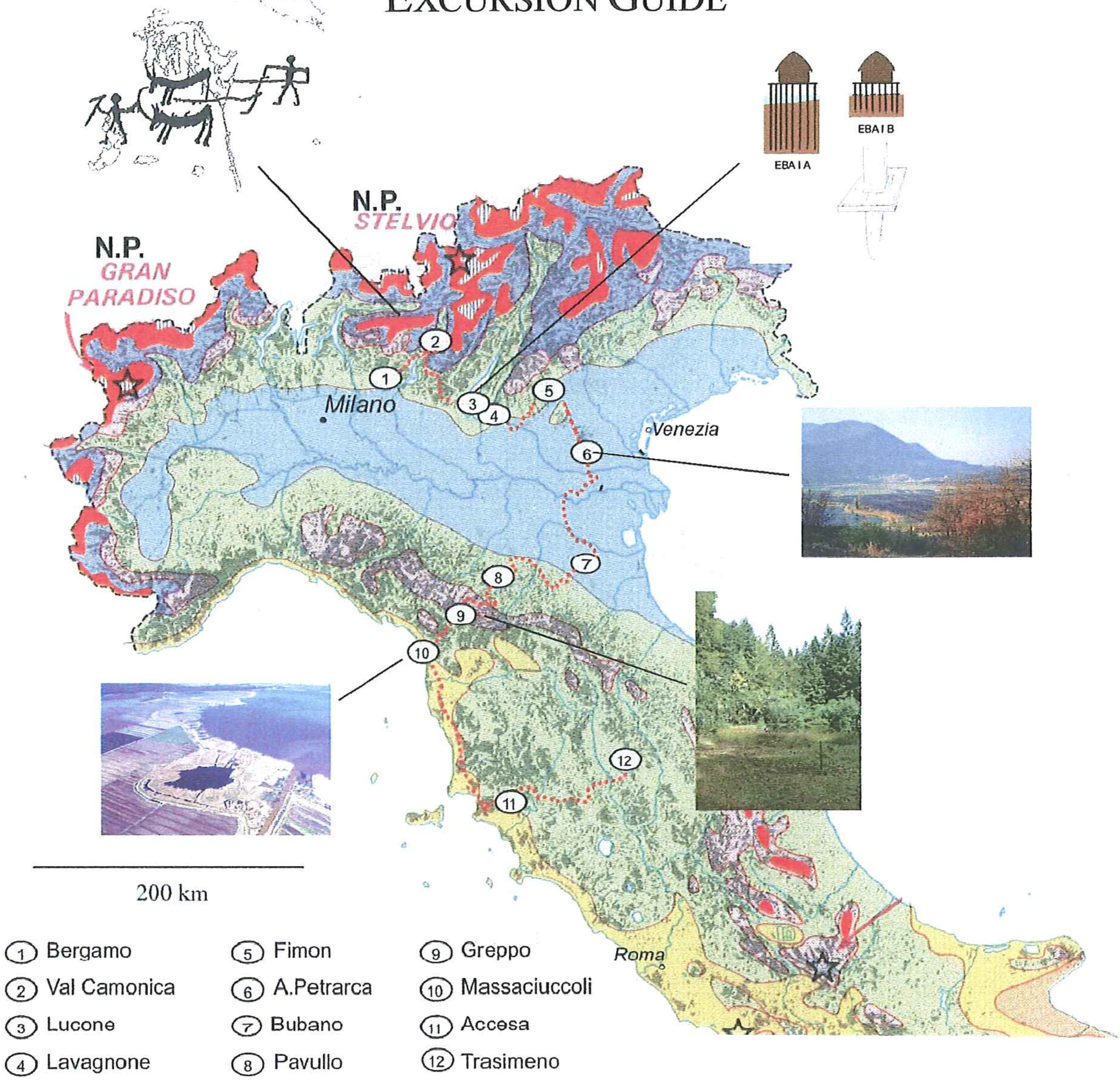
XXX International Moor-Excursion 2006
Northern and Central Italy

16.9.-24.9.2006

Excursion Guide



Organizers

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Elisa Vescovi and Willy Tinner

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XXX INTERNATIONAL MOOR-EXCURSION 2006
NORTHERN AND CENTRAL ITALY

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17, 18 Sept:
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Via Cavalle 19,
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19 Sept:
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Via Lughese Nord, 269/319,
40027 Mordano (BO),
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20 Sept:
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21, 22 Sept:
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PROGRAMME

Saturday, 16 September

16.30 h Meeting point Bergamo Hotel Mercure
17.00 h Meeting and scientific visit at the Museum of Natural Sciences, host and responsible of the day Anna Paganoni, Elisa Vescovi, Willy Tinner. Special guest: Cesare Ravazzi
Overnight in Bergamo.

Sunday, 17 September

8.30 h Departure
10.30 h Petroglyphs of Val Camonica, archaeological context.
12.30 h Lunch in field
13.30 h Departure
14.30 h Lago di Gaiano. Responsible of the site: Willy Tinner.
17.00 h Departure
18.30 h Arrival at Hotel Miralago (Lago di Garda).

Monday, 18 September

9.00 h Departure
9.30 h Lucone, Holocene vegetation history and archaeology of pile dwellings. Responsible of the site: Willy Tinner.
11.30 h Departure
12.00 h Lunch in field
13.30 h Lavagnone. Responsible of the site: Renata Perego, Marta Rapi.
Museum. Responsible: Claudia Mangani
18.30 h Arrival at Hotel Miralago (Lago di Garda).

Tuesday, 19 September

8.30 h Departure
10.00 h Fimon: Holocene vegetation and fire history, *Fagus* dynamics and human impact. Responsible of the site Willy Tinner.
Fimon: Late-Glacial vegetation history, *Larix* refugia: Lucia Wick.
12.00 h Lunch in field
13.00 h Departure
14.00 h Lago di Arquà Petrarca: Full Glacial Refugia of thermophilous trees and *Larix decidua*, Late-Glacial and Holocene vegetation and fire history.
Responsible of the site: Petra Kaltenrieder.
16.30 h Departure
18.30 h Arrival at Hotel Panazza (Mordano).

Wednesday, 20 September

9.00 h Departure
9.30 h Bubano: Late-Glacial finds of *Picea* and *Pinus* cones, vegetation history. Responsible of the site: Marta Donegana, Stefano Marabini, Cesare Ravazzi, Gian Battista Vai, Elisa Vescovi.
11.30 h Departure
13.00 h Lunch in field
14.00 h Pavullo: Late-Glacial and Holocene vegetation and fire history. Responsible of the site Elisa Vescovi, Petra Kaltenrieder, Willy Tinner.

16.30 h Departure
17.30 h Arrival at Hotel Valleverde (Pievepelago)

Thursday, 21 September

8.30 h Departure
9.30 h Riserva Orientata di Campolino Introduction. Dr.ssa Pettinà (Ufficio Territoriale per la Biodiversità di Pistoia)
Lago del Greppo: Late-Glacial and Holocene Vegetation History. Refugia of *Picea abies*. Responsible of the day: Elisa Vescovi.
12.00 h Lunch in field
13.00 h Departure
15.00 h Lago di Massaciuccoli: Palaeoenvironmental aspects of the basin of Lago di Massaciuccoli including pollen sequences of the past 130'000 years. Cristina Bellini, Marta Mariotti, Mariangela Guido, Bruna Ilde Menozzi, Carlo Montanari.
Holocene vegetation and fire history, long-term fire ecology of Mediterranean vegetation. Responsible of the site: Daniele Colombaroli and Willy Tinner.
19.00 h Arrival at Poggio Corbello (Lago dell'Accesa).

Friday, 22 September

9.30 h - Lago dell'Accesa: Late-Glacial and Holocene vegetation history : Ruth Drescher-Schneider, Jacques-Louis De Beaulieu.
- Fire history and fire ecology. Daniele Colombaroli, Willy Tinner, Boris Vannière.
- Lake-level fluctuations: Michel Magny.
- Sedimentology and seismic analyses: Manu Chapron.
- Surface sample of Mediterranean vegetation: Walter Finsinger.

Afternoon Visit to Massa Marittima
Overnight at Lago dell'Accesa. Farewell Party 1.

Saturday, 23 September

8.30 h Departure
10.30 h Visit to relict lowland *Abies alba* stands of the Apennine: Jacques-Louis de Beaulieu.
11.30 h Departure
13.00 h Lunch in field
14.00 h Lago di Trasimeno: responsible of the site: Ruth Drescher-Schneider. Vegetation History.
15.00 h Departure
19.00 h Arrival at Bergamo
20.30 h Farewell party 2. Città Alta.

Sunday, 24 September

Departure from Bergamo. Return home.

Invited Guests:

C. Bellini, M. Chapron, J.-L. De Beaulieu, M. Donegana, R. Drescher-Schneider, W. Finsinger, R. Gehrig, M. Guido, M. Magny, C.Mangani, S. Marabini, M. Mariotti, B.I. Menozzi, C. Montanari, A. Paganoni, R. Perego, Pettinà, M. Rapi, G.-B. Vai, B. Vannière, L. Wick.

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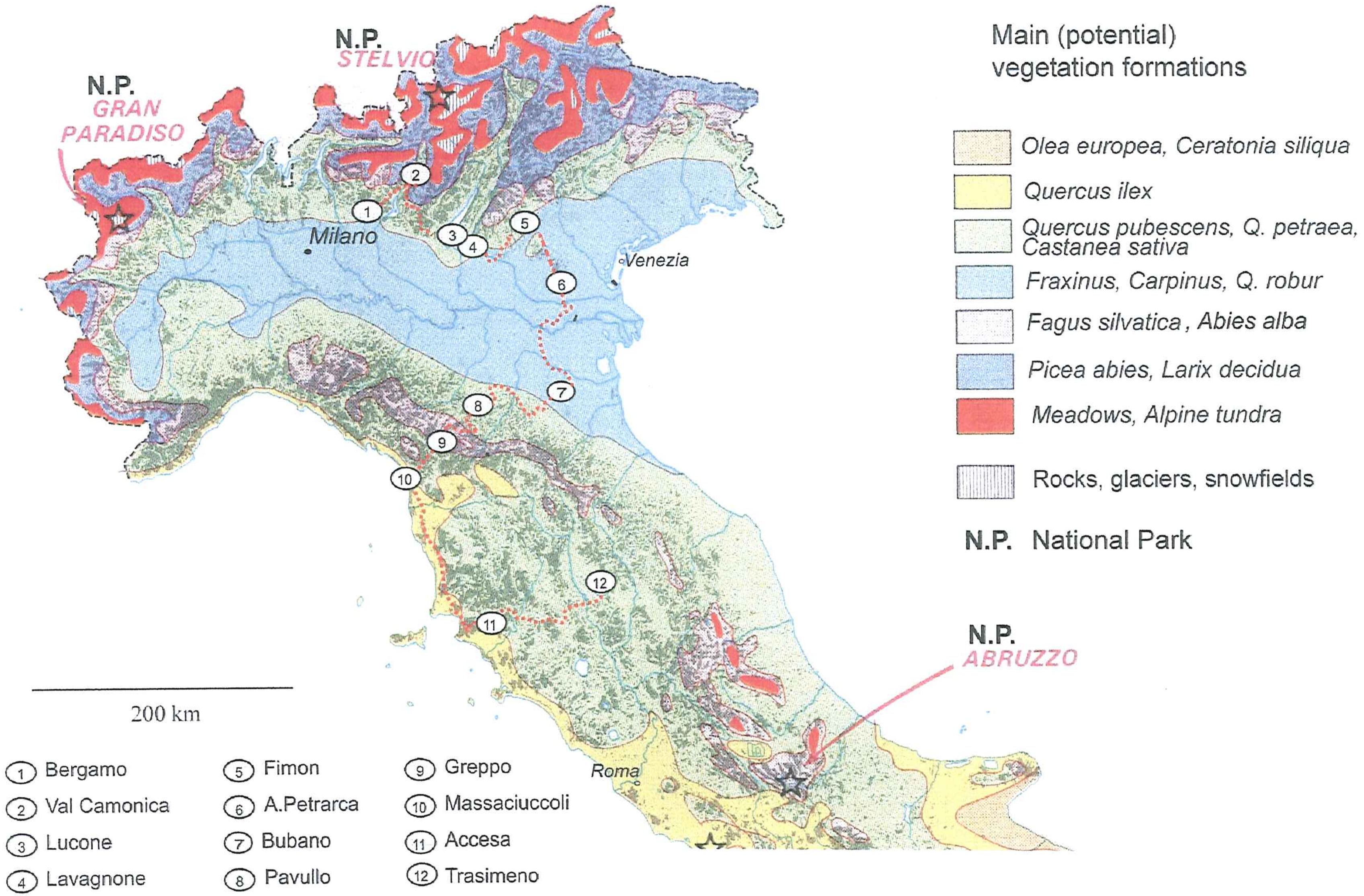
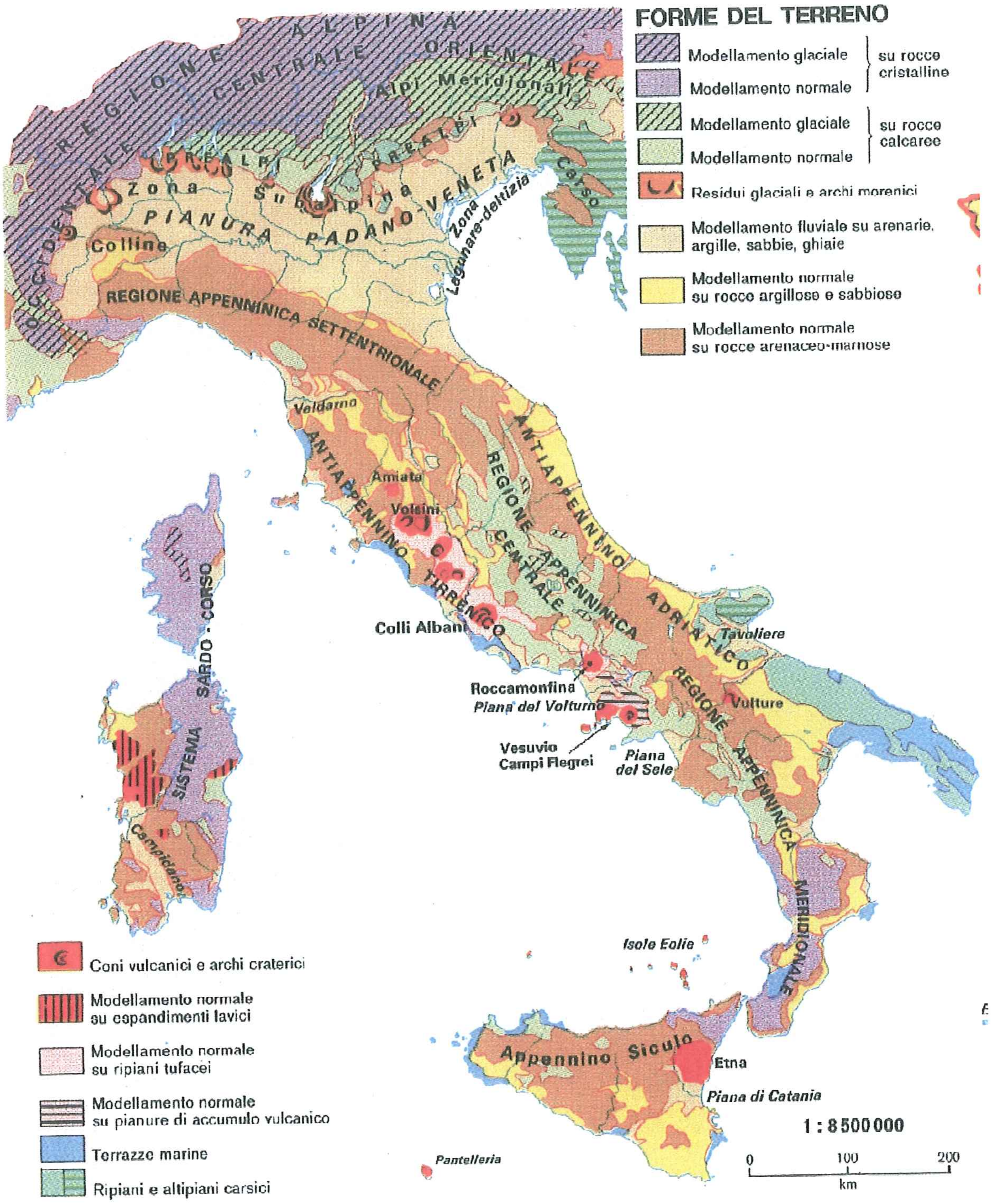
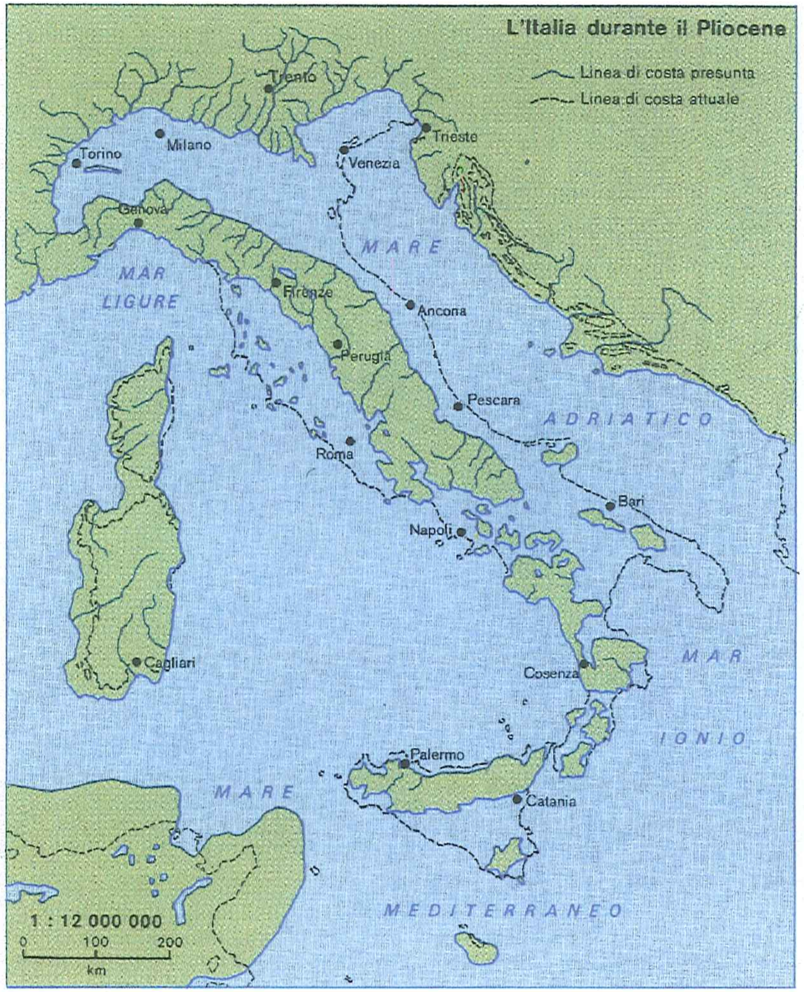
Visited sites and vegetation



Geology and Geomorphology of Italy



Italy during the Pliocene and the Last Glacial Maximum (Würm)



