# THE ÖKÜZINI MARSHES: A NEW UPPER PLEISTOCEN RECORD ON THE ANATOLIAN MEDITERRANEAN COAST

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## LOCATION

The Öküzini marches are located at the foot of the limestone Taurus Mountains, at the northern edge of the travertine-capped Antalya plain on the Mediterranean coast of Turkey. They occur at present in front of the Öküzini cave, where an Epipaleolithic settlement and Neolithic graves (period extending from uncal. 14C 16500 to 7900 BP) have been excavated (Yalçınkaya 1998).

## CORING

A 7.63 m long sequence was cored using a 63 mm wide Livingstone corer, and sampled every 10 cm out of three overlapping parallel cores, from 7.60 to 0.65 m. The sequence, resting above a hard layer which is most probably a travertine, is composed of non-laminated lake and marsh.

## STRATIGRAPHY

The bottom of the core (7.43-7.39 m) is sandy. Beige slits follow, becoming dark brown above 5.56 m until 4.80 m. Above 4.80 m, the rest of the sequence is composed of organic silts very rich in mollusc shells; peat is present from 3.03 to 2.25 m, and from 1.60 to 1.42 m.

Roots (at 5.74-5.64 m), fibres (5.85-5.51 m), reed leaves (4.80-4.05 m) and charcoals (4.70-3.10 m, at 2 m and above 0.5 m) are also present.

## DATING

### *Glacial*

Pollen Unit Ia belongs to MIS 3: 45600 ± 1740 yrs BP at 7.21-7.18 m (AMS); ca. 42080 ± 980 yrs BP at ± 6.01-5.96 m (AMS). Mineralogic changes in Unit Ia show similar indicators of increasing evaporation leading to a drying-off after 42 kys. Such a drought has been identified also in the Kpnya plain (central Anatolia) (Kuzucuoğlu *et al.* 1999).

### *Pleniglacial*

Unit Ib is identified by a 24120 ± 480 yrs BP date at 5.44-5.48 m depth. It corresponds to a freshwater lake phase which could be contemporaneous to the Pleniglacial high lake levels in inner Anatolia (Fontugne *et al.* 1999).

### *Late Glacial*

A 14190 ± 165 yrs BP age at 5.01-4.97 m indicates the start of Pollen Unit II. According to mineralogy, this date belongs to a freshwater lake phase following the Pleniglacial one. This phase ends with a sharp change in mineralogy, most probably indicating a hiatus corresponding to the YD during which many Anatolian lakes have dried.

### *Holocene*

Further dates (9330 ± 90 yrs BP at 4.17-4.13 m; 4450 ± 60 yrs BP at 3.39-3.36 m; 4180 ± 50 yrs BP at 2.65-2.61 m; 5650 ± 65 yrs BP at 2.09-2.05 m (date inversion); 3240 ± 65 yrs BP at 1.54-1.51 m) show that most of the Holocene is recorded in the rest of the sequence. Sedimentation rate is low at the beginning of the Holocene (1.6 cm/100 years) when compared to the middle part (28 cm/100 years) and the top part (11 cm/100 years).

## POLLEN

### *Results and interpretation*

Unit Ia (7.60-5.64 m) dated MIS 3; ends with soil formation at 5.74-5.64 m (at 33 ka?)

According to pollen, this Unit (mineralogic Units Ia and Ib) is cold and dry, with high percentages of *Artemisia* and chenopodiaceae and a low percentage of tree pollen (mainly deciduous *Quercus* and *Pinus*). Pollen of *Carpinus*, *Ulmus*, *Acer*, *Juniperus* and *Juglans* show that the region was a refuge area for these trees. Two small peaks in tree pollen at 7.50 and 6.80 m lay point out to milder sub-stages.

High percentages of aquatic plants pollen (*Nuphar*, *Nymphea* and *Myriophyllum*) confirm the presence of a lake, while the importance of *Typha*, reeds and carex pollen shows an abundant vegetation around the lake.

Unit Ib (5.64-5.00 m) dated MIS 2; Pleniglacial high lake level and Termination I drought followed by Late Glacial warming interrupted by the Younger Dryas.

Pollen sterile samples underline possible hiatus. The first one, at the end of the Glacial lake period, is recorded in central Anatolia in dune fields between 19 and 14.5 ka (Kuzucuoğlu *et al.* 1998). The second one, at the end of the Late Glacial warming, corresponds most

probably to the Younger Dryas.

In this unit, the percentage of tree pollen increases, especially *Quercus*, *Juniperus* and *Fraxinus*. *Pinus* has almost disappeared, as also *Artemisia*. Chenopodiaceae are still abundant, showing that insufficient humidity continues. The disappearance of aquatic taxa and the decrease in marsh plant pollen shows wetland shrinkage.

