 was then analyzed in 1996 as part of a student exchange programme between the University of Bergen and The Aristotelian University of Thessaloniki, Greece. This paper presents the preliminary results of the pollen-analytical studies from this profile in the sanctuary of Athena Alea.

Pollen preservation and the silt strata at the temple site

It is assumed that the sanctuary of Athena Alea was originally situated on a small elevation on the outskirts of the city of Tegea on the Tegean plain. However, when the site was discovered at the beginning of the 19th century in the present village of Alea, the sanctuary itself was not visible on the surface, but was covered by the houses of the village and, beneath those, by thick layers of silt.¹ Today the ruins of the Classical temple foundations rest more than 2 m below the level of the nearest village houses. This can clearly be seen when the temple site is observed from the road in front of the modern church. Silt layers are also found between refuse layers in the excavated profiles.

The Tegean plain (ca. 670 m above sea level) constitutes a large part of a highland area in south-east Arcadia, and serves as a sedimentation basin in a karstic landscape with sinkholes (known locally as *katavothra*) and depressions derived from tectonic activity. Subsurface river channels drain the plain, and have created a local sedimentation basin, Lake Takka. Mountains surrounding the Tegean plain reach 1800–2000 m above sea level. They are partly forested by coniferous trees such as fir (*Abies*), pine (*Pinus*) and spruce (*Picea*), but they have also been partly denuded by forest fires as well as intensive grazing. Weathering and subsequent erosion of the mountainsides bring sediments down the slopes. Coarse material is deposited in talus deposits, while temporary rivers and sheet flows transport finer material to the local sedimentation basin, Lake Takka.

The Tegean plain is composed of low undulating hills descending south-eastwards toward Lake Takka. The deposits on the plain are thick silt layers interrupted by inclined thinner layers of gravel. The layers of deposited silt at the temple site and on the plain are of lacustrine origin; this is indicated not only by features such as grain size and lamination, but also by the content of phytoplankton in the sediments and the presence of root channels from aquatic sedges (*Cyperaceae*).

Extensive and frequent floods from the nearby river Sarantapotamos have occurred in the area until recently, and have deposited successive layers of lacustrine silt. Such events have in recent historical times forced the

population to leave their residential areas on the plain and move to areas at higher altitudes. The silt has improved soil quality and counteracted soil degradation. The floods have caused blooms of blue-green algae in shallow pools and ponds. Nitrogen fixation after such events has also increased the fertility of the soil.

Small and more regular floodings have, therefore been a blessing, improving soil fertility and making the area well suited for irrigation and agriculture. The areas which have been frequently flooded are still the most fertile areas of the plain. These floodings may have been an important advantage in these highland plains compared to coastal and low altitude settlements, and may be a reason why the area was so important and powerful in ancient times.

Present vegetation

The climate in the area is continental, and most of the precipitation falls during winter (Horvat *et al.* 1974). Vegetation types on the Tegean plain are not governed by climate alone; they have been shaped and reshaped by human activities like cultivation and grazing through thousands of years. Historically, grazing by sheep and goats was widespread (Gejvall 1969; Brentjes 1965) and still persists today, although with somewhat reduced intensity. Agriculture is still important on the plain, but also this has decreased, particularly in the last 20–30 years. *Prunus* (cherries), potatoes and cereals are the most important agricultural products. Elements of natural vegetation types are therefore at present almost absent. All over the Peloponnese woodland is very scarce. Pine forests still exist at high altitudes, deciduous forests mainly in steep, inaccessible slopes. However, due to the drastically reduced grazing during the last decades, the widespread phrygana vegetation is now about to develop into forest. Young individuals of different deciduous *Quercus* (oak) species can be found all over in the tall phrygana.

Methods

Field sampling in the sanctuary

During the archaeological field season in 1994 a number of samples for pollen analysis were obtained from standing profile walls in the northern sector of the excavation. They were extended by coring into deeper levels in order to provide soil samples that covered the entire time period of the archaeological horizons.

The pollen diagram is constructed from samples obtained as follows: the upper part representing from –86 to –234 cm below the local 0 level was taken from the northern wall section of grid square D7 (coordinates x = 15.40 and y = 34.68 m), and the second, deeper part, from –210 to –343 cm, was from the northern wall section of a deep pit from an earlier, unpublished excavation, also in square D7 (coordinates x = 16.00 and y = 30.25 m). (*Fig. 1*) The third and lowermost part of the pollen

¹ For the discovery of the site and the development of archaeological investigation there, see conveniently *Tegea I*, Introduction (Østby), and section ii (Nordquist), 57–8.