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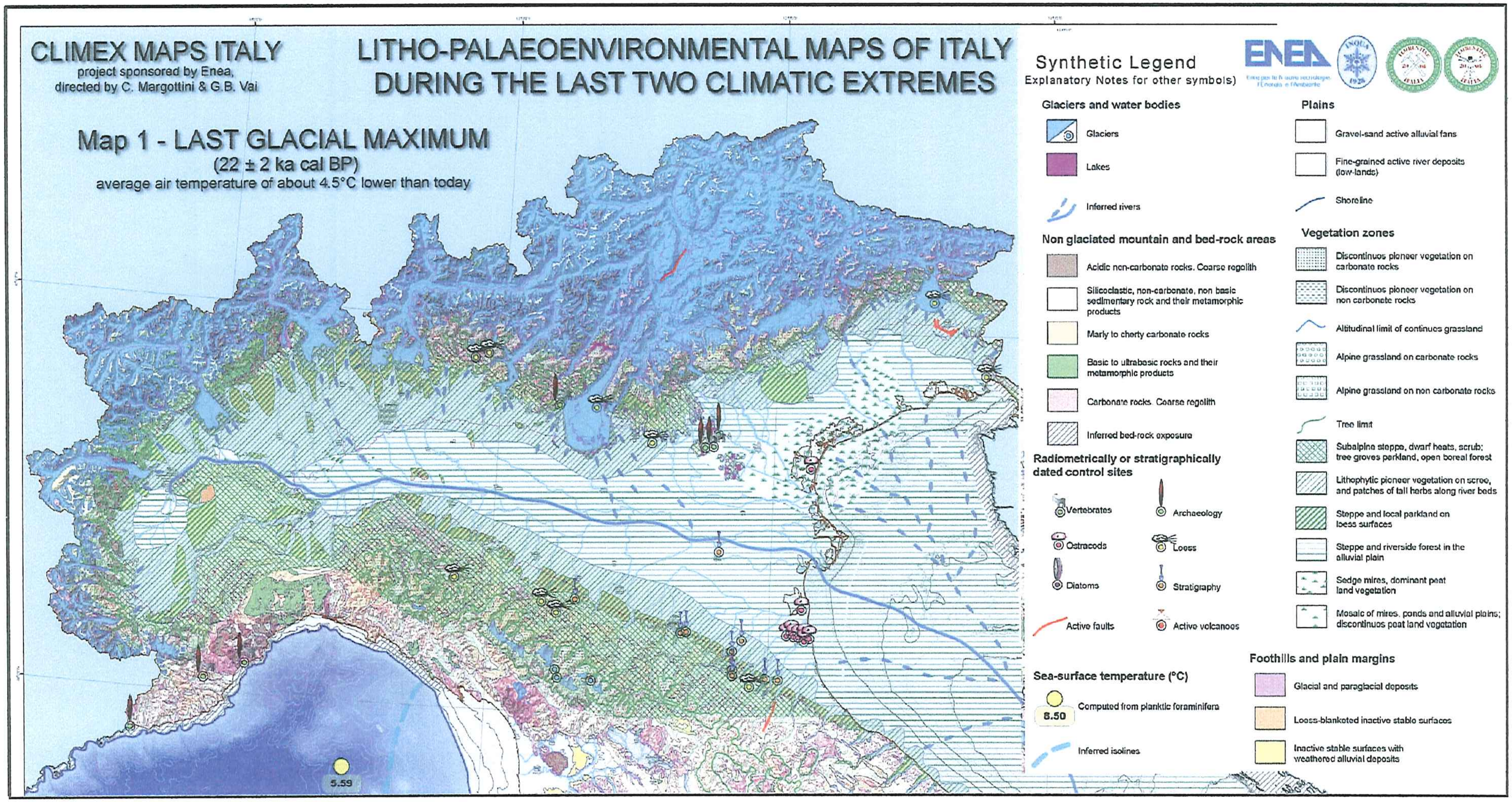
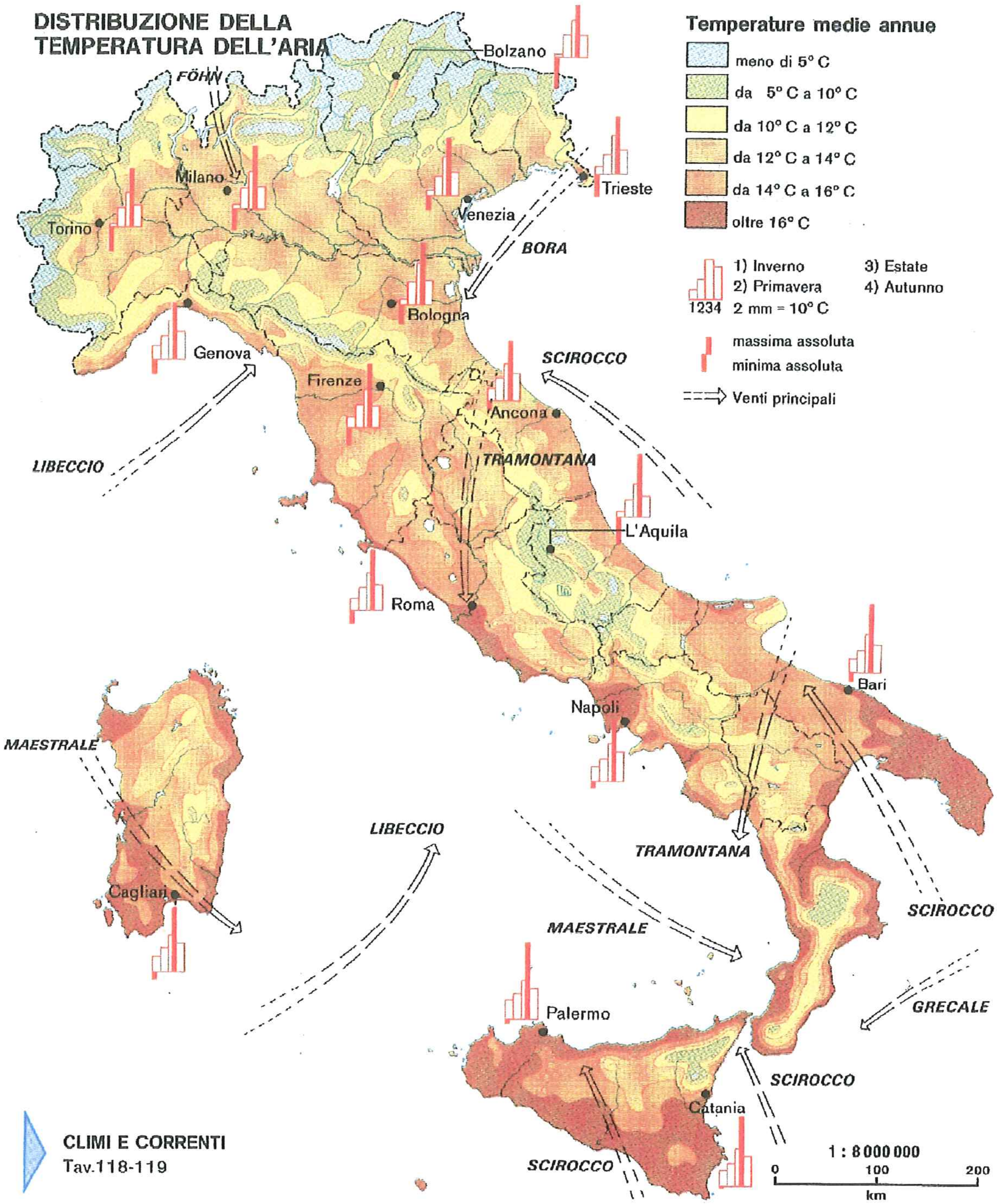
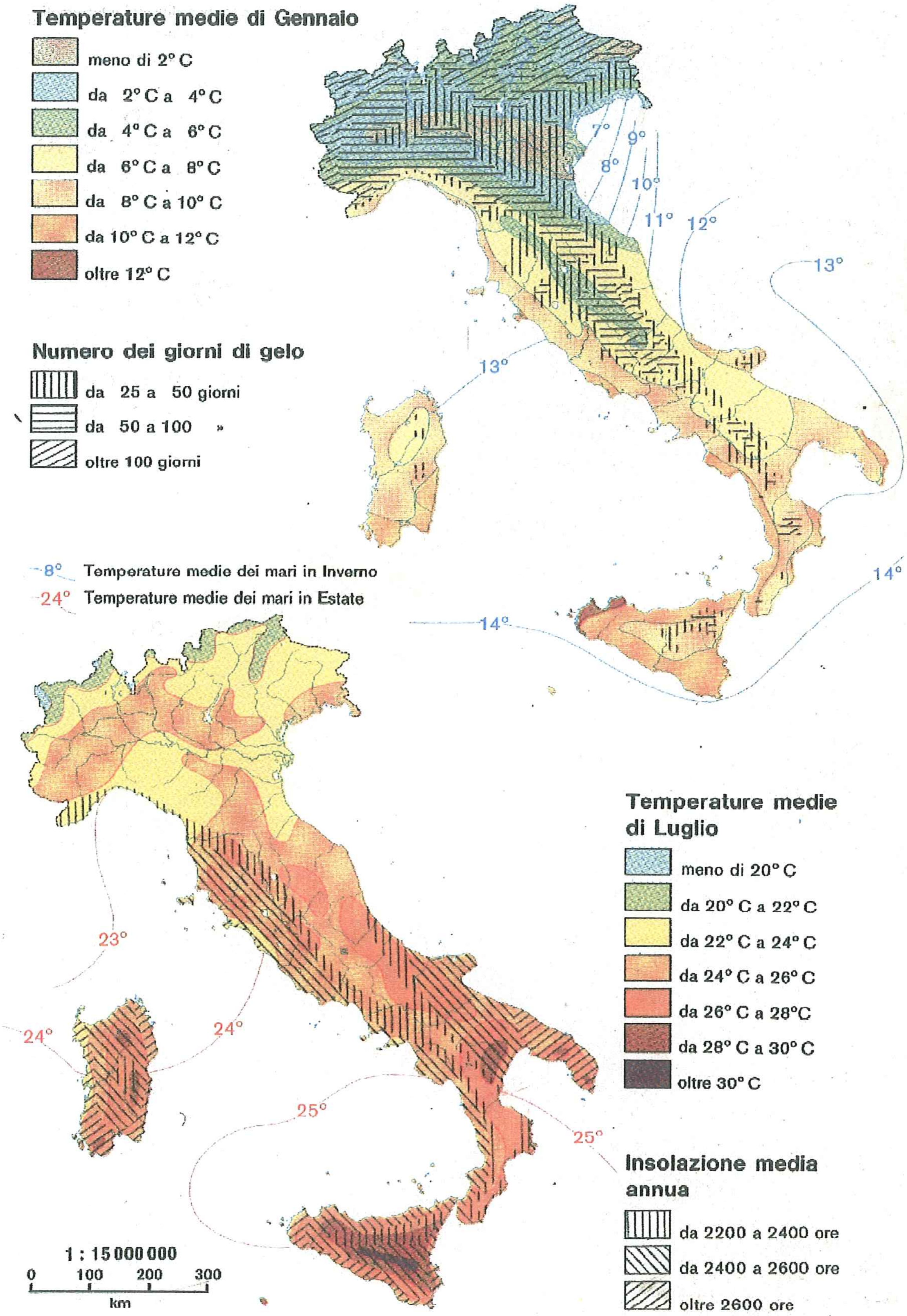
Italy during Last Glacial Maximum (CLIMEX MAPS, by cortesy of C.Ravazzi)



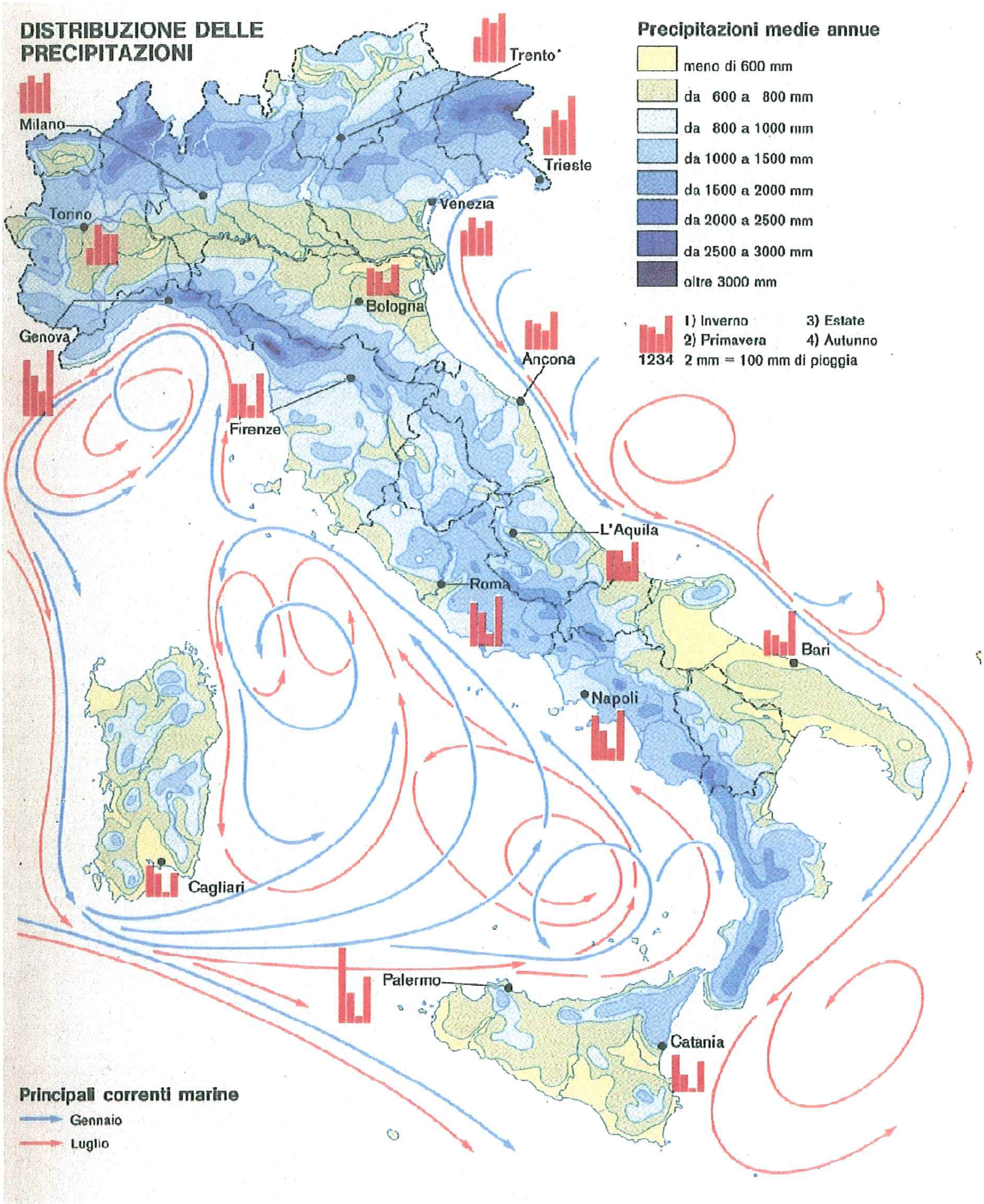
Mean air temperatures in Italy



Mean air temperatures in Italy for January and July



Mean annual precipitation in Italy




1) Bergamo
2) Val Camonica
3) Lago di Endine
4) Valle del Freddo
5) Lago di Garda
Milano
Brescia
Lecco
Lugano
Sondrio
Bellinzona
Chiavenna
Monza
Treviglio
Chiari
Crema
Lodi
Montichiari
Desenzano del Garda
Peschiera del Garda
Villafranca di Verona
Riva del Garda
Madonna di Campiglio
Saronno
Rho
Chiasso
Nobiallo
Gravedona
Bormio
Poschiavo
Ponte di Legno
Edolo
Aprica
Tresenda
Breno
Clusone
Lovere
Salò
Gargnano
Bagolino
Collio
Orzinuovi
Manerbio
SS 36
SS 38
SS 39
SS 45bis
A 2/E 35
A 13/E 43
A 21/E 70
20 km
20 mi

Vegetation and climate history of Val Camonica

Regula Gehrig

Source: Gehrig, R., 1997: Pollenanalytische Untersuchungen zur Vegetations- und Klimageschichte des Val Camonica. Dissertationes Botanicae, 276: 1-152.

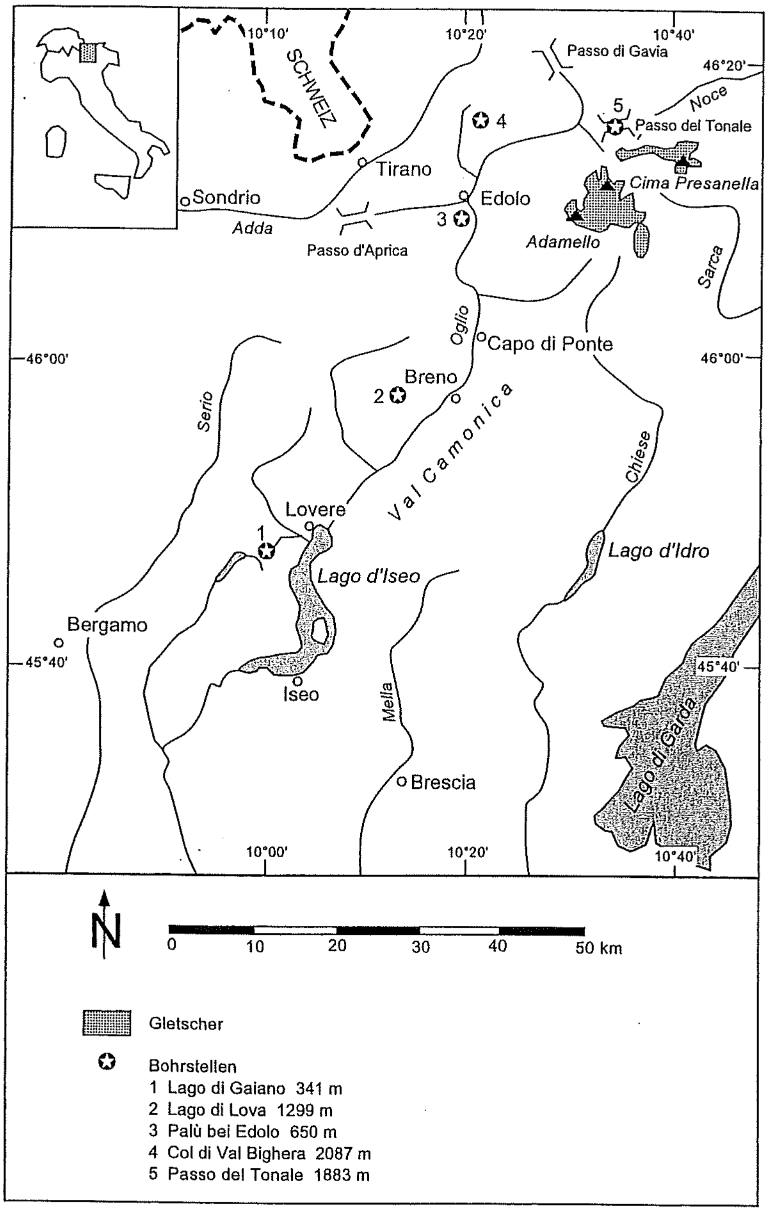


Abb. 1: Das Untersuchungsgebiet mit den Bohrstellen

Lago di Gaiano (341 m ü. M.)

Analysiert: Regula Gehrig

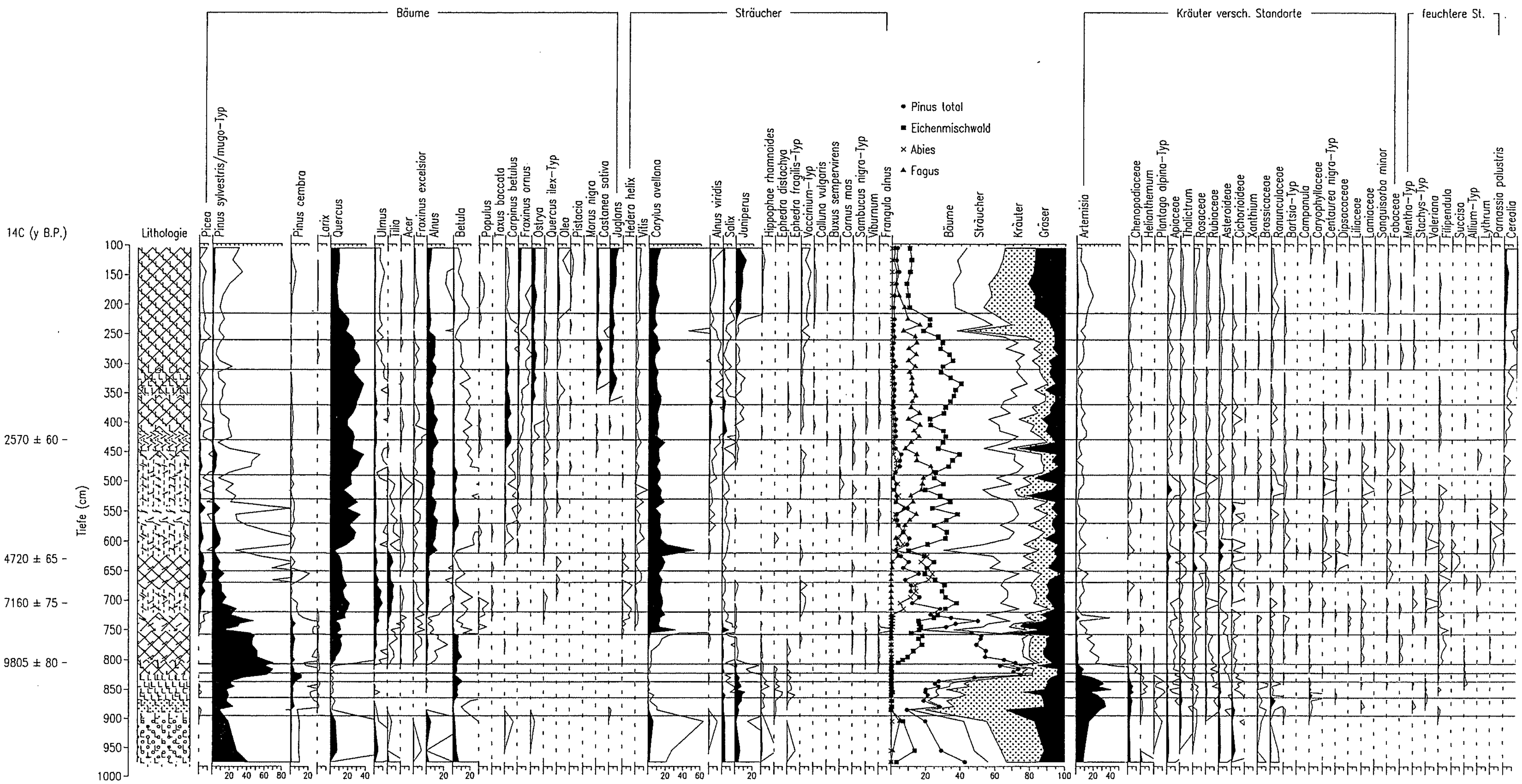


Abb. 17: Pollendiagramm Lago di Gaiano

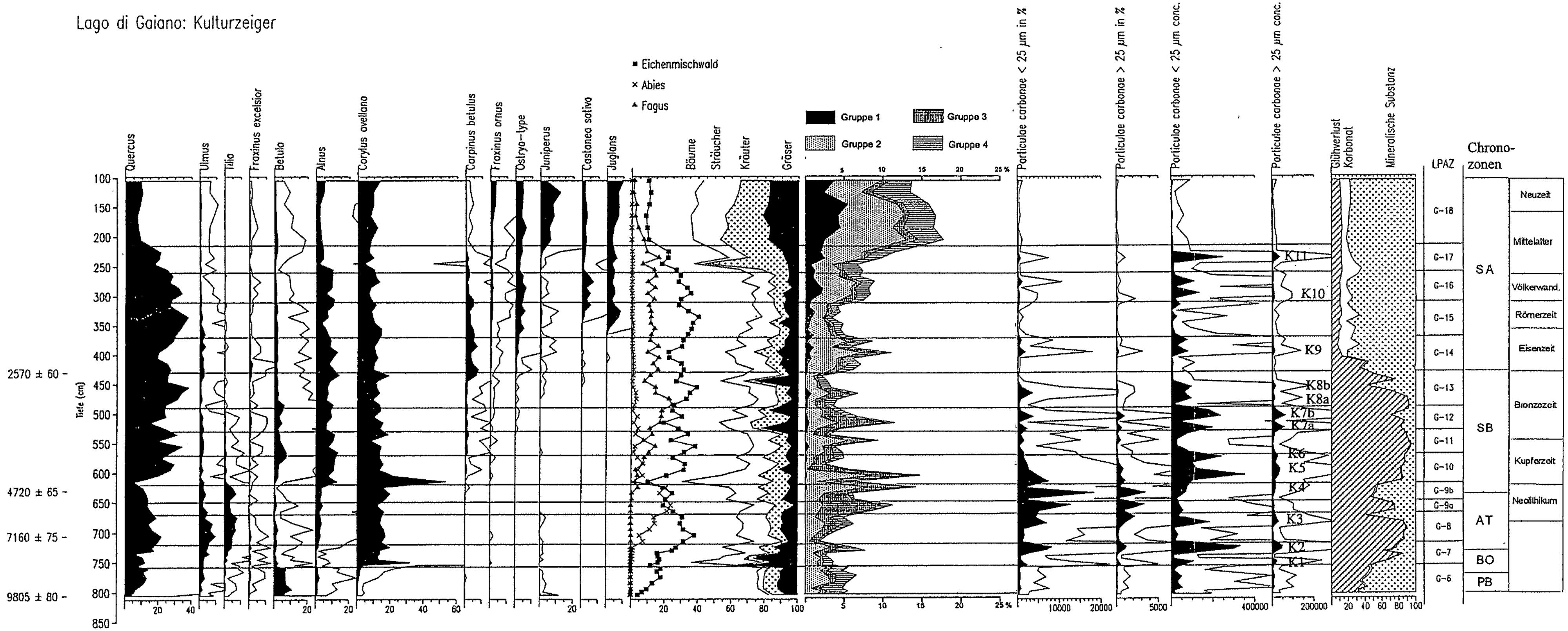


Abb. 27: Kulturzeiger-Diagramm Lago di Gaiano
Gruppe 1: Cerealia
Gruppe 2: Weidezeiger, Ackerunkräuter
Gruppe 3: Waldweidezeiger
Gruppe 4: Ruderalpflanze

