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## CONTRIBUTIONS TO THE EUROPEAN POLLEN DATABASE

## 13. Lake Saloio (Nazaré, western Portugal)

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The Lagoa do Saloio (39° 36' 48" N, 9° 00' 57" W) is a small lake situated 5 km east of the town of Nazaré in the Valado de Frades forest, central coast of Portugal. The lake is 70 m above sea level, 270 m long, 72 m wide, and oriented west-southwest–east-southeast (WSW–ESE). The site is a groundwater-fed, interdunal lake (Queiroz & Mateus, 2004) located on the border between Plio-Pleistocene sands of the Valado de Frades complex and more recent dunefields (Camarate França & Zbyszewski, 1963). The local soils are mostly podzols and regisols with fertile alluvial soils distributed along the Alcoa River.

The vegetation is typically Mediterranean, although today the Valado de Frades is a planted *Pinus* forest covering 1450 ha. Phytogeographically, the region is part of the Gaditan-Algarvian sub-province (Rivas-Martínez et al., 2002), which is a coastal unit with some palaeomediterranean and palaeotropical endemic elements.

The area experiences a Mediterranean climate with warm and dry summers and mild, humid winters. The average annual temperature (1976/1977–2006/2007) is 14.4 °C; the annual precipitation is up to 730 mm. This climatic zone is, according to the terminology of Rivas-Martínez et al. (2002), mesomediterranean but in recent years, it tended towards a thermomediterranean climate.

**Sediment description**

A core of 500 cm length was collected in June 2000 by a team from the Portuguese Institute of Archaeology (Lisbon) using a Livingstone corer. The

core was recovered from the central part of the lake, where the organic sediment was thickest and water depth was 6 m. Its lithostratigraphic units were as follows:

- 4–170 cm: organic gyttja, varying from black to brown;
- 170–278 cm: organic gyttja, with well-defined sand lenses at 219–220 cm and 225–226 cm;
- 278–410 cm: dark brown organic gyttja, with medium sand inclusions below 329 cm and clay content below 347 cm;
- 410–436 cm: organic gyttja, darker toward the base;
- 436–500 cm: white medium sand.

**Dating**

One accelerator mass spectrometer (AMS) radio-carbon date was obtained on *Erica* wood found at 435.5–436 cm depth, yielding a carbon-14 (<sup>14</sup>C) age of 2720 ± 40 BP (Beta-235000). A 2-sigma calibration using the INTCAL04 program (Reimer et al., 2004) suggests that this *Erica* wood dates to 2880–2750 cal. BP (930–800 BC).

**Interpretation**

More than 300 terrestrial pollen grains were identified in each sample and the pollen sum (100%) includes all pollen grains except hygrophytes and aquatic plants (Figure 1). The concentration of regional pollen varies little throughout the record indicating a relatively constant sedimentation rate. The age ranges for the pollen zones are formulated on that basis and five statistically significant

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Figure 1. Pollen diagram from Lake Saloio. Selected regional and local taxa are exaggerated 10 $\times$ .

pollen zones were defined using CONISS in Psimpoll (Bennett, 2009).

#### *SAL I* (c. 2800–2600 cal. BP)

This zone has a large percentage of heath [*Erica scoparia* L. and *Corema album* (L.) D. Don ex Steud.], which is decreasing towards the end of the zone. *Pinus* pollen is very abundant and increases as *Quercus* deciduous-type pollen decreases from its maximum. Pollen from dune vegetation is well represented, as are Poaceae and Cyperaceae pollen. The increase in almost all arboreal pollen values, especially *Pinus*, may reflect an expansion of forest.

#### *SAL II* (c. 2600–2200 cal. BP)

Arboreal pollen increases in this zone, with the highest values of *Pinus* pollen (almost 60%). *Alnus* pollen also increases. Pollen of sclerophilous shrubs is least abundant in this zone and almost all heath pollen types decrease. *Arbutus unedo* L. appears as a single pollen grain. *Myrica* pollen peaks and Poaceae, Cyperaceae, and other aquatic taxa decrease. This period is interpreted as a dry hydrological phase because of the reduction in aquatic pollen and spores. The sandy nature of the sediments of this phase indicates local landscape instability.

#### *SAL III* (c. 2200–1300 cal. BP)

*Pinus* strongly decreases, with a brief recovery in the middle of the zone. *Quercus* proportions remain stable. Heath and other shrub pollen types (*Cistus albidus* L.-type and *Ulex*-type) exhibit higher values. The pollen of ruderal plants (*Rumex acetosella* L.-type and *Plantago coronopus* L.) increases. Wetland pollen types are abundant and Poaceae, Cyperaceae, and other aquatic plants (*Nymphaea alba* L. and *Potamogeton*) increase at the end of this zone, while *Myrica* pollen declines. This zone indicates a phase of gradual forest destruction and its replacement with treeless scrub vegetation with *Erica scoparia* and *Erica umbellata* L.

#### *SAL IV* (c. 1300–700 cal. BP)

Arboreal pollen (*Pinus* and *Quercus*) proportions are low through this zone, with an evident decrease in *Quercus* pollen. Pollen representing tall heathlands (e.g. *Erica scoparia*) decrease while low heathland indicators (*Erica umbellata* and *Calluna vulgaris* Salisb.) and sclerophilous shrubs (*Cistus* sp., *Halimium* and *Ulex*-type) increase. Pollen of ruderal plants also increases and pollen of cultivated plants appears, including *Avena sativa* L., *Linum*

*usitatissimum* L.-type, and *Vitis*. *Erica erigena* R. Ross, semi-terrestrial and aquatic plants are represented in high proportions. Intense deforestation is evident in this zone with the appearance of some anthropogenic indicators of agricultural activity. *Linum usitatissimum*-type has been used since medieval times to make fishing nets. This may explain its appearance here.

#### *SAL V* (c. 700 cal. BP–present)

Pollen of forest trees recovers in this zone: *Pinus*, gallery forest elements (*Salix* and *Alnus*), and also *Quercus*. Heathland taxa like *Erica umbellata* increase. Ruderal pollen taxa (*Plantago coronopus*, *Urtica*, and *Corrigiola*) become dominant and pollen of cultivated plants occurs with an increase in *Olea* pollen, *Zea mays* L., and *Avena sativa*. Wetland pollen taxa such as Poaceae and Cyperaceae decrease. *Erica erigena* pollen peaks.

The top of the record is truncated; therefore, the historically documented establishment of the Valado do Frades pine forest between the thirteenth century and present day (Dinis et al., 2006) is not well represented palynologically. In this zone, the presence of some anthropogenic pollen indicators (*Cerealia*, *Plantago lanceolata* L.-type and *Rumex acetosella*-type) can be interpreted as a strong human impact in this area. The peak of *Erica erigena* probably indicates local paludification.

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