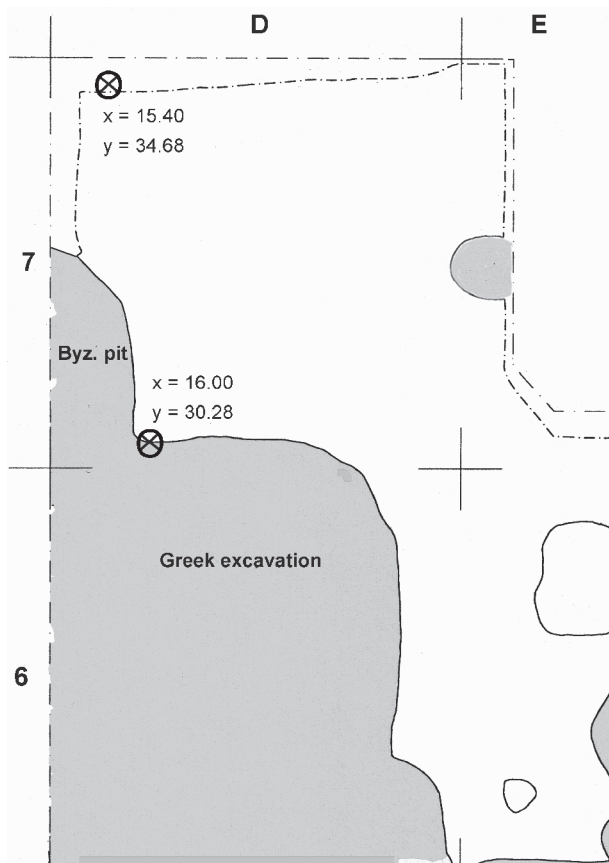


Figure 1. Map showing the locations of the profiles (indicated by the crosses in circles) where the samples were collected for pollen analysis. (Prepared by E. Østby)

diagram represents sediments taken with a peat sampler coring down below the second sampling spot. This core extended the profile to – 513 cm below the 0 level, without reaching the base of the silt.

Pollen concentration, chemical preparation, and microscopic analysis

From the upper sections a minimum of 100 g of soil material was extracted for pollen samples in 5 cm intervals. The pollen content from 29 of these samples was analysed, using 80–60 g of sediment. From the core eight samples were taken of varying weight, using 10 and 20 g of each sample for extraction.

The sample material was first dispersed by shaking in pyrophosphate solution until suspended. The samples were then decanted to remove coarse sand and sieved using successive monofilament sieves to extract the particles in the range of 10–100 microns. Sieving was performed by prolonged flushing with distilled water until spill water appeared clear and contained few or no particles below 10 microns. The remaining material on the second sieve was then transferred to a centrifuge tube and subjected to standard pollen preparation techniques according to Fægri and Iversen (*eid.* 1989), using acetolysis and HF-treatment to remove organic and remaining inorganic material respectively. Pollen

identifications are based on the keys of Fægri and Iversen (*eid.* 1989) and the illustrations in Reille (*id.* 1992). During microscopic examination an attempt to identify between 200 and 500 pollen grains was made for each sample. Spectra (samples) with low pollen contents had, however, in some cases to be joined with neighbouring spectra until acceptable pollen quantities could be reached, giving a total of 29 samples in the pollen diagram. (*Pl. 1*)

The preparations were done at the former Botanical Institute, now Department of Biology, University of Bergen, Norway, and the pollen analyses were done at the Laboratory of Forestry and Geobotany, Aristotelian University of Thessaloniki, Greece.

Results

The results presented here are based on the complete pollen diagrams presented in Bjune *et al.* 1997. The diagrams present pollen types as percentage values calculated on the basis of ΣP (total land pollen) and are plotted using the data program Core 2.0 (Kaland and Natvik 1994). Pollen grains of *Asteraceae sect. asteroideae*, *Asteraceae sect. cichorideae* and *Dipsacaceae* are omitted from the pollen sum. These are found in high amounts and would statistically suppress the other pollen types. By not including them the trends in the diagram become more easily visible (Haviga 1971).