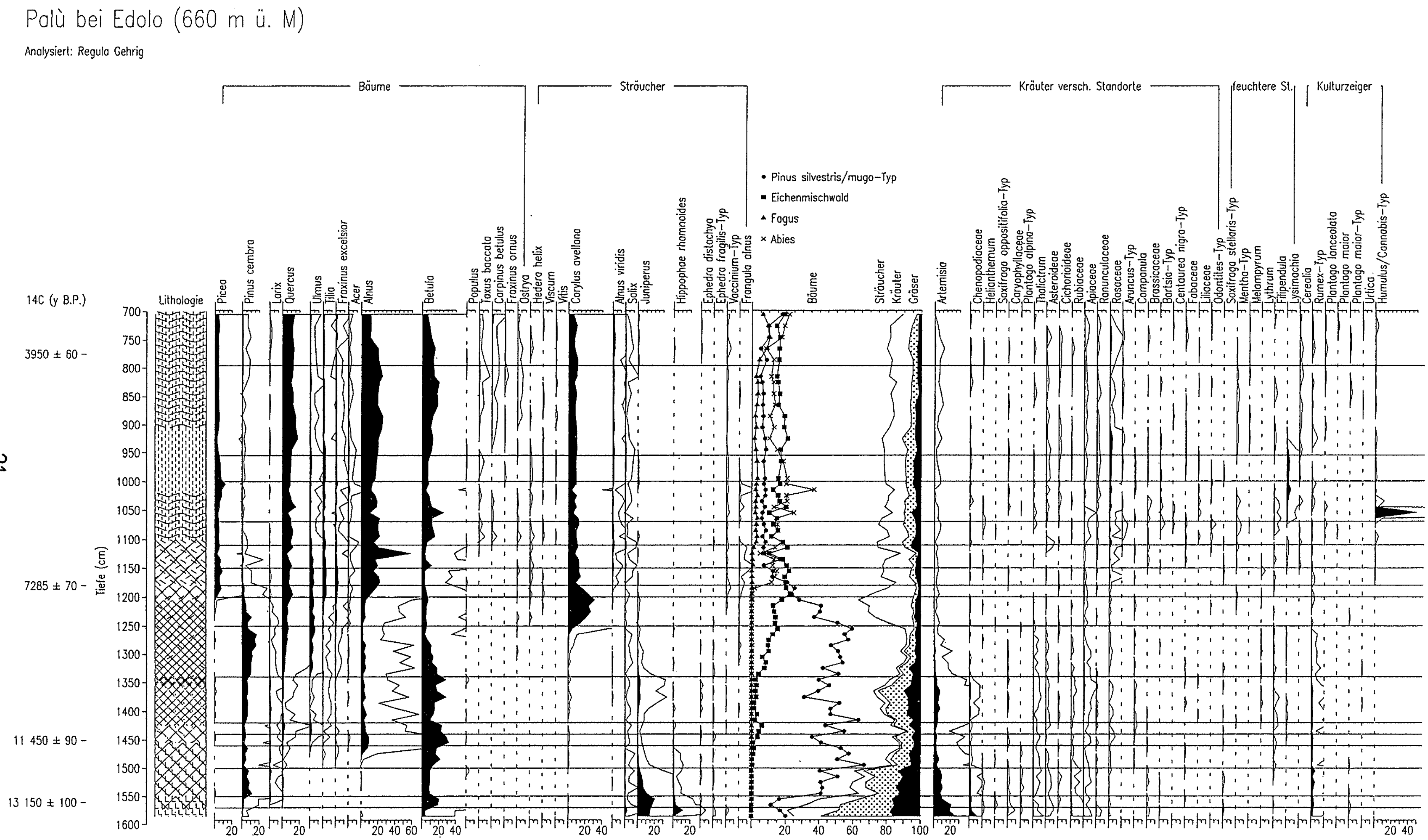


Abb. 18: Pollendiagramm Palù bei Edolo

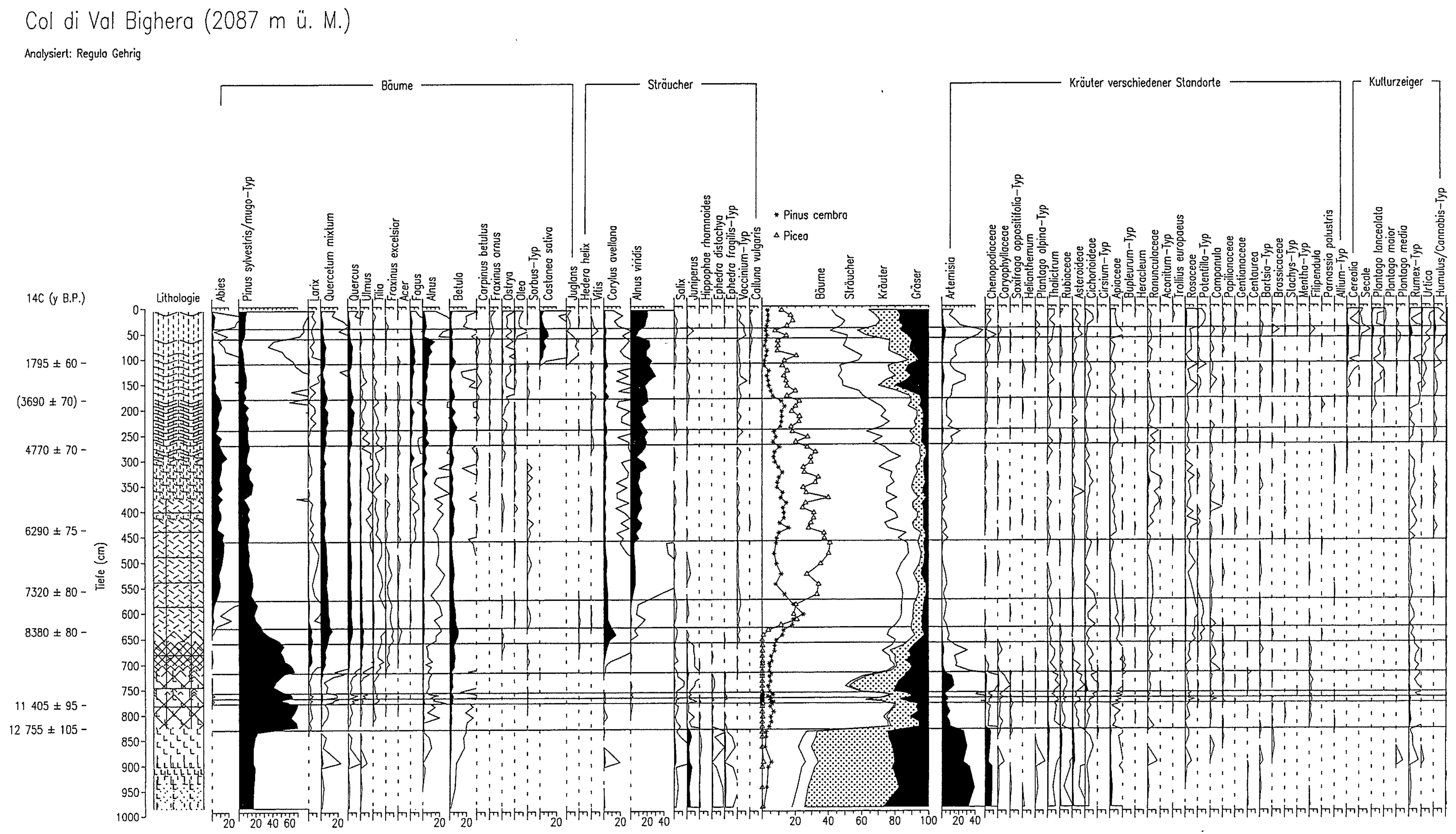


Abb. 21: Pollendiagramm Col di Val Bighera

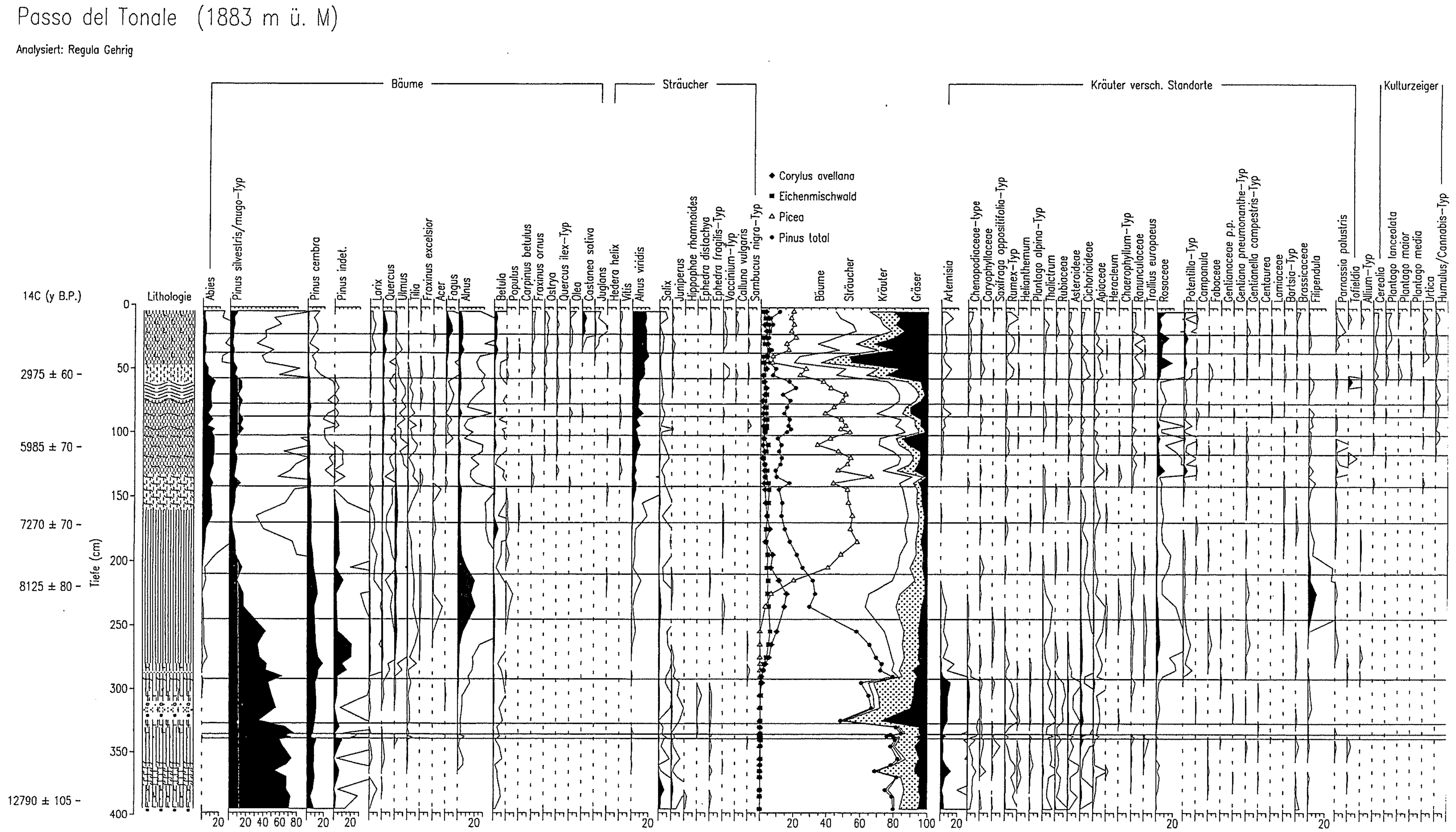


Abb. 20: Pollendiagramm Passo del Tonale

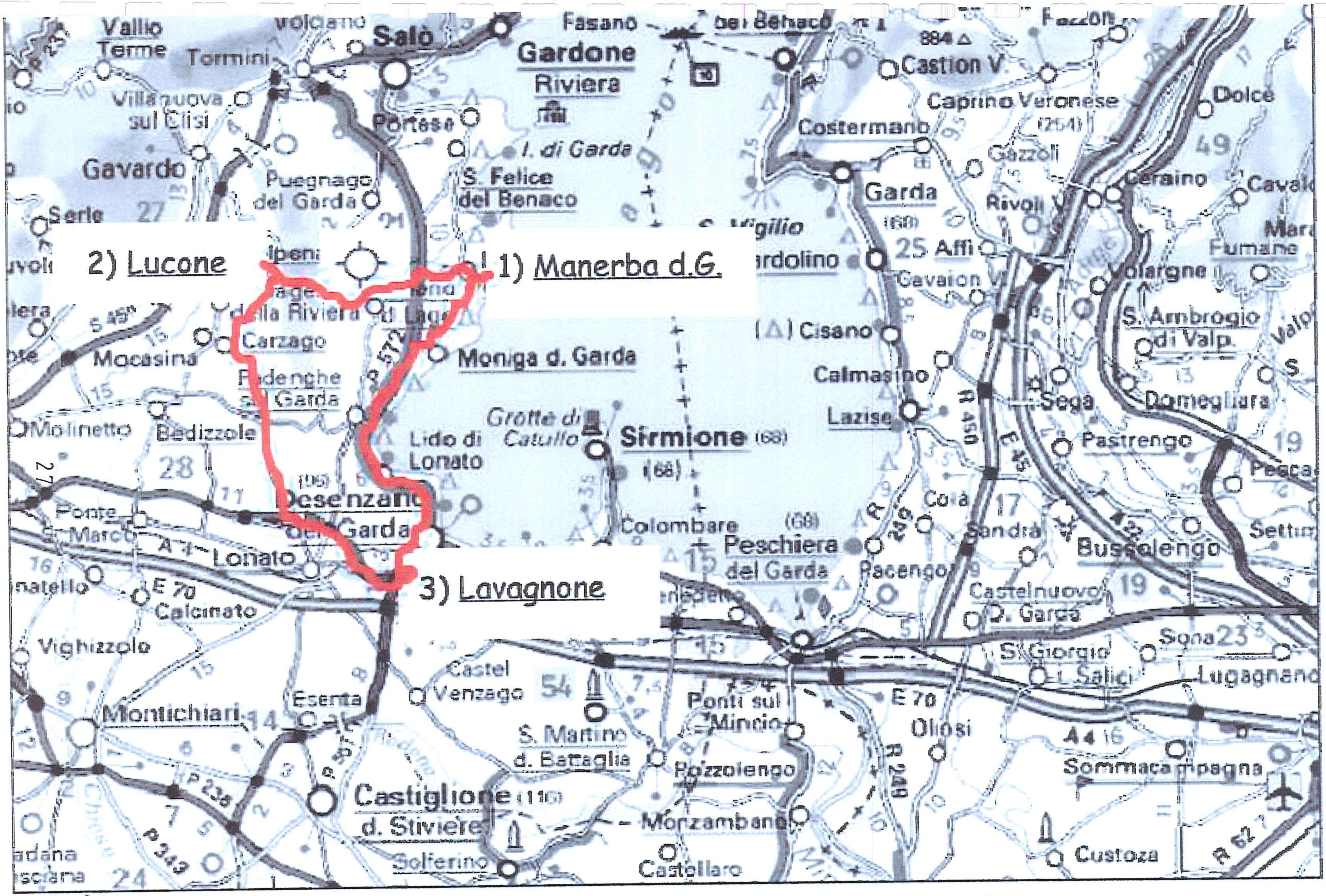
12 SUMMARY

In Val Camonica five pollen diagrams from various altitudes were analysed. The transect of these profiles allowed a detailed reconstruction of the vegetation development of various altitude zones since the last ice age. Four of these profiles were used to highlight several phases of human impact since the Neolithic in Val Camonica. Charcoal particles were counted in the pollen slides. They show further evidence of human influence on the vegetation. In the diagrams of Palù and Col di Val Bighera macro fossils of trees from late glacial sediments were analysed.

The regional vegetation development of Val Camonica

The vegetation during the Oldest Dryas was dominated by pioneer plants and herb species from grassland. The localities at lower altitudes are characterised by higher values of shrubs especially *Juniperus*, which is typical for profiles from Northern Italy.
The reforestation started at the beginning of the Bølling. The first trees which immigrated at approximately 13 000 B.P. were *Betula* and *Larix*. Soon afterwards *Pinus sylvestris/mugo* and *Pinus cembra* began to spread. During the Bølling the timberline may have reached an altitude of 1300-1500 m a.s.l.
During the Allerød the forest became denser. It was still a mixed forest of pine, birch, swiss stone pine and larch. With rising altitude *Betula*, *Pinus cembra* and *Larix* played an increasingly important role. The timberline was situated at about 1500-1700 m a.s.l. The two localities Passo del Tonale and Col di Val Bighera were still above the timberline, although there exists some evidence that single trees of birch and possibly larch may have reached almost this altitude in sheltered areas.
At the beginning of the Allerød, mixed oak forest immigrated into the Val Camonica. Towards the end of the Allerød, *Quercus* probably reached the region of Edolo while the other species of mixed oak forest grew only in the lower parts of the valley.
During the second part of the Allerød, the three diagrams Palù, Passo del Tonale and Col di Val Bighera show a decrease of *Pinus*, an increase of *Betula* and NAP and a stronger minerogenic inwash into the sediment. This oscillation which lasted about 200 years can be stratigraphically correlated with the Gerzensee-oscillation of the Swiss Plateau. This climate oscillation was given the local name "Bighera-oscillation". In this thesis it was described for the first time in Northern Italy.
The cooling of the Younger Dryas led to a thinning of the forest. The shrubs and pioneer plants spread again and the trees show decreasing pollen curves. In all diagrams an increased minerogenic inwash is visible in the sediment which indicates a sparser vegetation and an increased soil erosion.
With the rewarming at the beginning of the Preboreal the pine forest became denser again. At the same time mixed oak forest spread up to an altitude of more than 1300 m a.s.l. In the two profiles of the subalpine belt the reforestation with *Larix* and *Betula* also started at the beginning of the Preboreal. A scattered forest of *Larix*, *Pinus cembra* and *Betula* reached already an altitude of 2100 m. The climate during the Preboreal must have been continental and probably dry, because all diagrams still show a rather open forest with a high percentage of NAP.
During the Boreal the species of mixed oak forest spread more widely. The forest became denser in the entire Val Camonica. The woodland in lower altitudes consisted of pine and mixed oak forests, while the one in higher altitudes consisted of now denser larch, swiss stone pine and birch forests.
At around 8300 B.P. *Picea* reached the northern Val Camonica. The spruce immigrated from Trentino in the east and crossed the Passo del Tonale. Afterwards it spread into the valley in a southern direction and passed Passo del Mortirolo and Passo d'Aprica in the west towards the Valtellina. Due to the development of a denser spruce forest at about 7500 B.P. the belt of larch and swiss stone pine was reduced to a small zone at the timberline.
On elevations up to 1300 m the optimal development of mixed oak forest started at 8000 B.P. *Tilia*, *Ulmus*, *Fraxinus* and *Acer* played an important role. The thermophile elements *Hedera*, *Viscum* and *Vitis* were proved regularly.
From 7300 B.P. on *Abies* spread over the whole valley. *Abies* found the best conditions for growing in the montane zone which is shown by the diagram of Lago di Lova. During the Atlantic the altitude distribution of *Abies* was more extensive than today, since it was present from the colline to the subalpine belt.
The earliest, although weak evidence of human impact occurs in Val Camonica between 6500 and 6000 B.P. First pollen grains of *Cerealia*-type are found and at the same time herbs increase which probably indicate grazing.
From approximately 6000 B.P. on the mixed oak forest predominantly changed into oak forest. The sixth millennium B.P. shows clearer evidence of human impact like grazing and small scale farming. Even in the subalpine zone NAP-phases occur which probably point to a seasonal grazing at the timberline.
The Subboreal was a period of important vegetation changes in the Val Camonica. The most significant events were the decline of *Abies*, the spreading of *Fagus* and an increased human impact.
In Val Camonica the *Abies* decline did not occur concurrently in all places. While in the colline belt *Abies* declined at about 4600 B.P. and had been replaced by *Fagus*, it could persist until 3000 B.P. in the subalpine belt. Its decline in higher altitudes is clearly correlated with clearings.
The spreading of *Fagus* took place in the entire Val Camonica between 4200-4000 B.P. In connection with the spreading of beech, we can find clear evidence of human influence on the vegetation.
The copper age (4700/4300-3800 B.P.) is characterised by stronger evidence of human impact. The age of about 4700 B.P. is represented in all diagrams by a clear increase in NAP and influx of charcoal. In the entire valley cereals were cultivated and there are also hints for grazing. Also in the subalpine diagrams indicators for grazing and culture as well as influx of charcoals increase from this period on. But it is possible, that in the subalpine profiles, climate oscillations and phases of grazing superimposed, so that the people used areas in which the forest became more scattered due to climate change.
From 3600 B.P. on, the human impact in the colline belt clearly increased. It was mostly oak and alder forest which were cut. The culture pollen indicate the cultivation of cereals, grazing and the existence of ruderal places. From 3000 B.P. on *Fagus* was pushed back by clearings.
The use of the subalpine zone was intensified only slightly during the early and middle bronze age. Massive clearings are recorded from 3100 B.P. on. Important areas of spruce and swiss stone pine forest were then destroyed. *Pinus cembra*, which today is almost absent in Val Camonica, was widely spread at the timberline until 3100 B.P. Due to clearings during bronze and iron age and especially also during the roman period the