Unit II (4.95-3.75 m) dated Lower Holocene; Development of agriculture + close proximity of the Neolithic settlement (at -5-4 m)

Pollen shows, together with low level marsh environment and increasing temperatures, the development of human activities.

- Chenopodiaceae disappear, confirming that the steppe environment vanished.
- *Quercus* and *Fraxinus* are still present and *Juniperus* highly increases, *Pinus* remaining rare. From 4.80 to 4.60 m, tree pollen disappears suddenly (4.5% at 4.60 m = the signal of a human-related deforestation ?) before rising again. This later rise is due to *Pinus*, caducifoliated *Quercus*, *Fraxinus* and *Juglans*.
- Extension of Cichoriae confirms the rise in humidity also noticed in i) the increase in aquatic plant pollen (although their percentage does not yet reach the figures obtained in Unit Ia, and ii) the abundance of marsh plant pollen.
- Other pollen types show a very important agricultural activity and plant collecting, with:
  - a constant and relatively important Poaceae presence, of Cerealia types;
  - the increase in Fabaceae pollen, especially at 4.4, 4.0 and 3.8 m;
  - the presence of *Vitis*, *Lens* and *Linum* pollen;
  - the increase in fruit trees pollen such as *Juglans*, *Pistacia*, *Prunus* and *Celtis*.

The variety and abundance of these types, the high quantity of micro-charcoals (one of which – at 4.6 m – being a caducifoliae *Quercus*, the high cereal percentage (5% of total pollen), and may be also the rise in semi-aquatic plant taxa (used for construction or other purposes?) indicate the close proximity of a settlement, if not the Neolithic site itself.

Unit IIIa (3.60-3.20 m) starts at ca. 4450 ± 60 yrs BP; exploitation and degradation of environment + development of animal husbandry

Pollen show a strong herb presence, except for *Artemisia* and Chenopodiaceae, although some types decrease (cereals, plants typical of agricultural activities). *Lens* and *Linum* are still present. New types appear: Cucurbitaceae and *Olea* (10%) confirming agriculture-related activities. Together with *Olea* occurrence, the appearance of *Quercus calliprinos* seems to indicate exploitation and degradation of the environment in relation to the development of animal husbandry.

Tree pollen increases, this trend being mainly due to the development of *Pinus* parallel to the *Quercus* pollen decrease. According to van Zeist *et al.* (1975), this means an increase in humidity. This increase is also marked in the high proportion of aquatic and semi-aquatic plant pollen showing a rising lake and marsh levels.

Units IIIb (3.10-2.60 m) ends at 4180 ± 50 yrs BP; area abandoned by man: a less intensive soil exploitation and agriculture

This phase corresponds to the disappearance of site-related human activities: no more cereal or culture-related pollen. *Artemisa* reappears slightly indicating drought stress, while *Pinus*, although still very present, varies. Subsequently, the area seems relatively abandoned by man, with a less intensive soil exploitation and agricultural activities.

Decreasing aragonite and calcite, increasing quartz input and high mollusc content show a slowly decreasing level of the lake and marshes. According to the 14C date, the end of this period may correspond to the 2100 BC climatic brutal event recorded in several parts of the Eastern Mediterranean (Dalfes *et al.* 1997).

Unit IV (2.20-0.85 m): low level water bodies; the Beysehir Occupation Phase + intensive grazing

Tree pollen composition changes significantly, with a *Pinus* decrease and the extension of *Fraxinus* reaching 40% of tree pollen at 1.8 and 1.55 m. *Olea*, *Pistacia* and *Juglans* are present. A few cereal pollen reappear at 2.10 m, together with pollen of plants related to human activities. Moreover, *Plantago lanceolata* and aromatic Labiateae (up to 14% of herb pollen) expand. Some of these plants being eaten by herds, their development is here the signal of the intensive grazing of other pasture plants (as shown; for example, by the Cichoriae decrease).

This profile is typical of what van Zeist *et al.* (1984) called the "Beysehir Occupation Phase" (development of the *Fraxinus*, *Olea* and *Juglans* trees culture), which is confirmed by the date obtained.

Unit V (0.85-0.675 m): recent and today's marsh deposit; reinstallation of the naturel forest + presence of man and herds

As far as mineralogic records are concerned, this unit corresponds to the continuum of the previous trends. In the pollen record, the forest expands on the slopes, with tree pollen reaching 68-75%, *Pinus* becoming dominant (40%, then 60% of the tree pollen), confirming the reinstallation of the natural forest. However, the presence of *Quercus calliprinos* and *Olea* pollen, charcoals in the sediment, indicates the lasting presence of man and of his grazing herds.