The pollen diagram presented in *Pl. 1* is divided into four local pollen zones according to the archaeological stratigraphy. These zones represent the pre-Archaic period (Zone 1), the Archaic and Classical periods (Zone 2), the Early Medieval period after the destruction of the temple (Zone 3), and the layers of the disturbed Byzantine burials (Zone 4).

Zone 1: Pre-Archaic period

This zone has the highest amount of pollen in each spectrum, as well as in number of species encountered. The dominating tree species are *Betula*, *Fraxinus*, *Pinus* and *Quercus* (*Quercus robur*-type and *Quercus ilex*-type), while *Olea* have low values. *Poaceae* (grasses) have high frequencies, and indicators of human activity are abundant, *e.g.* *Vicia*-type, *Malvaceae*, *Centaurea* species, *Triticum*-type and *Cerealia*.

Zone 2: Archaic and Classical periods

In this zone the amount of tree pollen and *Poaceae* in general decreases from the bottom of the zone towards the top. The shrubs also have low values and are dominated by *Hedera*, *Lonicera xyleosteu*-type and *Salix*. Species of weeds like the *Polygonum aviculare*-type and *Chenopodiaceae* increase in this zone and the amount of cereal decreases, as compared to the previous zone. *Asteraceae sect. cichorideae* and *Dipsacaceae* are more frequent than before.

Zone 3: Early Medieval period

Populus occurs for the first time in this zone, and *Olea* increase towards the top of the zone together with other indicators of human impact and open ground conditions such as *Chenopodiaceae*, *Apiaceae*, *Asteraceae* sect. *cichorideae* and *Dipsacaceae*. *Cerealia* have very low values, and *Poaceae* decrease towards the top of the zone. Many of the herbs registered previously are no more encountered in these samples.

Zone 4: Byzantine layers

This zone has increasing values of *Fraxinus*, *Olea* and *Castanea*-type. Herbs like *Asteraceae* sect. *cichorideae*, *Dipsacaceae*, *Chenopodiaceae*, *Rubiaceae*, *Polygonum aviculare*-type and *Polygonum persicaria* have high values. *Cerealia* are also registered, but with relatively low values.

Interpretation and discussion

Even though pollen preservation was found to be exceptionally good at this site, there is clearly an over-representation of some pollen taxa because of selective corrosion (Havinga 1971). (See *Pl. I*) Pollen types like *Asteraceae* sect. *asteroidae*, *Asteraceae* sect. *cichorideae* and *Dipsacaceae* all have thick-walled pollen grains that withstand oxidation better than pollen types with thin and fragile exines. The relative over-representation of some taxa may indicate that selective pollen preservation has occurred, although one cannot exclude that the high frequency could be due to the local presence of these species at the site. Another danger of misinterpretation exists because of the very low pollen concentration in some samples; such low values might not always give a statistically reliable sample (Dimbleby 1985).

Another important source of error throughout the whole sequence is related to human activity at the site such as the digging of pits for votive material or other purposes. The soil from such pits was spread on the surface so that older pollen was mixed into later surfaces. There is no way to trace such in the profile other than by careful, visual stratigraphic inspection. The only place where the disturbances caused by human activity are stratigraphically visible is in the layers with Byzantine burials, but a certain element of human disturbance must be expected also elsewhere. Furthermore, burrowing animals such as worms or wasps causing bioturbation were observed. Disturbances by human or animal activity tend to make pollen curves smooth (Dimbleby 1985).

The pollen grains found in the sanctuary are a mixture of four components: 1) the general pollen rain from the regional vegetation; 2) the local vegetation from and around the site; 3) pollen grains from plant material stored, processed, consumed or for other reasons brought to the sanctuary; and 4) redeposited pollen brought in by the flood sediments. The challenge is to filter the component of redeposited pollen from the three other components,

and also filter the “landscape component”, both local and regional, from the “ritual component” of the site.