occurrence of *Pinus cembra* was almost totally destroyed. Apart from human influence also the climate which became slightly wetter at 3000 B.P. may have led to the fact that the swiss stone pine does not exist anymore in the Val Camonica today.
The clearings of the iron age appear clearly in the whole Val Camonica. In the colline belt all indicators of culture, ruderal and grazing plants are increasing. The cultivation of cereals was probably extended. Orno-Ostryetum forests could spread, probably favoured by brush wood cultivation. In the subalpine belt the clearings were intensified especially at Passo del Tonale, while at Col di Val Bighera larch meadows existed.
The beginning of the roman age is defined by the spread of *Juglans* and *Castanea*. The intensity of the landuse has decreased slightly compared to the iron age. *Quercus* was promoted in the colline belt. High values of *Juniperus* indicate an extensive grazing. The cultivation of *Secale* started. *Castanea* played an important role during the whole period. Also in the subalpine belt the human impact decreased slightly. *Picea* could spread again and *Alnus virids* was reduced. But the forest still remained open and the grazing of the area continued.
From 1600 B.P. on more open places were developed in the colline belt. Agriculture areas were extended. *Secale* played an important role in the cereal cultivation. From middle age on the clearings were even more intensified and most trees were diminished to low percentage. Especially the beech was decimated so that today it grows only in a few places in Val Camonica.
At Col di Bighera intensive clearings are documented during the middle age. The pressure on the forests was probably so high because of the need of firewood for the iron melting furnaces which were numerous in Val Camonica. Only in the uppermost samples of the profile a slight recovery of the *Picea-Larix*-forest is documented.
The dominance of larch at the present timberline clearly is man-made. *Larix* could spread in Val Camonica only due to the existence of larch meadows, first in a smaller scale since 3800 B.P. and then on a larger scale since the iron and roman age.



6 km
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Human impact during the Bronze Age on the vegetation at Lago Lucone (northern Italy)

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Abstract Lake-sediment records were used to reconstruct human impact on the landscape around Lago Lucone (45°33'N, 10°29'E, 249 m a.s.l.), a former lake in the western amphitheatre system of the Lago di Garda. Presence of prehistoric human populations is attested by pile-dwelling settlements from the Early-Middle Bronze Age, with one settlement at a distance of only 100 m from the coring site. Pollen, plant-macrofossil and microscopic charcoal analyses were applied to a 250 cm sediment core with four dates providing the time control. A mixed oak forest that was important during the Early-Middle Holocene was cleared and replaced by open vegetation during the Bronze Age (~2000–1100 B.C.) when open lands were estimated to have covered more than 60% of the total relevant pollen-source area. During a phase of high human impact, independent climatic proxies suggest warm and dry climatic onditions. Later, ca. 1100 B.C., palaeobotanical evidence indicates a sharp decrease in human pressure in the Lago Lucone area. The comparison with other sedimentary palaeocultural records shows that the period 1300–1100 B.C. was characterised by general declines of agricultural activities both south and north of the Alps. These declines have been previously attributed to a change towards wetter and colder climatic conditions in and around the Alps. However, the decline in human impact around Lago Lucone cannot be exclusively attributed to climatic variation. Therefore other forcing factors independent of climatic changes, such as cultural crises or changes in spatial organisation of the habitats, cannot be ruled out under the present state of knowledge.

Keywords Pollen analysis . Plant macrofossil analysis, Bronze Age . Human impact . Climatic changes, Northern Italy

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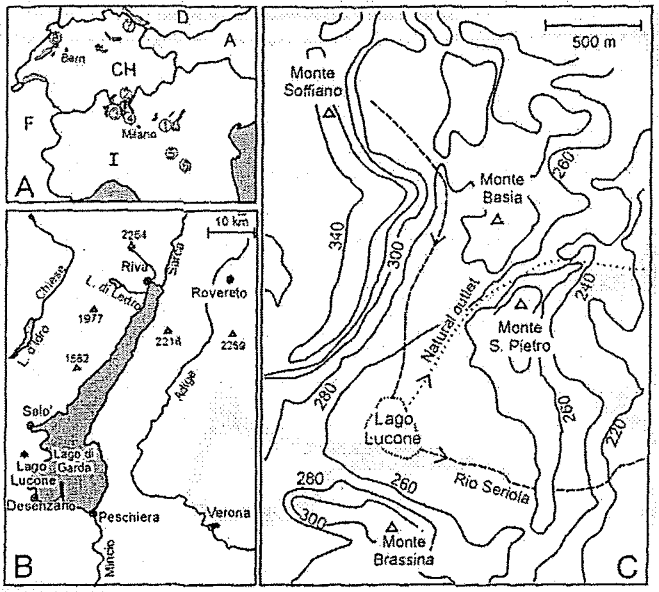


Fig. 1 Map of the study region. **A** sites mentioned in the text: **1** former Lago Lucone (this study); **2** Lago di Origlio and Lago di Muzzano (Tinner et al. 1999; Gobet et al. 2000); **3** Lago di Ganna (Schneider and Tobolski 1985); **4** Lago di Annone and Lago di Segrino (Wick 1996b; Gobet et al. 2000); **5** Terramara Santa Rosa di Poviglio (Ravazzi et al. 2004); **6** Tabina di Magreta (BertolaniMarchetti et al. 1989); **7** Nussbaumersee (Ammann 1977); **8** Twann (Haas and Hadorn 1998). **B** location of the Lago di Garda area. **C** location of the former Lago Lucone

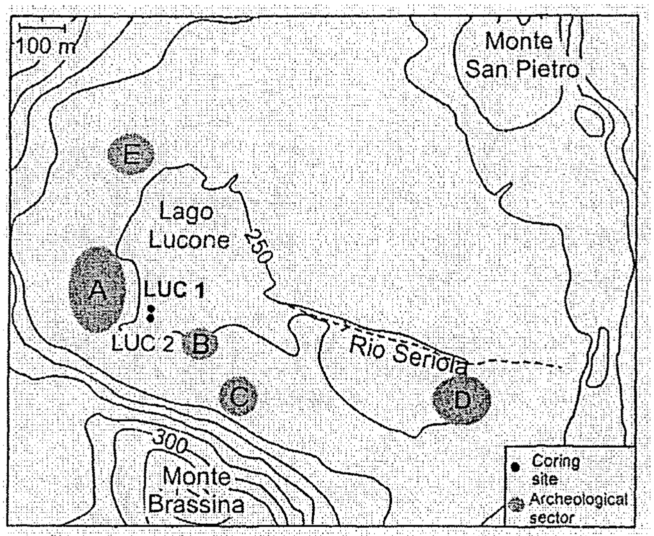


Fig. 2 Map showing archaeological sectors (*grey areas*) and coringsites (*black dots*). The archaeological sectors can be grouped as follows: **C**—Neolithic artefacts, **A** and **D**—Early-Middle Bronze Age settlements, **B** and **E**—Bronze Age findings

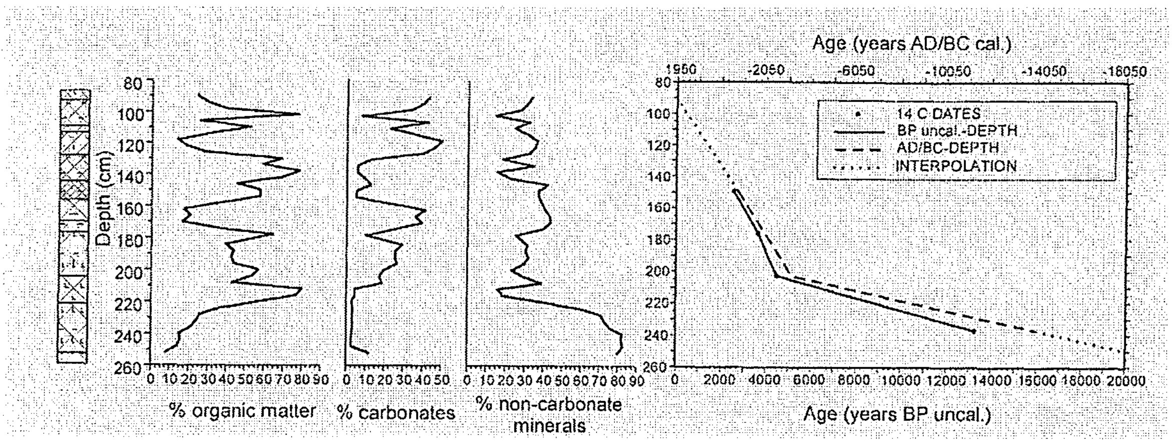
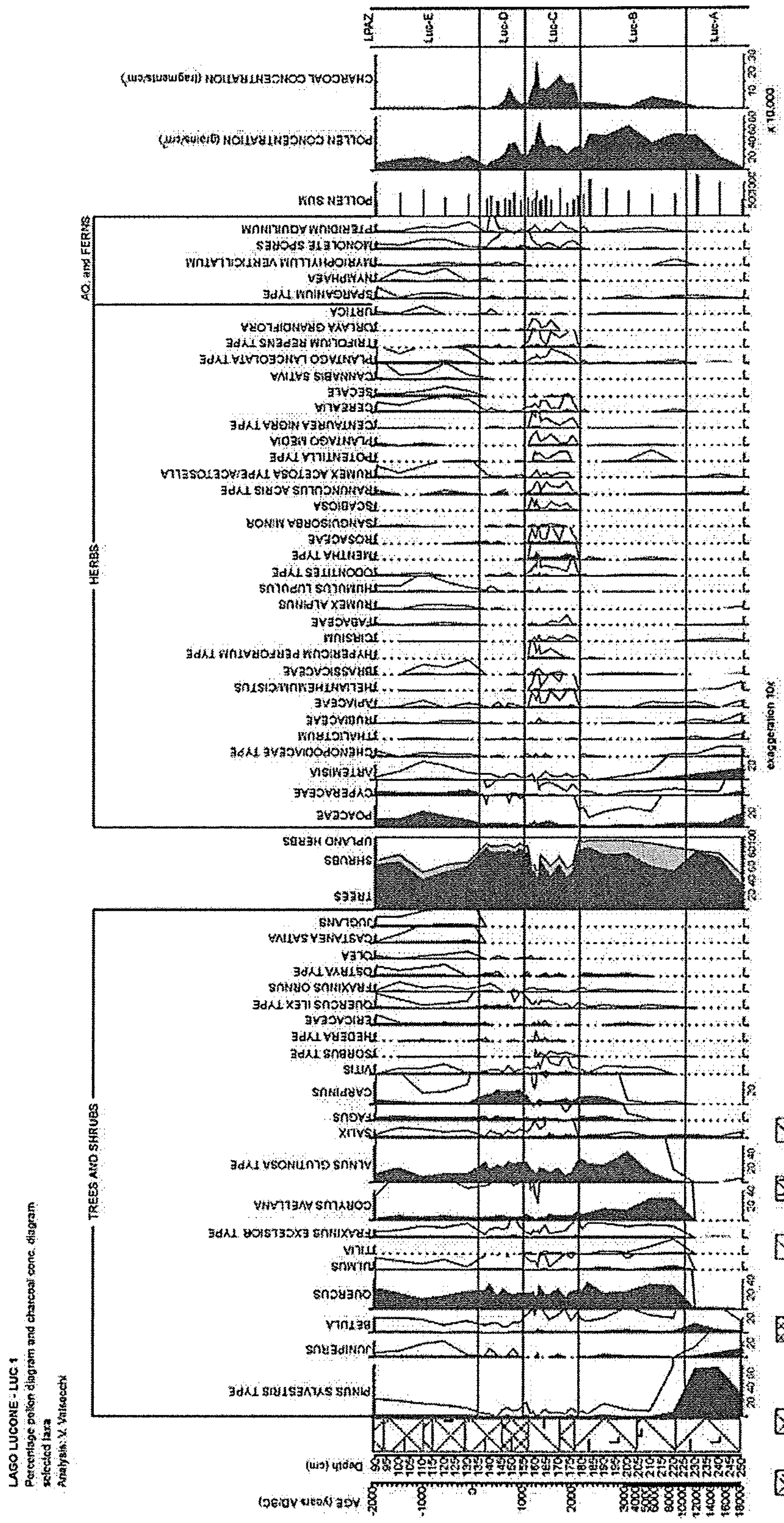


Fig. 3 Lithostratigraphy, loss-on-ignition curves and depth-age model for core LUC-1. For lithostratigraphic legend see Fig. 4

Fig. 5 Percentage pollen diagram of selected taxa for Lago Lucone



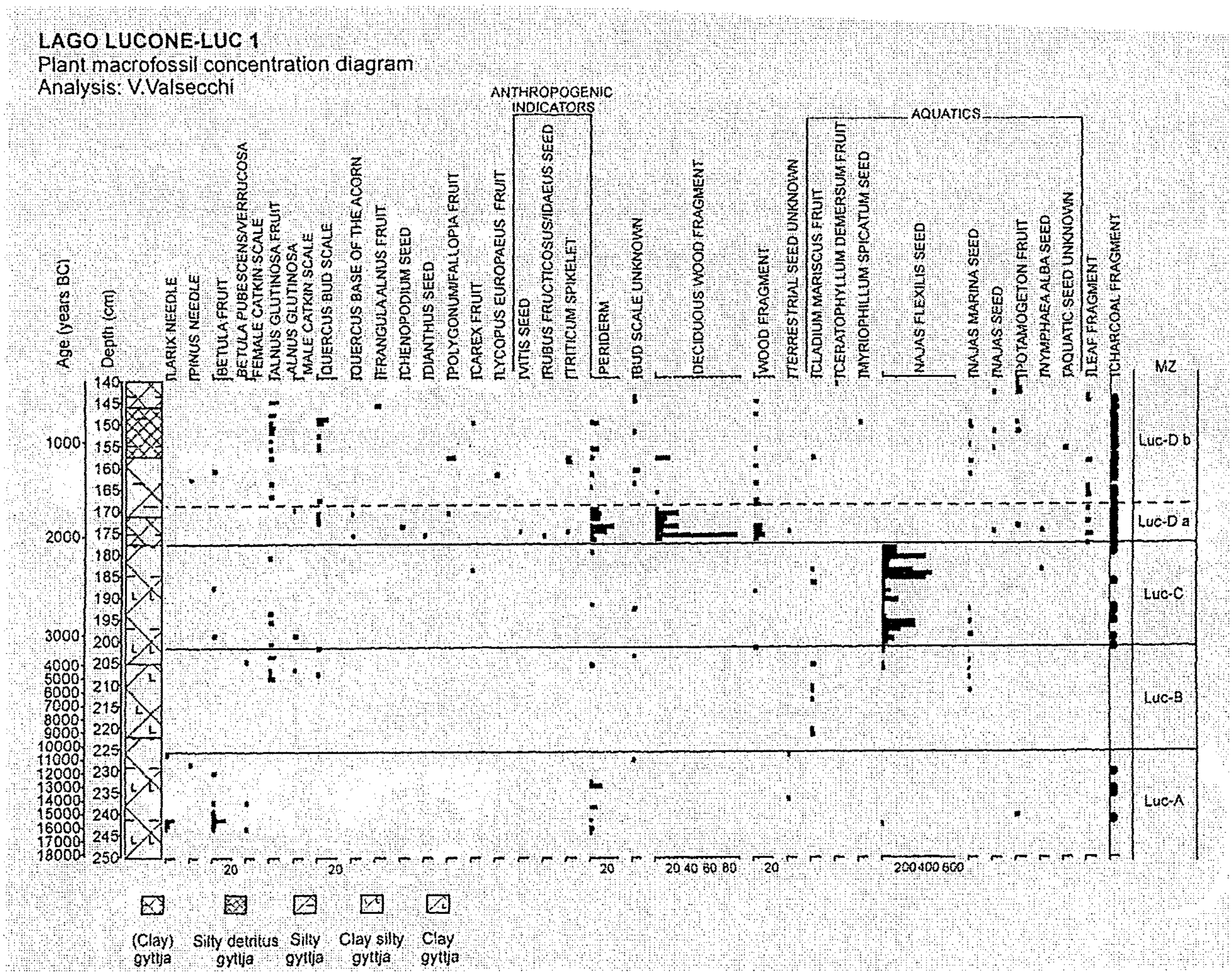


Fig. 4 Plant-macrofossil concentration diagram for Lago Lucone. Values refer to a sediment volume of 50 cm3

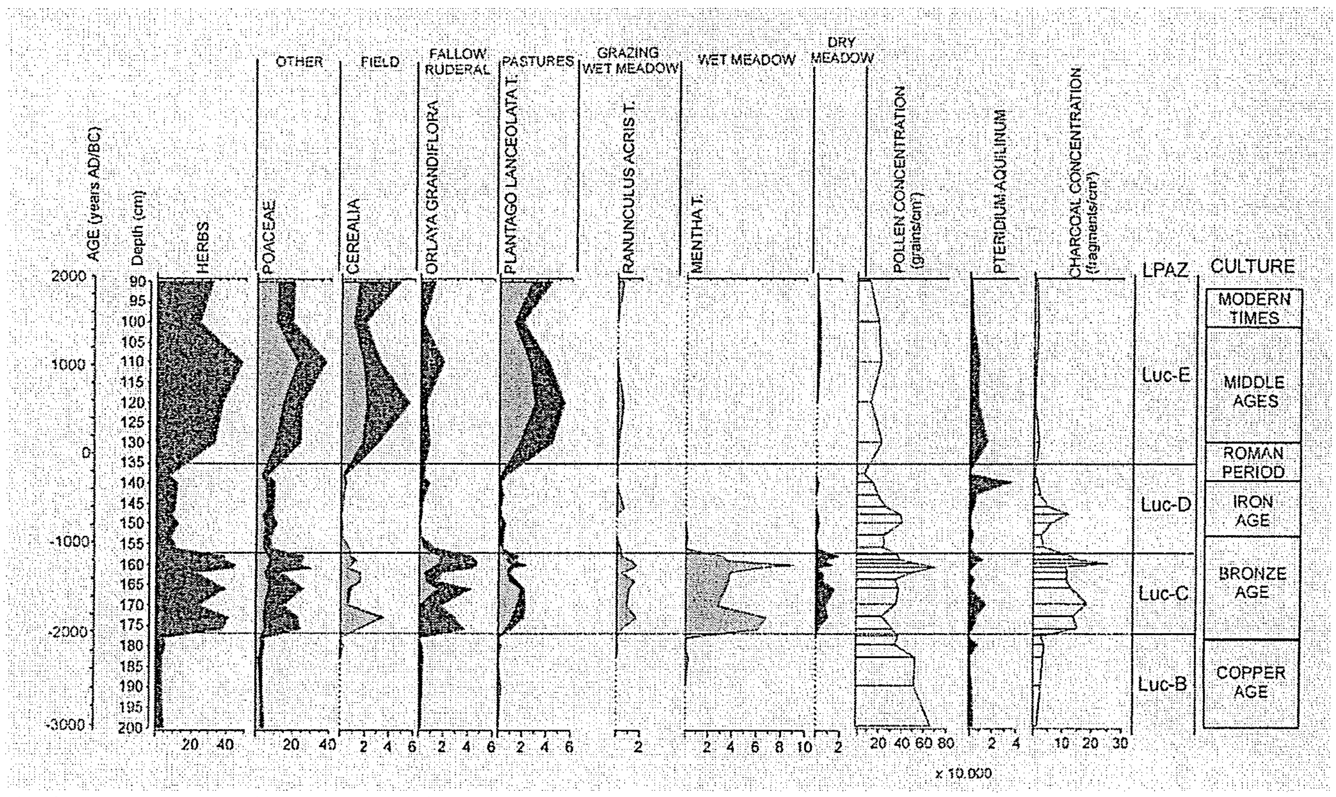


Fig. 6 Percentage pollen diagram of selected non-arboreal taxa. Pollen types are divided by the category of use and ecology. Black curves indicate the total pollen percentage of each category (e.g. field), grey curves show pollen percentages of the indicated pollen type (e.g. erealia).