## MINERALOGY

### *Methods of analysis*

Minerals (of calcite, aragonite and quartz) chosen for the study are quantified using FTIR (Fourier Transform Infrared absorbance spectroscopy) (Bertaux *et al.* 1998). The quantitative determination is performed by making a multicomponent analysis of the sampled sediment spectra using the spectra of standard minerals. The contribution of minerals to the overall content is also computed by measuring one of their specific absorption bands.

*Results and interpretation*

Lithology. Above the top part of the travertine at 7.63 m:

- Unit I (base) is composed of beige silts ending with a root rich soil;
- Unit II is composed of dark brown silty clay (lacustrine);
- Unit III is composed of dark brown silts (no clay);
- Unit IV is composed of several organic matter rich peat and silts layers.

Mollusc shells are present in varying quantities in most of the sequence, except in the uppermost part of Unit I.

Mineralogy. Calcite, aragonite and quartz curves allow to discriminate various environments:

- Unit Ia: high calcite, no aragonite (except at the base) and no quartz. The environment is that of a low level permanent lake; water is cold and brackish (high calcite).
- Unit Ib: water level decreases and lake becomes temporary (seasonal?).
- Unit Ic: low level lake water becoming increasingly calcitic while molluscs disappear.
- Unit ID: calcite reaches 80%. Further evaporation may have led to calcitic crusting.
- Unit Ie: a soil caps the drying off of the lake. Such MIS 3 lake disappearance is dated 33 ka in central Anatolia; this event may thus have occurred on the Mediterranean coast.
- Unit II: lake water is diluted, indicating a freshwater high level lake. Such MIS 2 deep lakes are present all along the northern parts of the Taurus Mountains in central Anatolia.
- Unit IIIa: calcite, aragonite and quartz show parallel peaks. Environment is that of a varying level (seasonally dried?) marsh, most probably springfed from the Taurus.
- Unit IIIb: calcite remains high, although decreasing, while aragonite and quartz disappear showing an increasing water level becoming permanent; at start, warm waters lead to high calcite concentration; marshes are of freshwater at the top of the unit (i.e., around 4200 BP).
- Unit IV: starts with a possible but short hiatus in evaporative condition (corresponding to the 2100 BC regional climatic event?). Phase IV shows low level marshes sensitive to evaporation (increasing calcite concentration), with periods of drying off.

## CONCLUSION

*Glacial*

MIS 3: increasing evaporation trends lead to a drying-off after 42 ka. Such a drought has been identified also in the Konya plain in central Anatolia where it is dated to 33 ka (Kuzucuoğlu *et al.*, 1999). According to pollen, this period is cold and dry. Pollen indicates refuge areas for deciduous *Quercus* and *Pinus*, *Carpinus*, *Ulmus*, *Acer*, *Juniperus* and *Juglans*.

*Pleniglacial*

MIS 2 corresponds to a freshwater lake phase which could be contemporaneous to the Pleniglacial high lake levels in central Anatolia. A drought occurs at the end of the Glacial lake period; this is also recorded in central Anatolia (Kuzucuoğlu *et al.* 1998).

*Late Glacial*

A freshwater lake phase follows the drying off of the Pleniglacial lake. However, pollen shows that insufficient humidity continues and that marshes tend to shrink. Thus, this humid phase ends with a hiatus corresponding to the Younger Dryas during which many Anatolian lakes have dried.

*Lower Holocene*

While level marsh development is low, humidity rises and temperatures increase, human activities develop. Pollen types and charcoal indicate the close proximity of a settlement, if not the Neolithic site itself.

*Mid-Holocene*

In a climate where humidity continues to rise, agriculture-related activities continue; pollen indicates exploitation and degradation of the environment in relation to the development of animal husbandry. This trend ends up with a phase during which the area seems relatively abandoned by man. Lake and marsh level slowly decreases. According to the 14C date, the end of this period may correspond to the 2100 BC climatic brutal event recorded in several parts of the Eastern Mediterranean (Dalfes *et al.* 1997).

*Antiquity*

The Beysehir occupation phase is present at Öküzini (development of the *Fraxinus*, *Olea* and *Juglans* trees culture), while other plants signal the impact of intensive grazing on vegetation. Marsh level remains low and variable, with indicators of varying evaporation effects.

*Modern and recent times*

Environmental indicators show the continuum of the previous characteristics. The natural forest conquers the slopes while man is present with animal husbandry modifying the vegetation cover.

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