The sanctuary was from the pre-Archaic period (Zone 1) onwards an open site. This is indicated in the low amount of pollen from trees (arboreal pollen, AP) the dominance of herb species (non-arboreal pollen, NAP), probably of local origin. Grasses (*Poaceae*) have the highest values, which strongly indicates an open, local landscape. The herbs present in the vegetation either grew at the site and hence represent the local vegetation, or they were brought to the site through cultural activity and represent use of the site. This accounts for weeds like *Brassicaceae*, *Caryophyllaceae*, *Dianthus*-type, *Filipendula*, *Geranium*, *Knautia*, *Lychnis*-type, *Malvaceae*, *Plantago lanceolata*, *Ranunculus acris*, *Rumex* sp., and *Trifolium*-type.

Indicators of human activity like *Chenopodiaceae*, *Polygonum aviculare*-type, *Polygonum persicaria*, *Centaurea cyanus*, and *Centaurea scabiosa* (Behre 1981; Bottema 1982) are considered to be weeds associated with growing of cereals (*Triticum*-type, *Cerealia*, *Secale*). Cereals are found in all zones, and these pollen types are not spread in the air (cleistogamous flowers), but rather by the cereal products (grains) or during processing such as threshing (Vuorela 1973; Hall 1989). Their pollen grains indicate the presence of cereals at or close to the sanctuary. Cereals could, however, also have been brought to or consumed at the site. Small amounts could also have been grown at the site as part of some symbolic or ritual practice. *Secale* on the other hand have open flowers, and their pollen grains are spread by wind.

In Zone 1 (pre-Archaic period) the number of indicators of human activity is high (e.g. *Triticum*-type, *Cerealia*, *Secale*, *Centaurea cyanus*, *Centaurea scabiosa* and *Malvaceae*). In Zones 2 and 3 only a few traces of these species are found, and other weeds appear, e.g. *Polygonum aviculare*-type and *Chenopodiaceae*. This can indicate changes in the local agricultural practice over time, and also how the floods influenced the vegetation surrounding the Tegean plain.

The silt layers of Zone 2 (spectra 22, 26 and 28) seem to have high values of grasses (*Poaceae*), but lower values of herbs like *Polygonum aviculare*-type and *Chenopodiaceae*, compared to the spectra from the Classical period (spectra 16 and 18). The pollen sample from the Archaic period (spectrum 24) seems also to be different from the samples from Classical times. The species that were particularly frequent in the flood layers, such as hazel (*Corylus*), *Filipendula*, *Fritillaria* and *Rosaceae*, may also indicate wetter conditions in the sanctuary after the floods, as well as reflecting the vegetation where these sediments originated.

The samples representing the Archaic and Classical periods probably indicate both the local flora as well as the regional pollen vegetation, providing a wider pollen source area than in the pre-Archaic period. The amount of pollen from the original soil is probably minimal, due to corrosion in aerated soils (Dimbleby 1985). The pollen

samples indicate changes in the local flora, and probably also a different use of the sanctuary in Archaic compared to Classical times.

The diagram has given some indications of the general development of the regional vegetation. In the upper part of the diagram trees become more and more abundant. Pollen grains from trees are normally anemophilous, *i.e.* the trees are wind pollinated, and their pollen is spread in large amounts by wind. Even though both trees and herbs held a special position in ancient Greece and were included in ritual practices on temple sites (Baumann 1993), one might assume, until further evidence suggests otherwise, that most of the pollen grains from tree species arrived from the regional and extra-local pollen rain, or they were transported with flood sediments, and consequently represent the vegetation of the regional landscape surrounding the city. Some trees may possibly have existed at the site in various periods through time, and some pollen grains of tree species could also have been brought to the site through ritual practice or consumption at the site. This may in particular be the case and the reason for the high percentage of *Olea* pollen (olive). The olive is an insect-pollinated species, and modern surface samples close to olive groves contain on average less than 10% olive pollen (Wright 1972). There is a general assumption that olive trees were not grown on the Arcadian plain because they cannot tolerate the low winter temperatures (Rackham 1982). This assumption does not seem to hold in absolute terms as olive plantations actually occur even today, particularly in slopes facing south-east, but large-scale olive cultivation is not encouraged by the low winter temperatures. Since winter temperatures were not very different in antiquity we must seek other explanations for the high frequencies of olive pollen in some of the spectra.