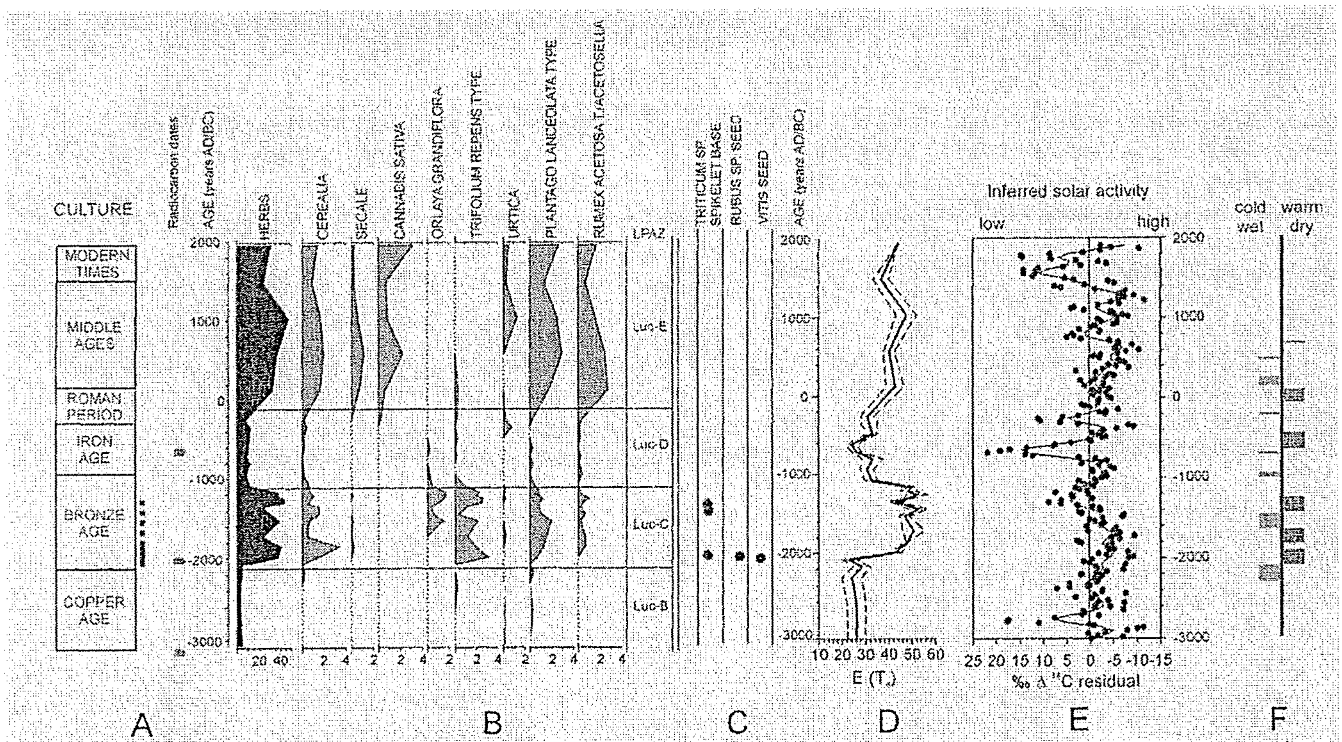


Fig. 7 Comparison between pollen and plant macrofossil data for Lago Lucone, atmospheric _14C (proxy for solar activity) and climatic phases (cool/wet versus warm/dry). **A**: periods of settlement in sector A (Guerreschi 1980–1981); **B**: pollen percentage of selected anthropogenic indicators for Lago Lucone, radiocarbon dates are indicated by arrows; **C**: presence of anthropogenic plant macrofossils for Lago Lucone; **D**: estimated number of pollen taxa standardised to a common count size and plotted against sample age; **E**: atmospheric _14C from tree rings (LOWESS-smoothed curves with span 5%; Stuiver and Reimer 1993); **F**: climate phases following Tinner et al. (2003) with an error of ±100 yr. Warm and dry climate phases are indicated as dark grey boxes while cool and wet climate phases are in light grey

Table 2 Description of the Lago Lucone sediments (core LUC-1)

Depth (cm)	Description	Colour
66–77	(Clay) gyttja	10 YR 2/2
77–93	(Silty clay) gyttja	2.5 Y 4/2
93–111	(Silty clay) gyttja	10 YR 4/3
111–114	(Clay) gyttja	10 YR 2/2
114–130	(Silty clay) gyttja	10 YR 4/3
130–144	(Clay) gyttja	5 YR 2/2
144–158	Silty detritus gyttja	10 YR 2/2
158–171	Silty gyttja	5 Y 3/2
171–179	Silty clay gyttja	10 YR 2/2
179–207	Clay silty gyttja	5 Y 4/2
207–223	Clay gyttja	10 YR 2/2
223–253	Clay silty gyttja	5 YR 4/2
253–256	Silty clay gyttja	5 YR 5/1

Table 3 AMS-radiocarbon dates from Lago Lucone (LUC-1)[a]

Lab-number	Depth (cm)	Material dated	Years ^{14}C B.P.	δ^{13}C (‰)	Age cal B.P. (2σ)	Mean calibrated date
Poz-3201	149–150	Periderm and *Quercus* sp. bud scale	2545±35	−28.4	2750–2490	2735 cal B.P., 785 B.C.
Poz-3111	176	periderm and *Quercus* sp. base of acorn	3650±35	−23.6	4090–3865	3950 cal B.P., 2000 B.C.
Poz-3203	202–204	*Quercus sp.* bud scale, *Alnus glutinosa* seed	4485±35	−27.4	5300–4975	5145 cal B.P., 3195 B.C.
Poz-3202	237	Terrestrial seed	13,280 ± 70	−26.7	16440–14970	15,960 cal B.P., 14010 B.C.

[a]Calibration was carried out with CALIB rev 4.3 using the IntCal98 database (Stuiver et al. 1998)

Lavagnone: the former lake and the pile dwelling

Renata Perego, Marta Rapi

Geological setting (by C. Ravazzi)

The depression hosting the former Lavagnone lake and the Bronze Age pile dwelling is located in the morainic amphitheatre surrounding the Garda basin.

Venzo (1969) carried out the geological survey of the complete amphitheatre, and was able to distinguish three main morainic systems, moving from the inner to the outer ridges (Fig. 1):

- 1) The Wüm (last glaciation) system, bounding the Garda lake close to the coast line;
- 2) The "Riss" system, probably corresponding to the penultimate glaciation. These moraines form a succession of several sinuous ridges, and extend much further out of the Wüm system
- 3) The "Mindel" system, of Middle Pleistocene age, only visible on the western side of the amphitheatre. The top of these moraines emerges from the fluvioglacial plain deposited during the subsequent glaciations.

In the map by Venzo (1969) the Lavagnone lake is situated between the Wüm and "Riss" systems (Fig. 1b). According to this interpretation, the scarp surrounding the Lavagnone depression on the N-W-S sides (Fig. 2) originated from a pre-Wüm downcutting. The lake formed by a morainic dam built up on the eastern side of the depression during the last glaciation. Geomorphologic evidence supporting this interpretation is the absence of scarp on the eastern side of the depression. Instead, there is a "peninsula" extending as a platform into the basin (proglacial delta ?). This unusual gravel platform was chosen by the prehistoric inhabitants to build the pile dwelling at the very beginning of the Bronze Age (Fig. 2, Sectors B-C-A).

Cremaschi (1987) revised the subdivision of the glacial units and attributed the first two morainic systems to the last glaciation (Late Pleistocene). In this view, the depression of Lavagnone should be originated by morainic dam during the latest phases of the last glaciation. It is noticed here that the glaciers withdrew the amphitheatres at the southern Alpine foreland as early as 19-20 ka cal BP, at least 4 ka before the onset lateglacial interstadial (Monegato et al., submitted).

The ongoing stratigraphical researches by the C.N.R. – IDPA (Milano) pointed to a thick layer of gravel underlying the basal lateglacial lacustrine layers. Pebbles forming this gravel body are similar - in size and roundness degree - to the material forming the surrounding fluvioglacial plain. There is no diamicton nor glaciolacustrine deposits. This excludes that the lateglacial Lavagnone lake would originate from a former glaciolacustrine basin. We cannot exclude that the depression is actually a kettle hole, i.e. a water-filled hollow subsided into the fluvioglacial plain.

A recent trench excavated below the archaeological layers into the gravelly "peninsula", exposed a soil with charcoal fragments. The radiocarbon dating of charcoal (in progress) will provide further evidence to help in the interpretation.

CREMASCHI M. (1987) - Paleosols and Vetusols in the Central Po Plain (Northern Italy). PhD Thesis. Unicopli, Milano.
MONEGATO G., RAVAZZI C., DONEGANA M., PINI R., CALDERONI G. WICK L., (submitted) - Evidence of a two-fold glacial advance during the Last Glacial Maximum in the Tagliamento end moraine system (SE Alps). *Quaternary Research.*
VENZO S. (1969) – Carta Geologica d'Italia. Foglio 48 - Peschiera del Garda. Istituto Italiano d'Arti Grafiche, Bergamo.

Extended abstract of the following paper:

R.C. de Marinis, M. Rapi, C. Ravazzi, E. Arpenti, M. Deaddis, R. Perego (2005) - *Lavagnone (Desenzano del Garda): new excavations and palaeoecology of a Bronze Age pile dwelling in northern Italy.* In: P. Della Casa Ph. & Trachsel M. (eds) (2005) WES'04 – Wetland Economies and Societies. Proceedings of the International Conference in Zürich, 10-13 March, 2004. Collectio Archaeologica 3, 221-232 (Zürich: Chronos).

The former lake of Lavagnone (119 m a.s.l.), nowadays a drained peat-bog, was formed during one of the most recent Quaternary glaciations as an intermorainic basin isolated from the main hydrographic network. The basin was continuously inhabited since the earliest phases of the Early Bronze Age (EBA), till the Late Bronze Age (LBA). Thanks to a huge archaeological stratified deposit, Lavagnone is one of the main reference sites for the chronological periodisation of northern Italy Bronze Age. In 1991 researches were taken up under the direction of Raffaele de Marinis (Università degli Studi di Milano); Peter Kuniholm (Cornell University of New York) cooperates for dendrochronology and the Laboratory of Palynology and Palaeoecology (CNR-IDPA, Milan) carries on palaeobotany.

Archaeological researches

The archaeological researches concern four areas that are lined up for about hundred and seventy meters. Sectors A, B, C and D are located in such a way to make it possible to examine the stratigraphic sequences starting from the north eastern edge to nearly the middle of the basin.
The four sectors show cultural sequences not perfectly comparable, indeed some phases are documented only in certain areas and therefore one should think that periodical shifting of the dwellings have occurred in the settlement place from the middle of the basin to the shore and *viceversa.* At the beginning of the EBA, the water level of the small lake was probably lower than it had been during the Mesolithic and Neolithic periods. A pile dwelling village was set up during this time.
In sector A we have two phases of pile dwelling in stratigraphic continuity; the main difference between the two can be observed in the building technique. In order to reach more easily the dwelling area a timber trackway was built starting from the northeastern edge (sector B). Finds and dendrochronological datings fixed the trackway first works at 2077 ± 10 BC. A fence, located in the sector C, and belonging to the same period, bounded the eastern side of the village towards dry land. MBA is the best documented phase as for finds amount, either from excavations area (sector A, B, C, D) and from surface collections on the north-eastern and south eastern edges of the basin.

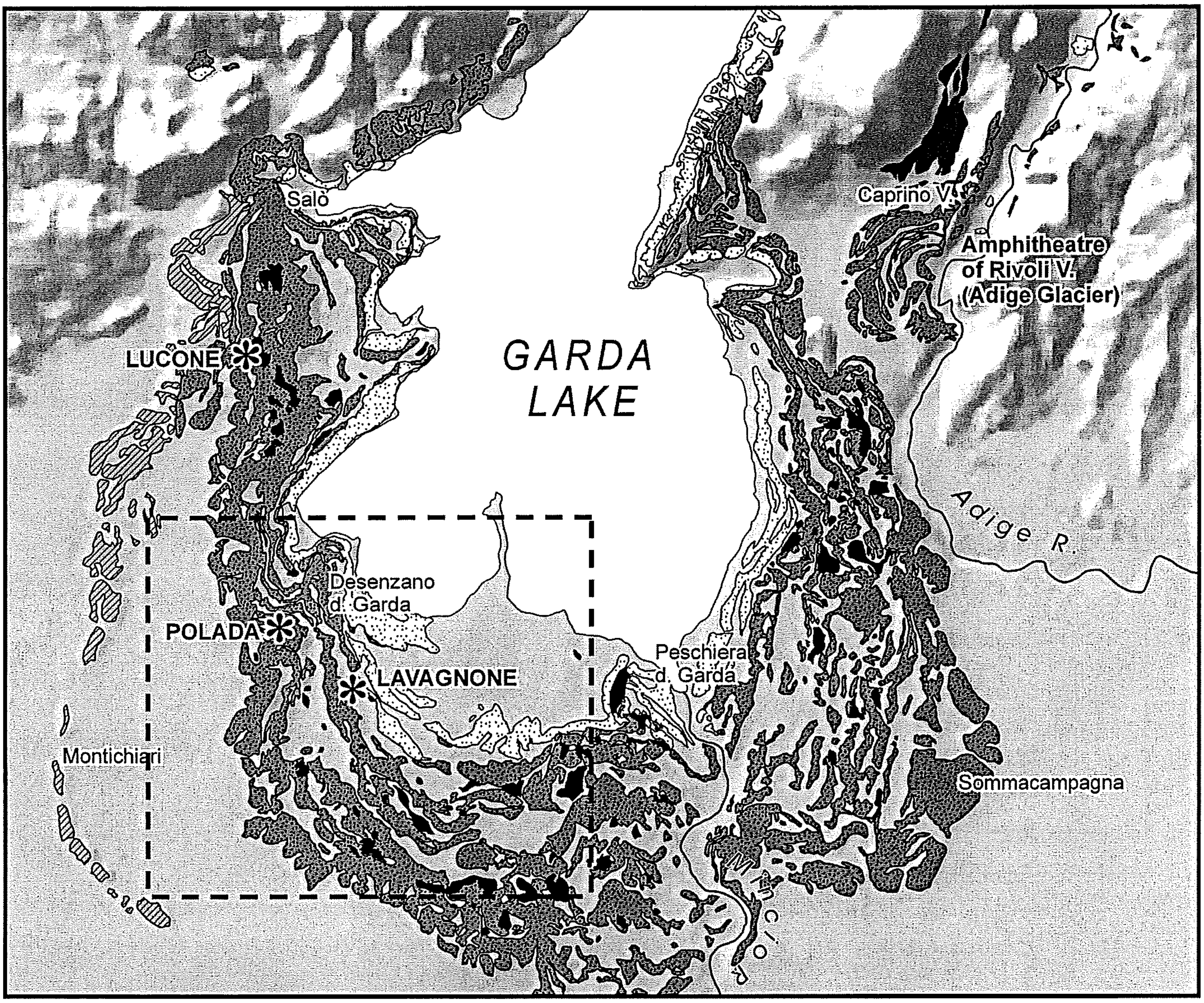
Core drilling, pollen analysis, and plant macrofossil investigation

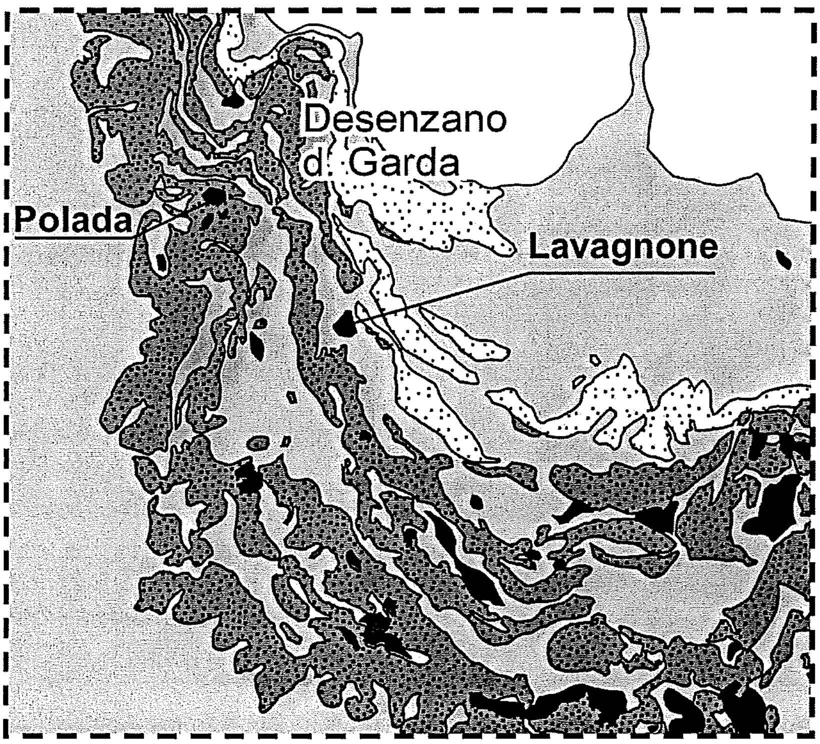
Seven cores (LAV 1-7) were drilled in the central part of the basin (about 200 m west of the archaeological excavations). Pollen analysis and five AMS ^{14}C datings were carried out on the master core, LAV 1, which is 6.05 m long. So far, the master core interval from 353 to 98.5 cm depth has been analysed for pollen.
At the beginning of the Bronze Age the Lavagnone basin was a closed lake (= without an outlet), about 300 m in diameter, and fed by the underground watertable. Its pollen source area extended over an area with a radius of about 1 km from the edge of the basin. This suggests that the composition of pollen assemblages reflects the vegetation changes in such a restricted area. Furthermore, variations in the local component of vegetation testify the impact of the human settlement on the ecosystem resident in the lake.

One of the main features of the pollen record is an abrupt change from natural, nearly undisturbed forest to an anthropogenic landscape with crop and grazed fields, meadows, abandoned-ruderal perilacustrine belts, and reduced forest stands. This happens at 333-331 cm depth in the master core (at the beginning of the pollen zone LV2 in the pollen diagram). At this depth also the sediment composition turns from lake marl to detritus gyttja. The micro-charcoal concentration curve showes a strong increase, coeval to these changes. This high charcoal accumulation is ascribed both to hearth waste, dumped directely from the pile dwelling, and to antropogenic fires in the surrounding area. Palynological evidence and archaeological data point to different phases of settlement displacement.

A preliminary investigation of plant macrofossil remains was carried out on one archaeological layer (338 C/D, Sector A). This plant material was deposited in a submerged environment underneath the pile dwelling; therefore, the carpofloral association includes both terrestrial species accumulated by human activities and aquatic wetland plants.

The palaeobotany study of the Lavagnone site describes in detail Bronze Age vegetation history thanks to a detailed stratigraphic succession of organic deposits. The occurrence of peculiar archaeological structures in waterlogged context and as well as several types of coprolites provides opportunities to deal with specific archaeobotanical questions.





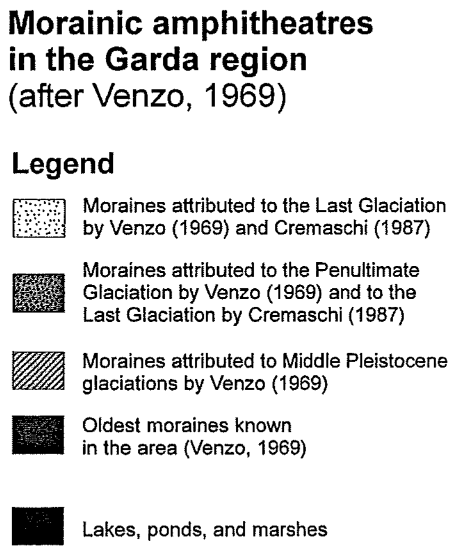


Figure 1 Morainic amphitheatres in the Garda region and geographical position of Lavagnone, Lucone and Polada sites.

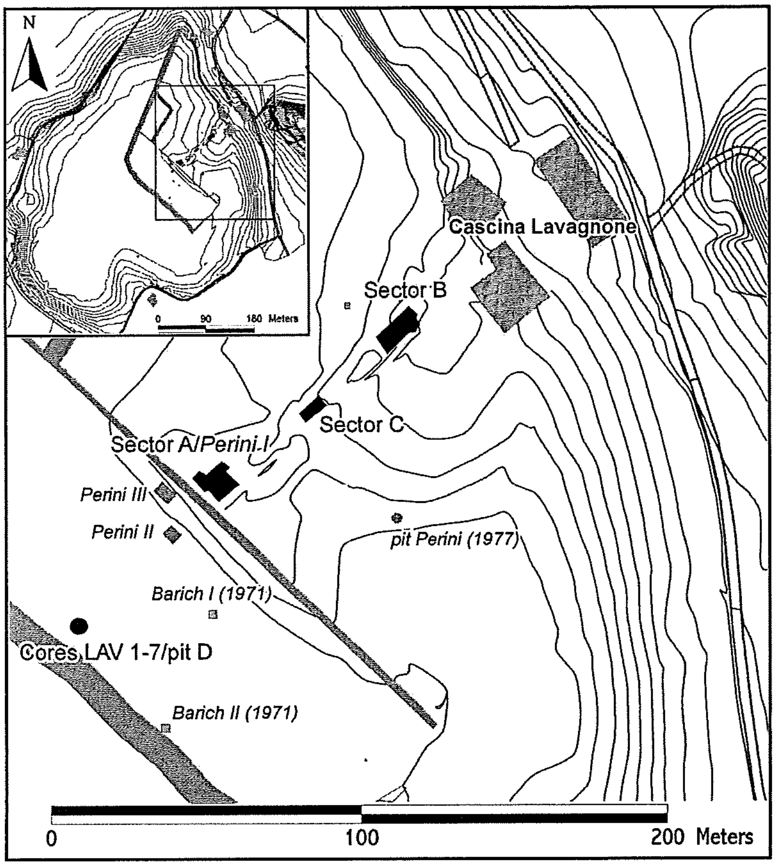


Figure 2. Topographic map of the Lavagnone basin with the position of core drillings (LAV 1-7, black dot); the ongoing archaeological excavations by the University of Milano (sectors A, B, C, and D, black areas), and sites investigated by previous researchers (Perini R. and Barich B., grey areas). Topographic survey by G. Baratti and C. Sidoli, equidistance of contour lines 0.5 m.

	absolute chronology (±10 BC)	*cultural horizon*	Sector A	Sector B	Sector C	Sector D
LBA			abandonment	dwelling	abandonment	abandonment
MBA II B		*Lavagnone 7*	abandonment	dwelling (ground house)	abandonment	dwelling (structures to define)
MBA II A			abandonment	dwelling (ground house)	abandonment	dwelling (structures to define)
MBA I		*Lavagnone 5-6*	dwelling (houses on dry land)	bonifica layers	dwelling (structures to define)	*not yet excavated*
EBA II		*Lavagnone 4 late Polada*	dwelling (houses on bonifica layers)	dwelling (structures to define)	dwelling (structures to define)	*not yet excavated*
EBA I C		*Canar and Dossetto horizon*	temporary abandonment	dwelling (structures to define)	*not yet excavated*	*not yet excavated*
EBA I B	1916 1984	*Lavagnone 3*	pile dwellings	timber trackway	fence	*not yet excavated*
EBA I A	1994-1991 2010-2008 2077-2048	*Lavagnone 2*	pile dwellings	timber trackway	fence	pile dwellings

Figure 3. Comparative scheme for the archaeological sequences recognized in sectors A, B, C and D. (after de Marinis et al., 2005)

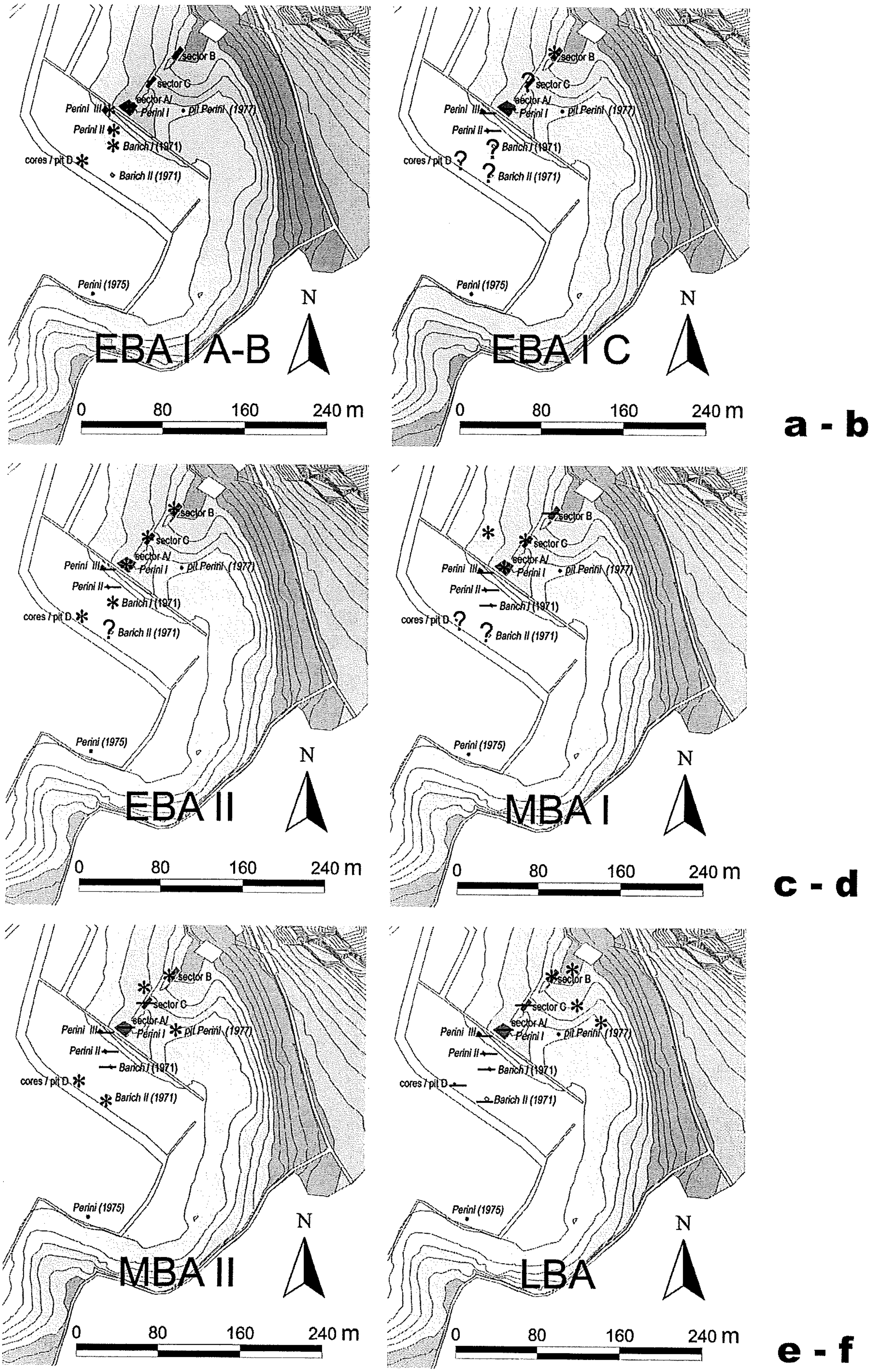


Figure 4. The development of the Lavagnone pile dwellings during the Bronze Age phases: settlement evidences are pointed out by an asterisk. (after de Marinis et al., 2005, modified)

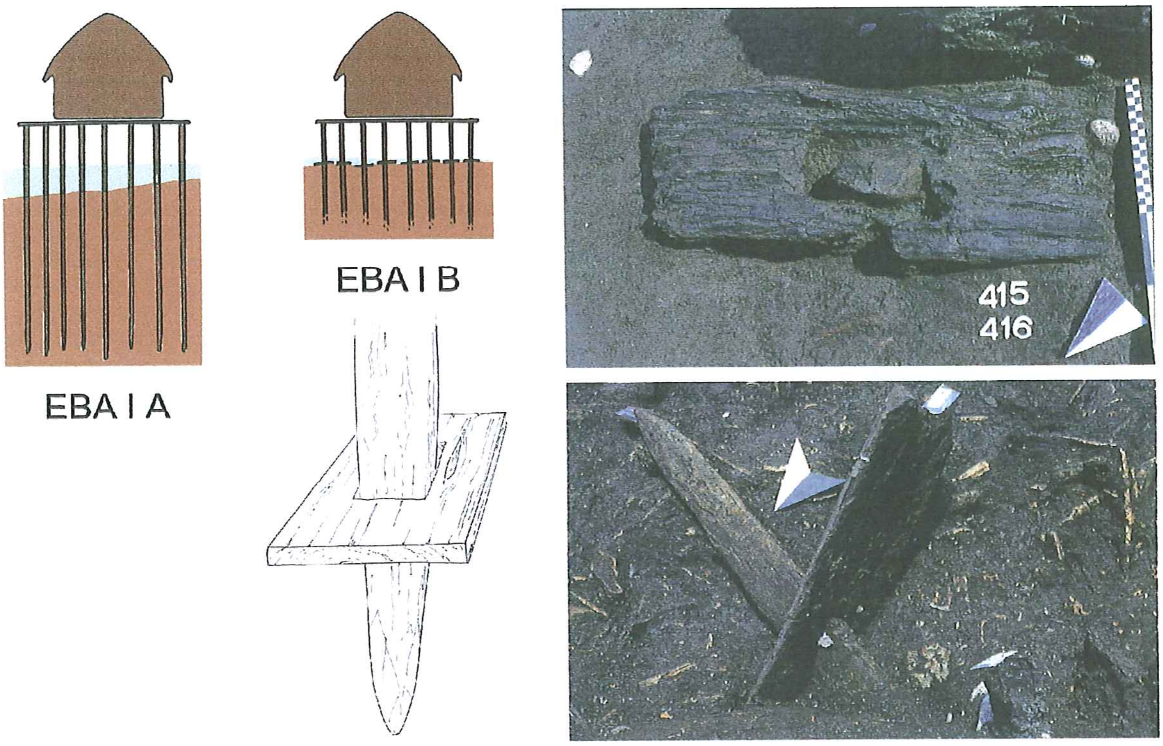


Figure 5. *Left*. Schematic model of different building thecniques of the two pile dwellings identified in sector A. While the EBA IA dwellings were simple post constructions, the posts of dwelling dated to EBA IB rested on perforated wooden base plates. *Right*. Racket plinths from sector A (photo R.C. de Marinis). (after de Marinis et al., 2005).

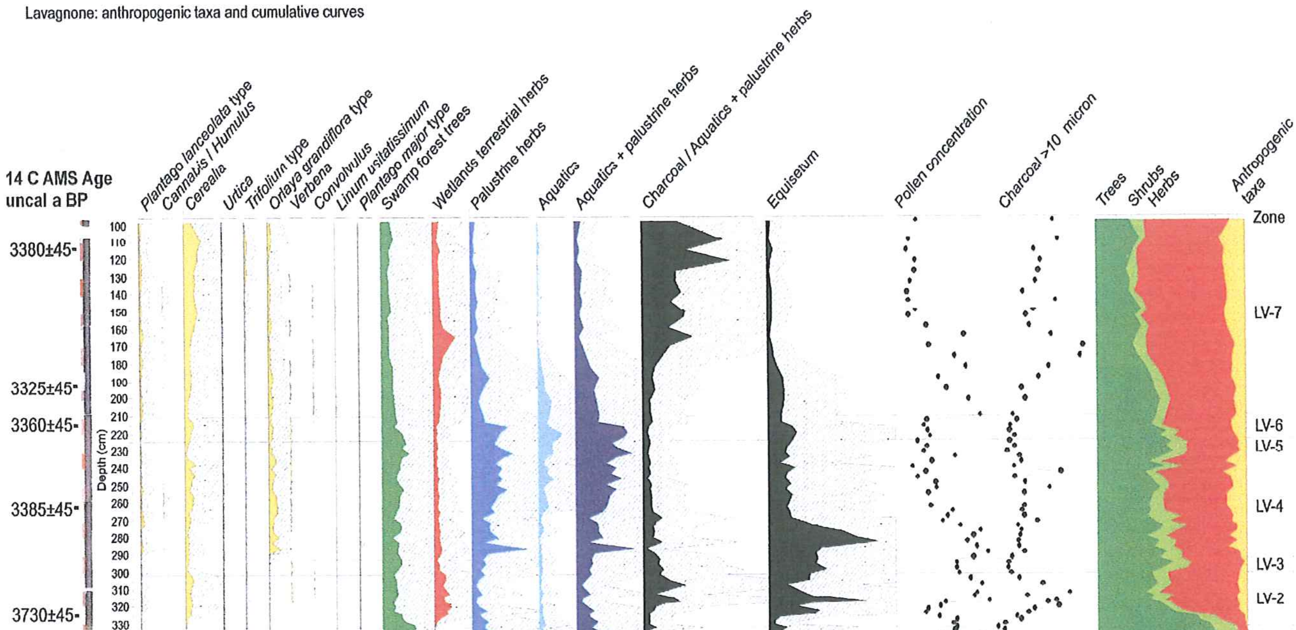
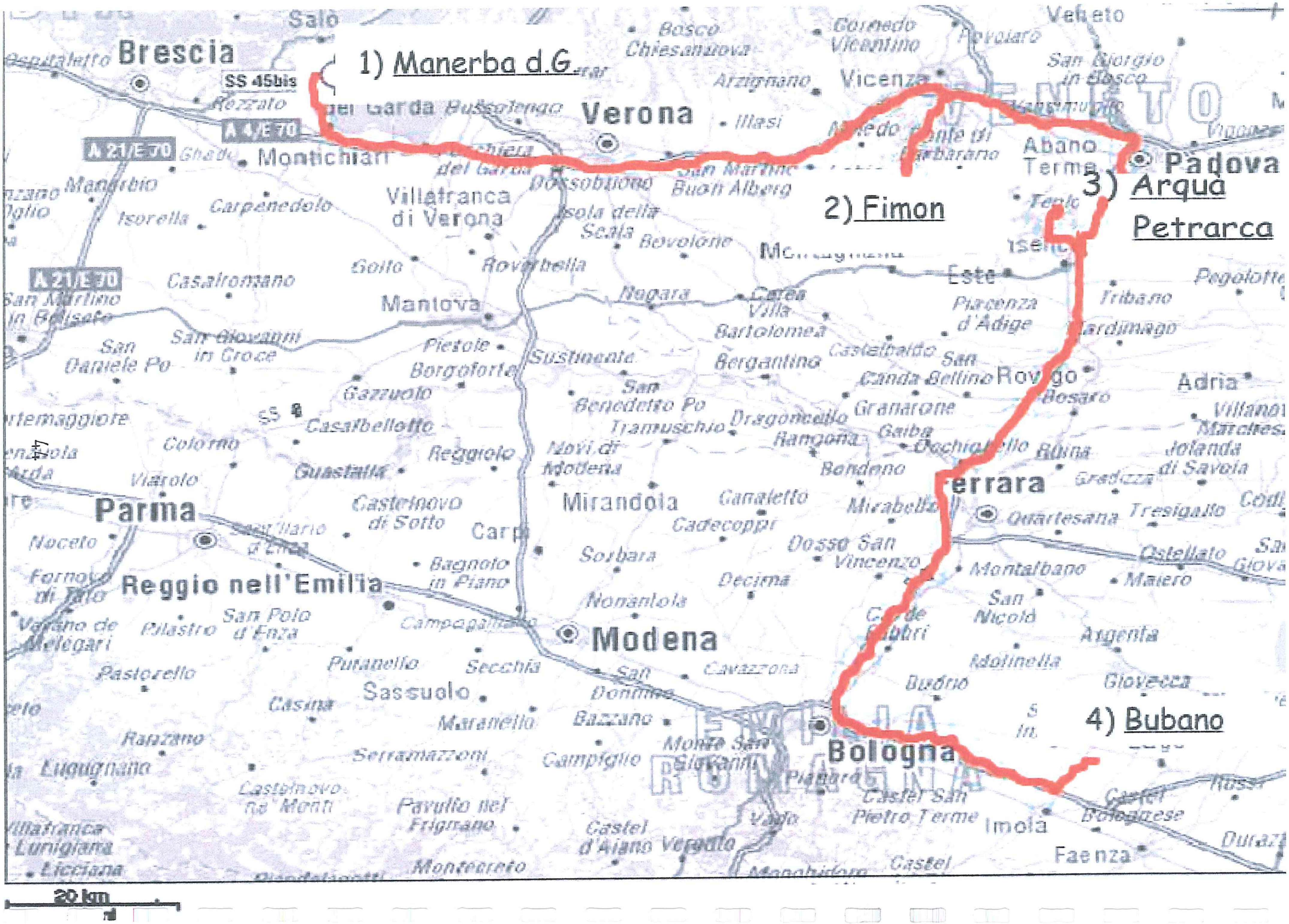


Figure 6. Simplified pollen diagram from the Bronze Age succession (gyttja) in the central part of the Lavagnone basin. The diagram includes selected anthropogenic *taxa* and cumulative curves of swamp forest trees (*Alnus, Salix*), wetland terrestrial herbs (*Filipendula, Viola, Hypericum, Myosotis-type, Epilobium, Lythrum, Valeriana*), palustrine herbs (*Typha, Sparganium, Polygonum persicaria*, Primulaceae, Cyperaceae) and aquatics (*Nymphaea, Nuphar, Lemna, Potamogeton, Myriophyllum, Hydrocharitaceae*). (after de Marinis et al., 2005)

Photo 1.Sector B, July 2006. Digging of the lower sterile layer.

Photo 2
Sector C, July 2006. White arrows show the position of the fence.

Photo 3
Southern section of Sector A (year 2002). Between EBA IB and EBA II settlement phases all the posts were bent at a 45 degree angle toward dryland. It is proposed that posts collapsed during a phase of complete drying up of the lake.


1) Manerba d.G.
2) Fimon
3) Arquà Petrarca
4) Bubano
Brescia
Salò
SS 45bis
A 4/E 70
A 21/E 70
Montichiari
Verona
Vicenza
Padova
Abano Terme
Villafranca di Verona
Isola della Scala
Bovolone
Este
Mantova
Rovigo
Adria
Ferrara
Parma
Reggio nell'Emilia
Modena
Carpi
Mirandola
Sassuolo
Bologna
Imola
Faenza
Budrio
Argenta
Castel San Pietro Terme
Castel Bolognese
20 km

Holocene population expansions of *Fagus* in the southern Alps, evidences from Lago di Fimon and Lago Piccolo di Avigliana (northern Italy)

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ABSTRACT

Factors enabling the Holocene mass population expansion of *Fagus sylvatica* were discussed for two sites located in the southern Alps. Lago di Fimon (45°28' N, 11°32' E- 23 m a.s.l.) and Lago Piccolo di Avigliana (45°03' N, 07°23' E - 353 m a.s.l.), located at the eastern and western sector of the Po plain respectively. A Neolithic settlement occurred from 6600 to 6300 cal BP ~2 km at the Lago di Fimon; this rare condition allowed us to test whether human impact on the vegetation was the main trigger for the *Fagus* build-up. High temporal-resolution pollen and charcoal analyses, and time series analysis were done during the time of *Fagus* expansion for both sites. At Fimon the first increase (~7300 cal BP) is connected with a change towards wetter and cooler summer conditions. *Fagus* mass expansion occurred ~6900 cal BP and peaked during the occurrence of a Neolithic settlement. This second expansion was a consequence of fire events that affected *Tilia* and *Ulmus*. At Lago Piccolo di Avigliana *Fagus* was slightly favored by fire, whereas significant human impact on the forests were not recorded. At both sites, the beginning of the *Fagus* expansion occurred during cold and wet phases and *Corylus* was subsequently displaced by *Fagus*. At Avigliana the *Fagus* expansion occurred 2000 years later than at Fimon. We suggest that migrational lags are not responsible for this delay.