Can this amount of olive pollen possibly show that olive, as branches or fruits, was brought to the site for ritual purposes? In any case these branches could have been taken from trees grown locally. Another possibility is that the olive pollen was brought to the sanctuary through olive products, like unpurified oil. If this is the case, olive might as well be imported. According to Runnels and Hansen (1986) and Boardman (1976) olive has been cultivated on mainland Greece since the Bronze Age, and on Crete since the Middle Neolithic period (Rackham and Moody 1996). As shown by Grieg and Turner (1974) the cultivation of olives increased from the Late Geometric to Early Classical times both in southern and northern Greece. The *Olea* curve in Zones 3 and 4 increases through the zones, and the amount of olive in the deposits from the sanctuary is probably to be correlated with the practices on the site. For the moment we cannot infer that it is correlated with local changes in *Olea* cultivation, but the results show that the olive must have been important at Tegea.

Conclusions and future perspectives

Although problems arise from interpreting the pollen content of refuse layers at the temple of Athena Alea in Tegea, the palynological investigation demonstrates that such analysis may potentially be an important source of information for understanding not only the activities at the site but also the cultural, economical, and social development of the polis state. Moreover, these data can reveal the influence of the city on the surrounding Arcadian landscape in different historical periods. Changes in the cultural landscape and its ecosystems are an immediate result of social, cultural, and economical changes within the city. The investigation of the cultural landscape and its interactive relationship with the city and the sanctuary may provide information on the use of natural resources, and the use and development of agricultural areas around the city, both in space and time.

At present the material analyzed and the knowledge gained from this preliminary pollen investigation can only encourage future work and analyses of palynological material from Tegea. Too little can at present be revealed from only one pollen profile in such a complex context for any firm conclusions to be drawn about the use of plants or food products in the sanctuary, the local agricultural traditions, or the local vegetation in comparison with other regional vegetation types. The different pollen source components, and consequently the vegetation components, can only tentatively be separated; therefore it is not easy to give a thorough description of landscape components. The data set is in general too local and too small to provide anything more than indications of changes in the local vegetation and the agricultural economy.

Further development of the interpretations can only be achieved by an extension of the analysis not only in the sanctuary itself but also into its immediate and more distant surroundings. This would involve sampling several sites, to compare records from sediment cores within the city and its local and regional surroundings, in order to fully understand local and regional vegetation patterns and changes. A network of several pollen profiles could probably isolate a “ritual component” of herbs from the “local vegetation component”, and could give an indication as to whether the cereals found in the sanctuary were grown locally or were brought to the site; this is also the case for history and the importance of *Olea* in this region. We do recommend that a regional pollen diagram be constructed from Lake Takka, as a reference, and that the local vegetation changes be placed in a wider regional perspective.

In addition to the expansion of sites for pollen analysis, detailed investigations into sedimentation patterns are vital in order to understand not only the transport of pollen, but also the development and the changes that have occurred in the cultural landscape through time.

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Literature:

- Baumann 1993 = H. Baumann, *Greek wild flowers and plant lore in ancient Greece*, London 1993.
- Behre 1981 = K.E. Behre, "The interpretation of anthropogenic indicators in pollen diagrams," *Pollen et Spores* 23, 1981, 225–45.
- Berglund 1991 = B.E. Berglund, *The cultural landscape during 6000 years in southern Sweden – the Ystad project*, Copenhagen 1991.
- Bjune *et al.* 1997 = A. Bjune, A. Overland and K. Krzywinski, *Palynological investigations of the Athena Alea temple in Tegea, Greece. Report from a preliminary study of a profile north of the sanctuary*. internal report, Department of Botany, University of Bergen.
- Boardman 1976 = F.B.A. Boardman, "The olive in the Mediterranean: its culture and use," *Philosophical Transactions of the Royal Society of London*, Ser. B.275, 187–96.
- Bottema 1982 = S. Bottema, "Palynological investigations in Greece with special references to pollen as indicators of human activity," *Palaeohistoria* 1, 1982, 257–89.
- Brentjes 1965 = B. Brentjes, "Der geschichtliche Tierweltwechsel in Vorderasien und Nordafrika in altertumskundlicher Sicht," *Säugetierkundliche Mitteilungen* 13, 1965.
- Dimbleby 1965 = J.W. Dimbleby. *The palynology of archaeological sites*, London 1965.
- Fægri and Iversen 1989⁴ = K. Fægri and J. Iversen, *Textbook of pollen analysis*, 4th ed. by K. Fægri, P.E. Kaland and K. Krzywinski, Chichester 1989.
- Gejvall 1969 = N.-G. Gejvall, *The fauna* (Lerna, a preclassical site in the Argolid I), Princeton 1969, 1–107.
- Grieg and Turner 1974 = J.R.A. Grieg and J. Turner, "Some pollen diagrams from Greece and their archaeological significance," *Journal of Archaeological Science* 1, 1974, 177–94.
- Hall 1989 = V.A. Hall, "A study of modern pollen rain from a reconstructed 19th century farm," *Irish Naturalist's Journal* 23, 1989, 82–92.
- Havinga 1971 = A.J. Havinga, "An experimental investigation into the decay of pollen and spores in various soil types," in J. Brooks, P.R. Grant, M. Mnrir, P. van Gijzel and G. Shaw (eds.), *Sporopollenin*, London 1971, 446–78.
- Hjelle *et al.* 1992 = K. Hjelle, A.K. Hufthammer, P.E. Kaland, A. Bruen Olsen and E.C. Soltvedt (eds), *Kotedalen – en boplass gjennom 5000 år* Vol. 2, *Naturvitenskapelige undersøkelser*, Historisk Museum, Universitetet i Bergen 1992.
- Horvat *et al.* 1974 = I. Horvat, V. Glavac and H. Ellenberg, *Vegetation Südosteuropas* (Geobotanica Selecta vol. 4), Stuttgart 1974.
- Jahns 2003 = S. Jahns, "A late Holocene pollen diagram from the Megaris, Greece, giving possible evidence for cultivation of *Ceratona siliqua* L. during the last 2000 years," *Vegetation History and Archaeobotany* 12, 2003, 127–30.
- Kaland 1986 = P.E. Kaland, "The origin and management of Norwegian coastal heaths as reflected by pollen analysis," in K.E. Behre (ed.), *Anthropogenic indicators in pollen diagrams*, Rotterdam 1986, 19–36.
- Kaland and Natvik 1993 = P.E. Kaland and Ø. Natvik, *Core 2.0*. Unpublished computer program.
- Krzywinski and Kaland 1984 = K. Krzywinski and P.E. Kaland, "Bergen from farm to town," *The Bryggen Papers* Suppl. Series 1, 1984, 1–39.
- Krzywinski and Soltvedt 1988 = K. Krzywinski and E.C. Soltvedt, "A Medieval brewery (1200–1450) at Bryggen, Bergen," *The Bryggen Papers* Suppl. Series 3, 1988, 1–68.
- Krzywinski *et al.* 1983 = K. Krzywinski, S. Fjellidal and E.C. Soltvedt, "Recent paleoetnobotanical work at the excavations at Bryggen, Bergen, Norway," in B. Proudfoot (ed.), *Site, environment and economy (BAR 173)*, Oxford 1983, 145–69.
- Kvamme *et al.* 1992 = M. Kvamme, J. Berge and P.E. Kaland, "Vegetasjonshistoriske undersøkelser i Nyset-Steggjevassdragene," *Arkeologiske rapporter* 17, 1992, Historisk museum, Universitetet i Bergen 1992.
- Rackham 1982 = O. Rackham, *Land-use and the native vegetation of Greece (BAR-IS 146)*, Oxford 1982, 177–98.
- Rackham and Moody 1996 = O. Rackham and J. Moody, *The making of the Cretan landscape*, Manchester 1996.
- Reille 1992 = M. Reille, *Pollen et spores d'Europe et d'Afrique du nord*, Marseille 1992 .
- Runnels and Hansen 1986 = C.E. Runnels and J. Hansen, "The olive in the p(re)historic Aegean: The evidence for domestication in the early Bronze Age," *OJA* 5, 299–308.
- Vuorela 1973 = I. Vuorela, "Relative pollen rain around cultivated fields," *Acta Botanica Fennica* 102, 1973, 1–27.
- Wright jr. 1972 = H.E. Wright jr., "Vegetation history," in W.A. McDonald and G.R. Rapp (eds), *The Minnesota Messenia Expedition; Reconstruction of a Bronze Age regional environment*, Minneapolis 1972, 188–99.