Table 2. The sediment of Lago di Fimon (FIM A)

Depth (cm)	Description	Colour
0-32	Calcareous marl	Olive brown
32-200	Calcareous silty clay	Olive brown
200-250	Calcareous silty clay sandy	Grayish brown
250-600	Calcareous gyttja loam	Olive grey
600-800	Calcareous gyttja	Olive grey

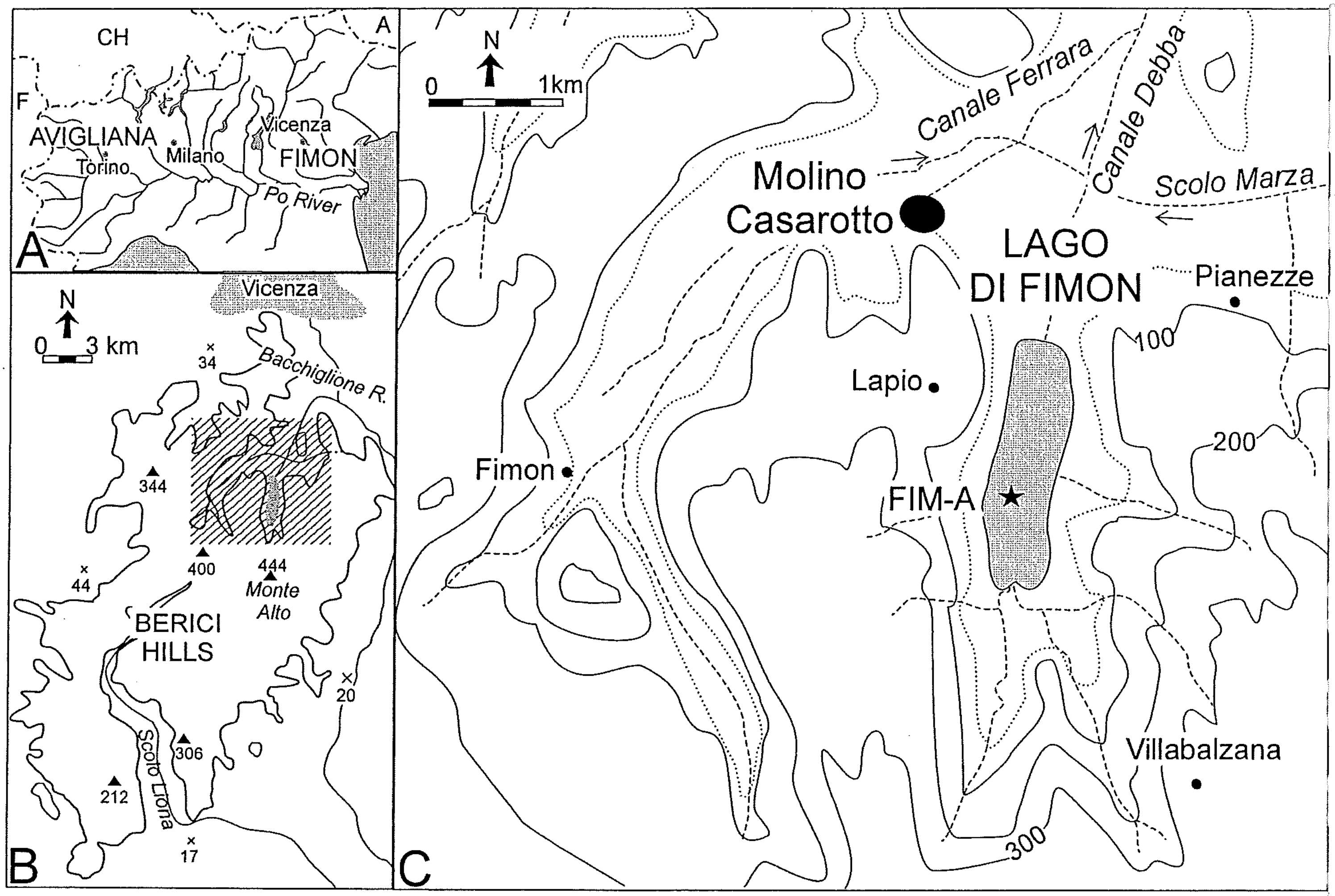
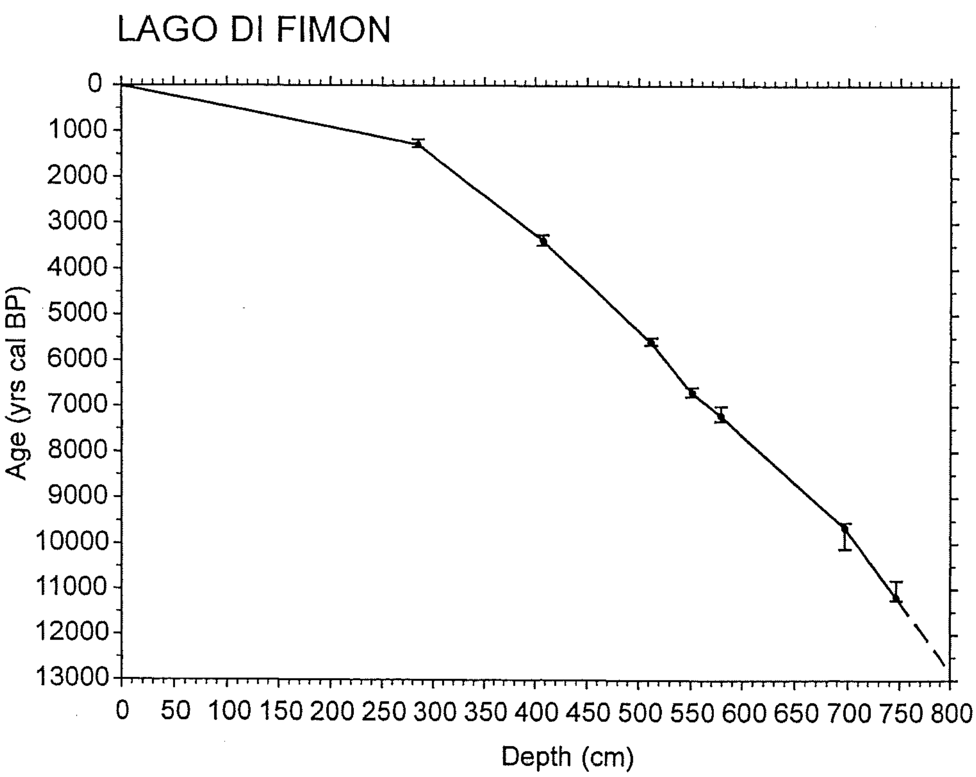


FIGURE 1

Table 1. AMS-radiocarbon dates from Lago di Fimon (FIM A). Calibration was made with CALIB rev 4.3 (Stuiver et al. 1998; Stuiver and Reimer 2000) and selecting the IntCal98 database (Stuiver et al. 1998).

Lab. number	Depth (cm)	^{14}C age BP	Cal. age BP (2 sd)	Cal age BP (mean intercept)
Erl-5579	284.5	1346 ± 56	1345-1170	1286
Erl-5580	407.5	3160 ± 58	3475-3255	3378
Poz-5305	512	4840 ± 40	5650-5485	5592
Poz-5306	551	5860 ± 35	6775-6570	6696
Erl-5581	578.5	6261 ± 61	7315-6990	7198
Erl-5582	697	8707 ± 75	10110-9535	9651
Erl-5583	746.5	9736 ± 79	11235-10790	11172



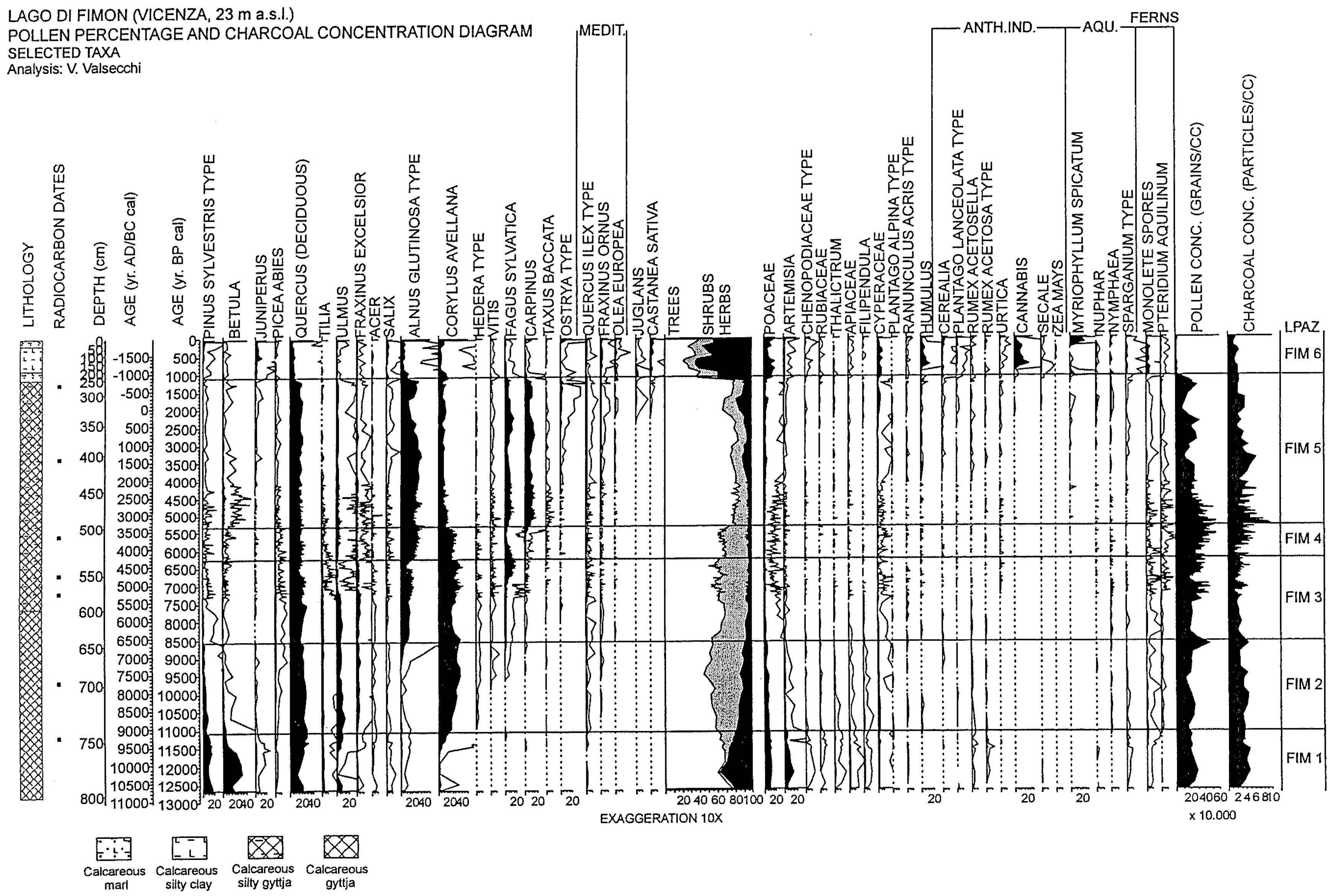

LAGO DI FIMON (VICENZA, 23 m a.s.l.)
POLLEN PERCENTAGE AND CHARCOAL CONCENTRATION DIAGRAM
SELECTED TAXA
Analysis: V. Valsecchi
LITHOLOGY
RADIOCARBON DATES
DEPTH (cm)
AGE (yr. AD/BC cal)
AGE (yr. BP cal)
PINUS SYLVESTRIS TYPE
BETULA
JUNIPERUS
PICEA ABIES
QUERCUS (DECIDUOUS)
TILIA
ULMUS
FRAXINUS EXCELSIOR
ACER
SALIX
ALNUS GLUTINOSA TYPE
CORYLUS AVELLANA
HEDERA TYPE
VITIS
FAGUS SYLVATICA
CARPINUS
TAXUS BACCATA
OSTRYA TYPE
MEDIT.
QUERCUS ILEX TYPE
FRAXINUS ORNUS
OLEA EUROPEA
JUGLANS
CASTANEA SATIVA
TREES
SHRUBS
HERBS
EXAGGERATION 10X
POACEAE
ARTEMISIA
CHENOPODIACEAE TYPE
RUBIACEAE
THALICTRUM
APIACEAE
FILIPENDULA
CYPERACEAE
PLANTAGO ALPINA TYPE
RANUNCULUS ACRIS TYPE
ANTH.IND.
HUMULUS
CEREALIA
PLANTAGO LANCEOLATA TYPE
RUMEX ACETOSELLA
RUMEX ACETOSA TYPE
URTICA
CANNABIS
SECALE
ZEA MAYS
AQU.
MYRIOPHYLLUM SPICATUM
NUPHAR
NYMPHAEA
SPARGANIUM TYPE
FERNS
MONOLETE SPORES
PTERIDIUM AQUILINUM
POLLEN CONC. (GRAINS/CC)
x 10.000
CHARCOAL CONC. (PARTICLES/CC)
LPAZ
FIM 6
FIM 5
FIM 4
FIM 3
FIM 2
FIM 1
Calcareous marl
Calcareous silty clay
Calcareous silty gyttja
Calcareous gyttja

FIGURE 3

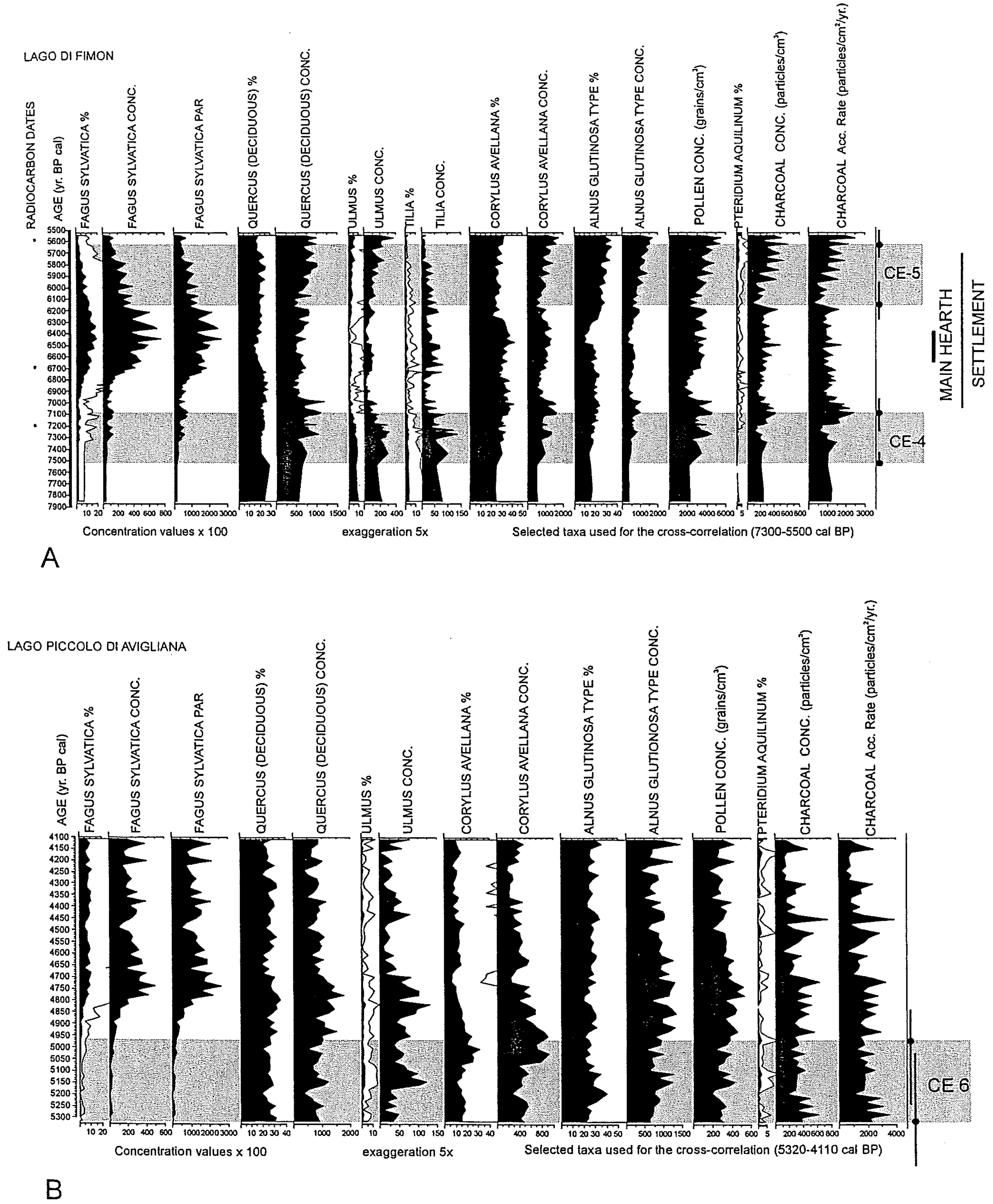

LAGO DI FIMON
RADIOCARBON DATES
AGE (yr. BP cal)
FAGUS SYLVATICA %
FAGUS SYLVATICA CONC.
FAGUS SYLVATICA PAR
QUERCUS (DECIDUOUS) %
QUERCUS (DECIDUOUS) CONC.
ULMUS %
ULMUS CONC.
TILIA %
TILIA CONC.
CORYLUS AVELLANA %
CORYLUS AVELLANA CONC.
ALNUS GLUTINOSA TYPE %
ALNUS GLUTINOSA TYPE CONC.
POLLEN CONC. (grains/cm³)
PTERIDIUM AQUILINUM %
CHARCOAL CONC. (particles/cm³)
CHARCOAL Acc. Rate (particles/cm²/yr.)
CE-5
CE-4
MAIN HEARTH
SETTLEMENT
Concentration values x 100
exaggeration 5x
Selected taxa used for the cross-correlation (7300-5500 cal BP)
A
LAGO PICCOLO DI AVIGLIANA
AGE (yr. BP cal)
FAGUS SYLVATICA %
FAGUS SYLVATICA CONC.
FAGUS SYLVATICA PAR
QUERCUS (DECIDUOUS) %
QUERCUS (DECIDUOUS) CONC.
ULMUS %
ULMUS CONC.
CORYLUS AVELLANA %
CORYLUS AVELLANA CONC.
ALNUS GLUTINOSA TYPE %
ALNUS GLUTIONOSA TYPE CONC.
POLLEN CONC. (grains/cm³)
PTERIDIUM AQUILINUM %
CHARCOAL CONC. (particles/cm³)
CHARCOAL Acc. Rate (particles/cm²/yr.)
CE 6
Concentration values x 100
exaggeration 5x
Selected taxa used for the cross-correlation (5320-4110 cal BP)
B

FIGURE 4

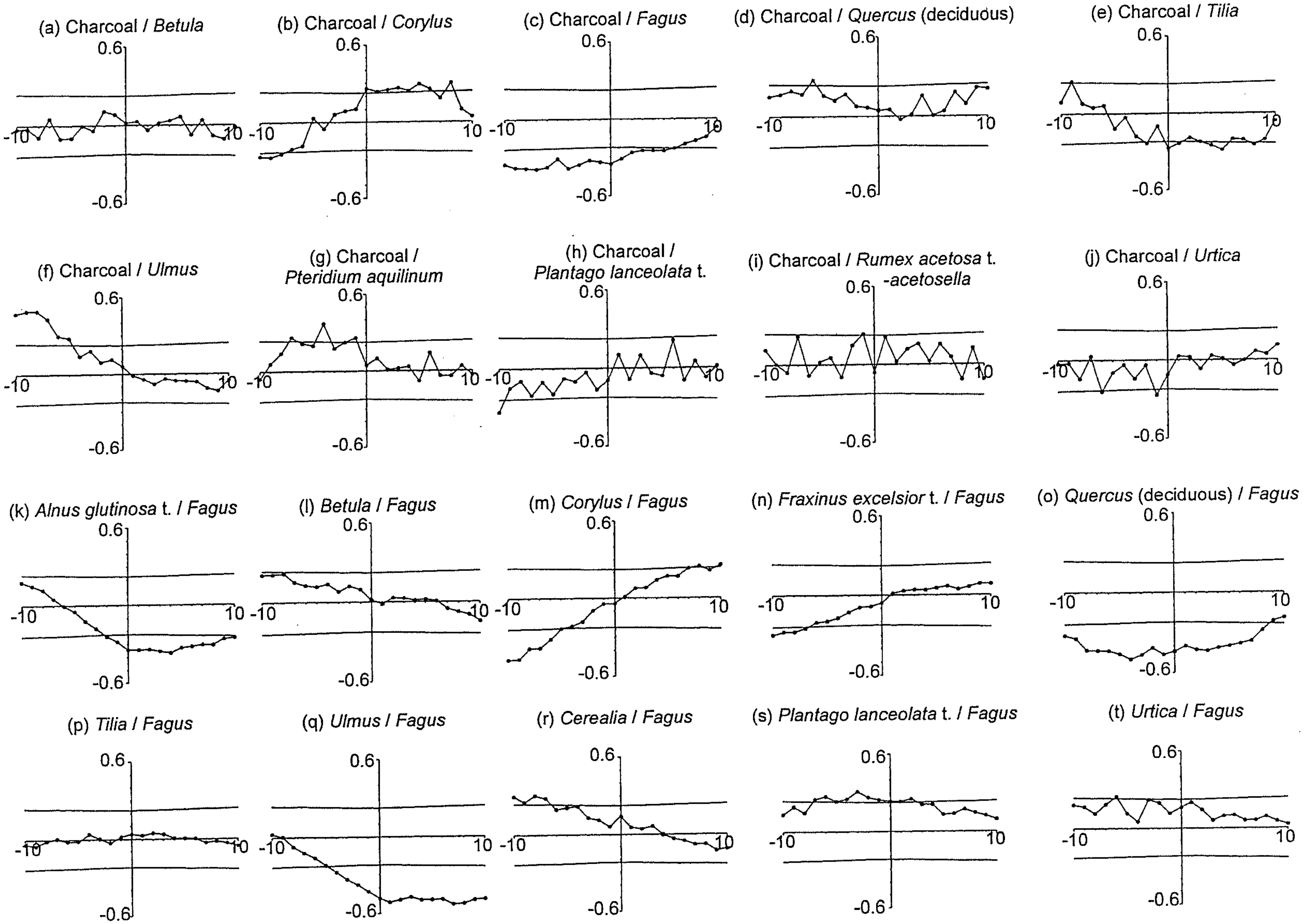
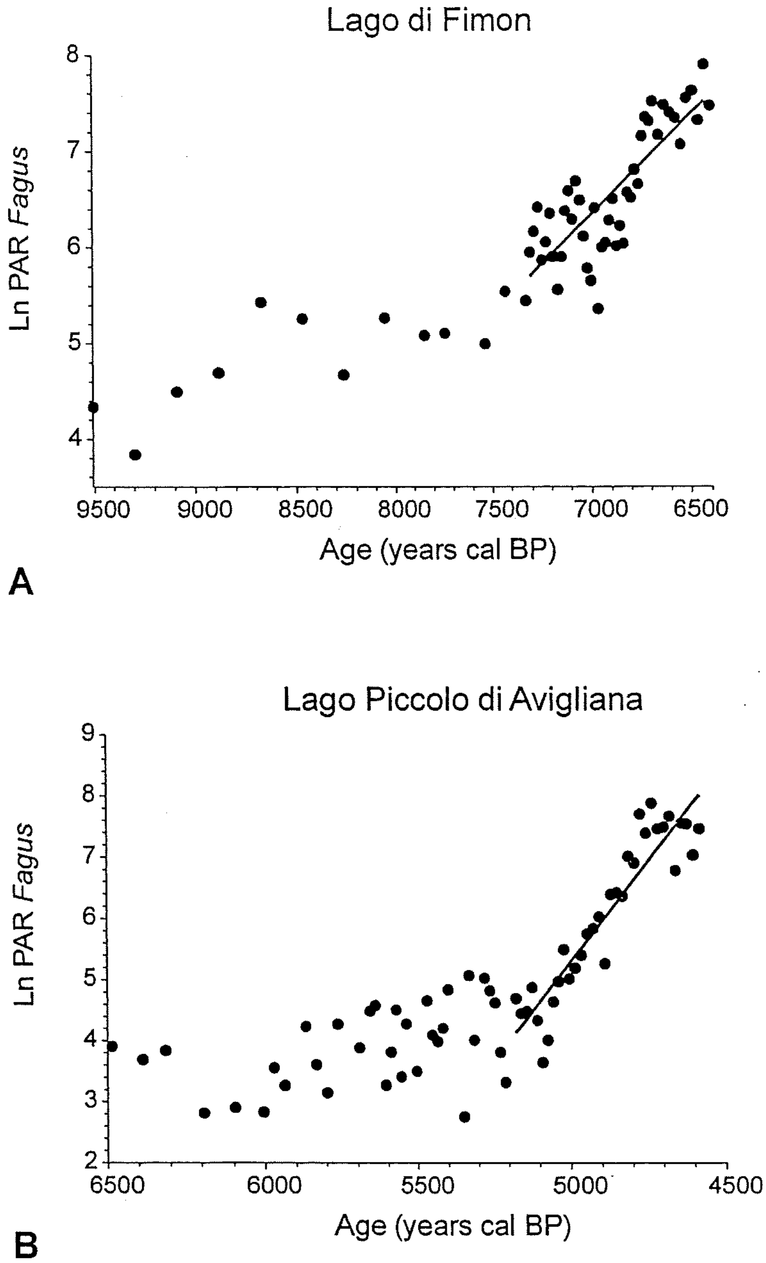