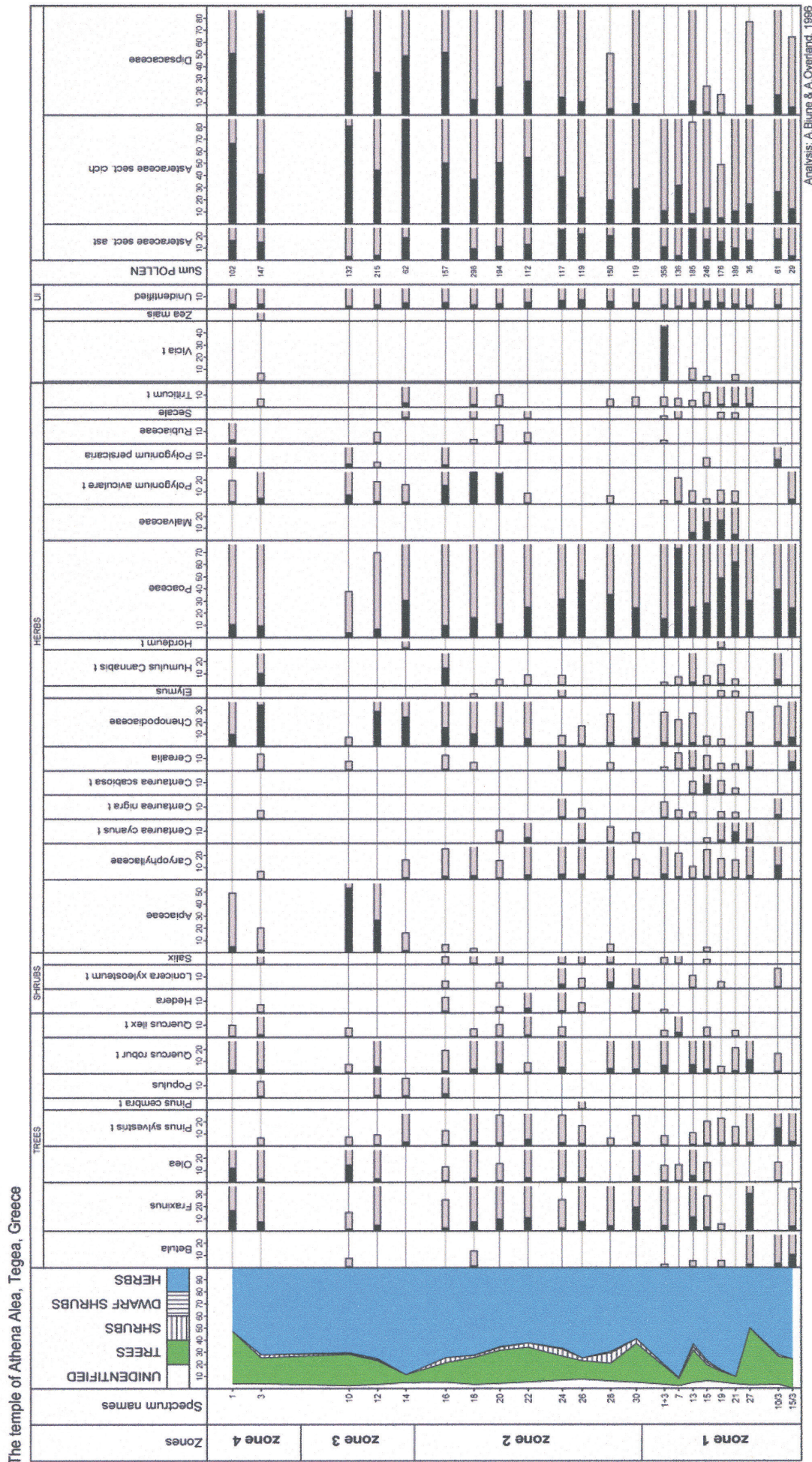


Plate 1. Pollen diagram with selected pollen taxa from the profile in the sanctuary of Athena Alea at Tegea. The data are arranged by depth with the oldest sample in the lower part of the diagram (spectrum 15/3). Pollen is presented as a percentage of the total land pollen (black histograms). The grey parts of the histograms denote a 10x exaggeration of the percentage values. The pollen zones are shown in the left-hand column. The green silhouette indicates the total amount of tree pollen, whereas the total amount of herbs is shown in blue. (Diagram prepared by A. Bjune and A. Overland)