(a) Charcoal / Betula
(b) Charcoal / Corylus
(c) Charcoal / Fagus
(d) Charcoal / Quercus (deciduous)
(e) Charcoal / Tilia
(f) Charcoal / Ulmus
(g) Charcoal / Pteridium aquilinum
(h) Charcoal / Plantago lanceolata t.
(i) Charcoal / Rumex acetosa t. -acetosella
(j) Charcoal / Urtica
(k) Alnus glutinosa t. / Fagus
(l) Betula / Fagus
(m) Corylus / Fagus
(n) Fraxinus excelsior t. / Fagus
(o) Quercus (deciduous) / Fagus
(p) Tilia / Fagus
(q) Ulmus / Fagus
(r) Cerealia / Fagus
(s) Plantago lanceolata t. / Fagus
(t) Urtica / Fagus
0.6
-0.6
-10
10

FIGURE 5



Lago di Fimon
Ln PAR *Fagus*
8
7
6
5
4
9500
9000
8500
8000
7500
7000
6500
Age (years cal BP)
A
Lago Piccolo di Avigliana
Ln PAR *Fagus*
9
8
7
6
5
4
3
2
6500
6000
5500
5000
4500
Age (years cal BP)
B

FIGURE 8

Full- to late-glacial vegetation and climate changes and evidence of glacial refugia in the south-eastern Alps (Italy)

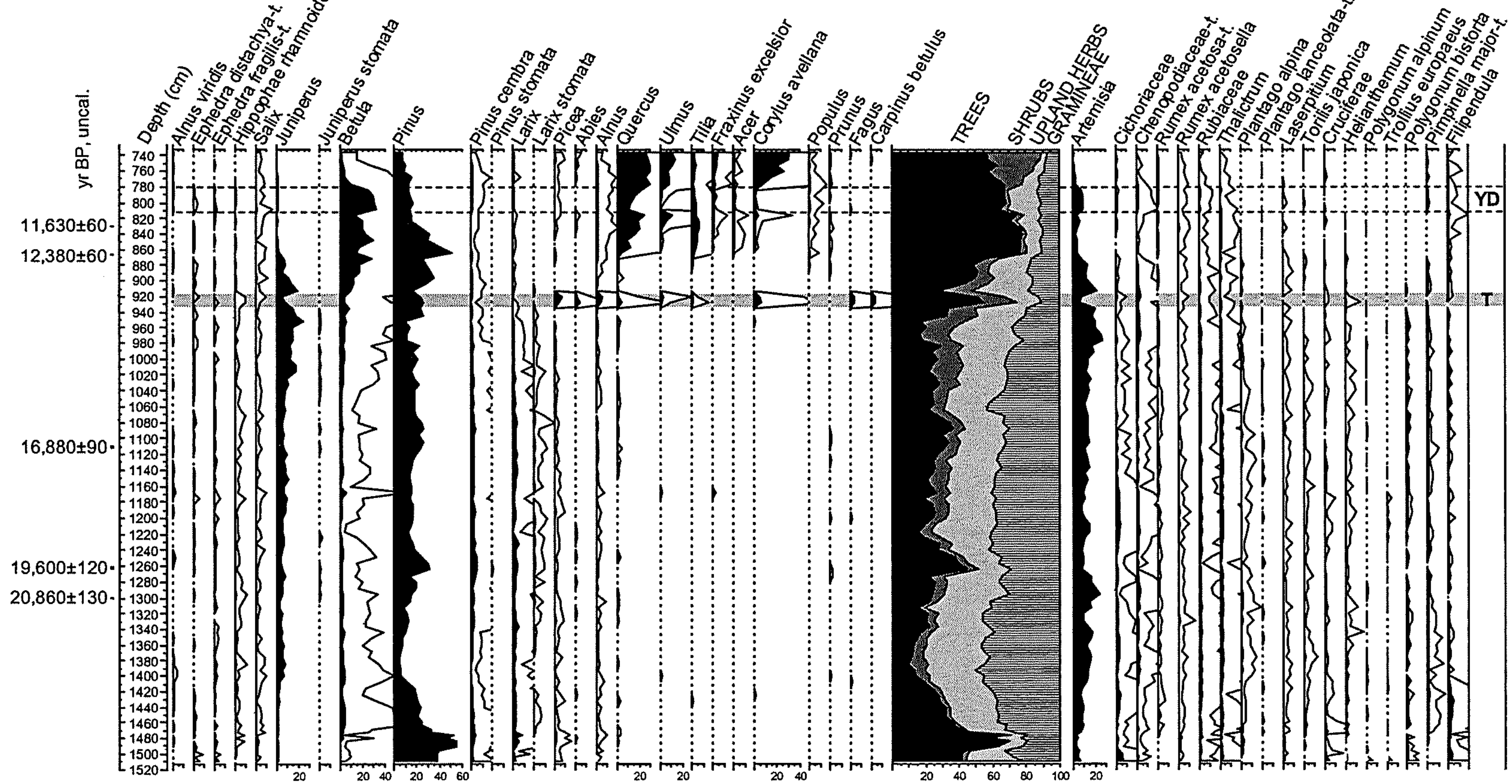
Lucia Wick

Pollen and macrofossils were studied at three lakes situated within the maximum glacier extention (Lago di Ragogna, 188 m asl; Lago di Revine, 224 m asl) and in the periglacial area (Lago di Fimòn, Monti Berici, 23 m asl), respectevely, covering the time period between c. 26 and 9 kyr BP (uncal.). The pollen record from Lago di Fimòn suggests cold and dry climatic conditions during the LGM, with the vegetation cover dominated by steppic elements, such as grasses, *Artemisia*, and Chenopodiaceae, and possibly some isolated stands of conifers on more favourable habitats. During an interstadial phase between c. 25 and 23 kyr BP the lake dried up at times; this corresponds to a lake-level decrease of 16-17 m compared to the recent water table. A rich aquatic flora, increases in the pollen percentages of pine and larch, charred *Larix* needles, and high concentrations of charred herbaceous plant remains point to a continental climate with warm and dry summers and high fire frequencies. Two further short-term climatic improvements around 19.5 kyr and 16.8 kyr BP, respectively, are indicated by increases in coniferous trees. The late-glacial reforestation of the area by *Betula* started at c. 13.5 kyr BP, followed by the expansion of *Pinus sylvestris* at c. 12.4 kyr BP. At the same time mesophilous deciduous trees immigrated. *Quercus*, *Ulmus*, and *Tilia* became major components of the late-glacial forests. As in all the pollen records from the southern Alpine lowlands, the Younger Dryas is characterised by strong decreases in mesophilous trees and increases in *Artemisia* and other steppic elements, indicating rather dry climatic conditions.
The lakes along the border of the Alps were cut off from melting-water inflow around 15 kyr BP, when open *Larix-Pinus cembra* woodlands established on the morainic soils. After a short-term climatic deterioration *Betula* woodlands spread, followed by *Pinus sylvestris* and mesophilous trees. At Lago di Ragogna *Picea* started to expand at the onset of the Younger Dryas. Between c. 15 and 14 kyr BP *Larix*, *Pinus cembra*, *P. mugo*, and *P. sylvestris* are recorded by macrofossils and *Picea* by rather high pollen percentages, suggesting that these trees had their glacial refugia on microclimatically favourable habitats at low to medium altitudes in the south-eastern Alps. Though it is very unlikely that any of the mesophilous tree taxa was able to survive in the extremely continental climatic conditions during the full-glacial and early late-glacial period.

Abstract , XI International Palynological Congress Granada, 2004

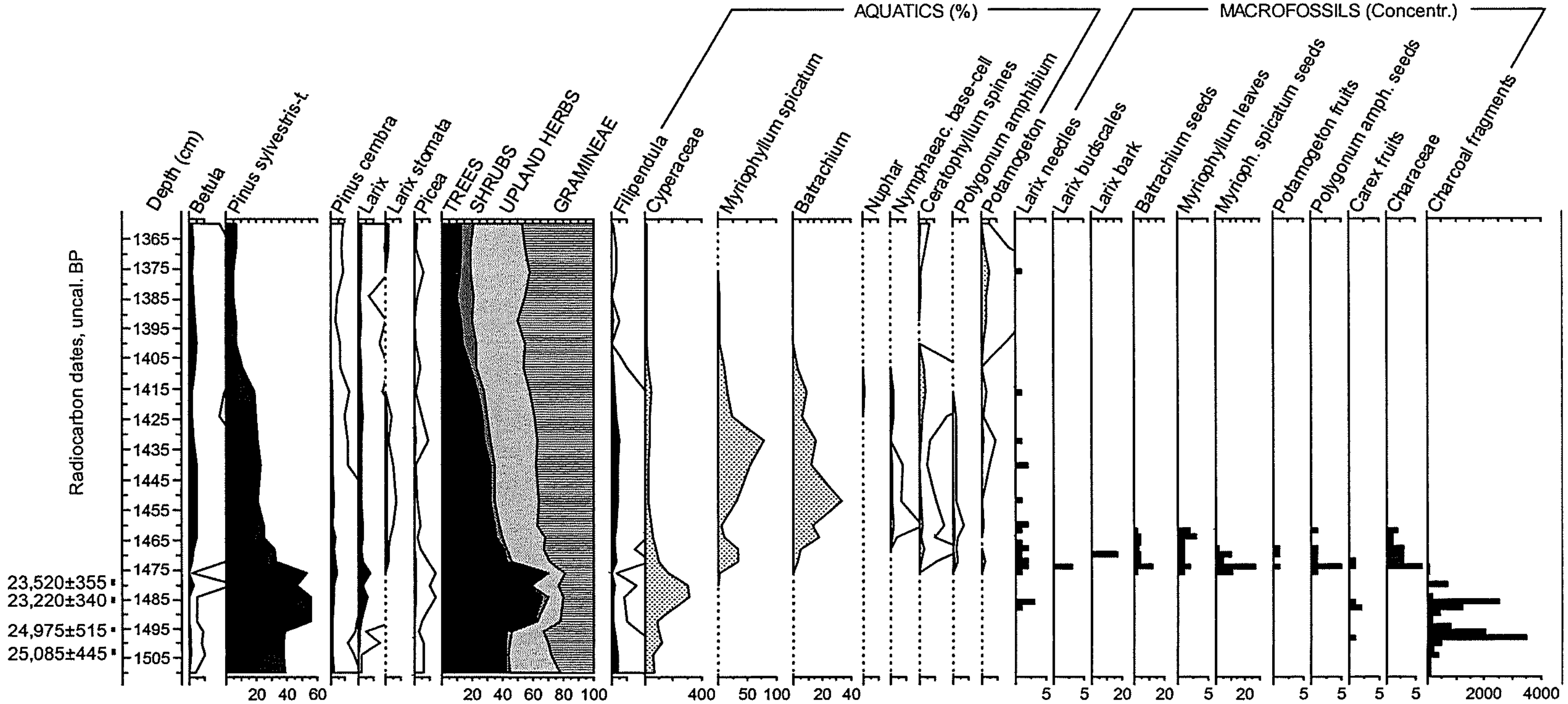
LAGO DI FIMON

Pollen percentages of major taxa
Analysis L. Wick



LAGO DI FIMON

Pollen percentages and macrofossil concentrationsof selected taxa
Analysis L. Wick



Lago della Costa, Arquà Petrarca

Petra Kaltenrieder, Willy Tinner and Brigitta Ammann

Site:

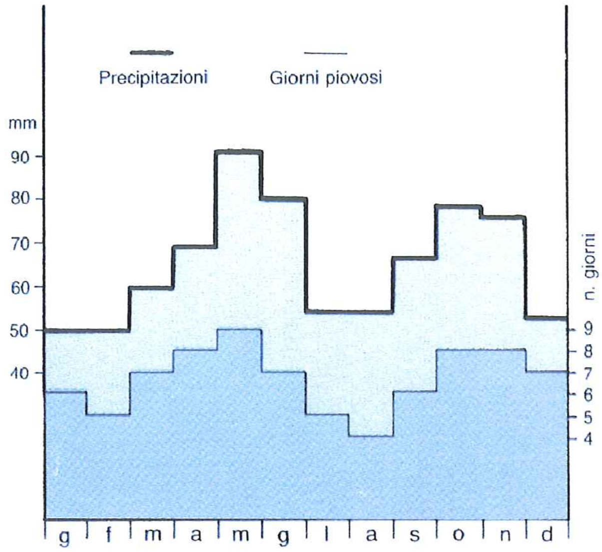


Fig. 1: Mean monthly precipitation (mm) and number of rainy days in the Colli Euganei. The site has a Cfa climate with no dry summer; mean temperature of hottest month is above 22°C, and with more than four months of above 10°C.

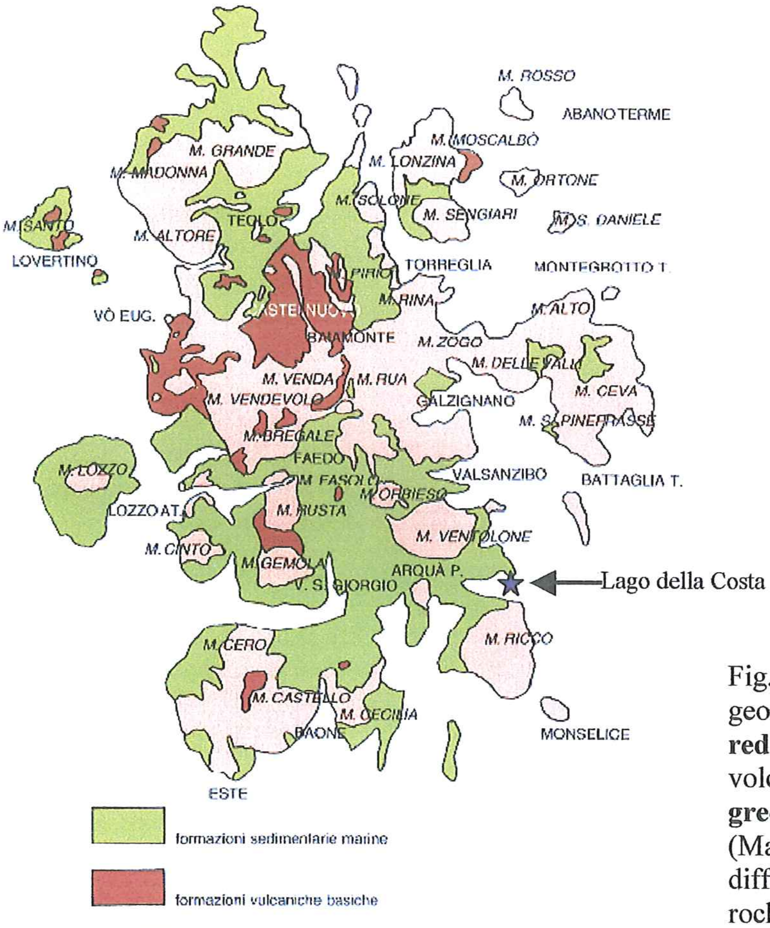


Fig. 2: simplified layout of the geology at Colli Euganei: **in dark red**: the oldest formation of alkaline volcanic rocks (Vulkanite: Basalte); **green**: marine calcareous sediments (Marne = Mergel, engl. marl); **rose**: different mainly acidic volcanic rocks (Vulkanite: Rhyolithe, Trachyte, Andesite)

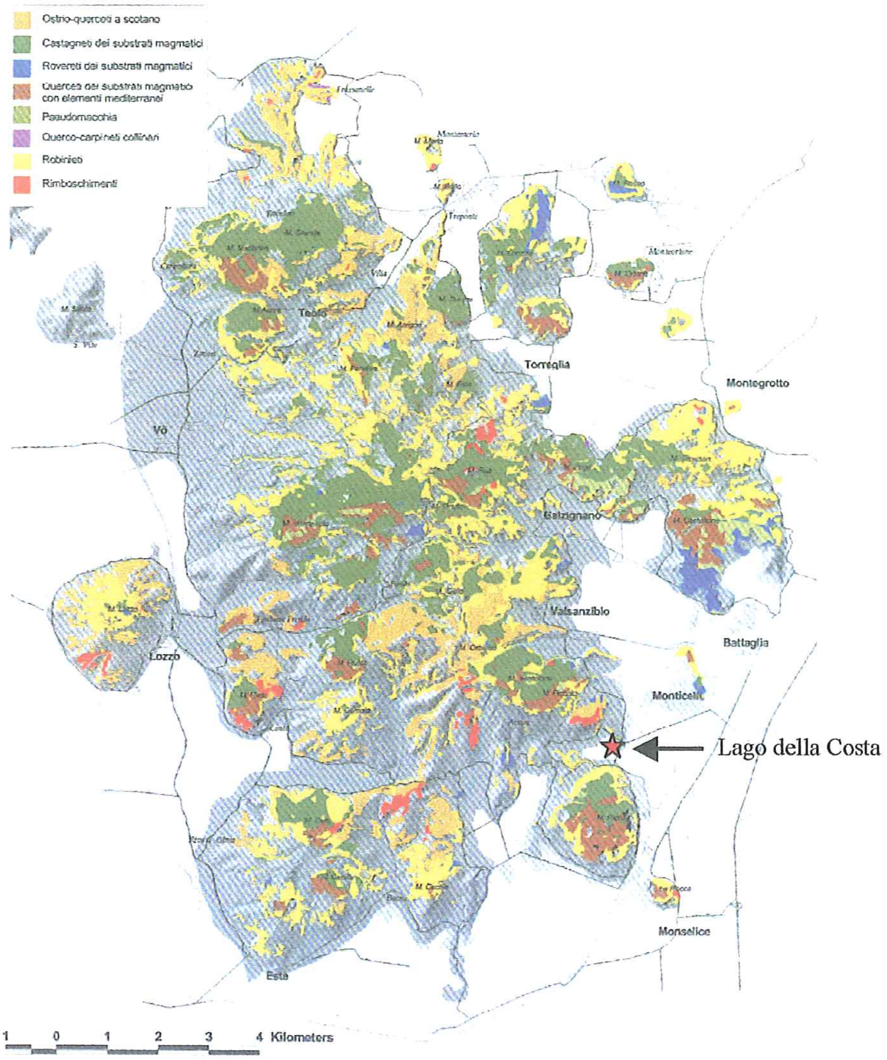
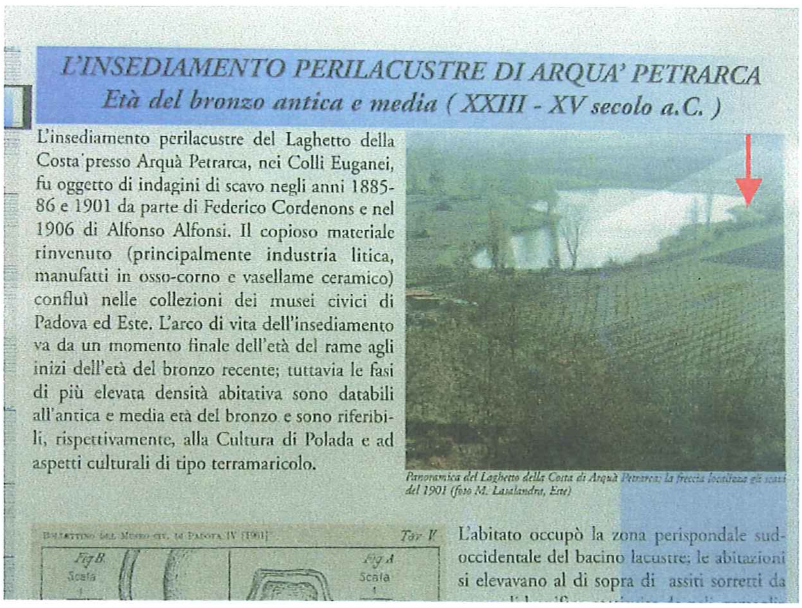


Fig. 3: Map of the recent forest types of the hilly region Colli Euganei. On silicate sites there are *Quercus* woods with some mediterranean elements **(brown spots)**; on northern slope aspects dominates *Castanea sativa* **(green spots)**. On calcareous substrate *Ostrya* and *Quercus* stands are prevailing **(orange spots)**. **In yellow** there are Robinia sites, between forest and agricultural land. Source: Progetto Boschi del Parco Regionale dei Colli Euganei



L'INSEDIAMENTO PERILACUSTRE DI ARQUA' PETRARCA

Età del bronzo antica e media (XXIII - XV secolo a.C.)

L'insediamento perilacustre del Laghetto della Costa presso Arquà Petrarca, nei Colli Euganei, fu oggetto di indagini di scavo negli anni 1885-86 e 1901 da parte di Federico Cordenons e nel 1906 di Alfonso Alfonsi. Il copioso materiale rinvenuto (principalmente industria litica, manufatti in osso-corno e vasellame ceramico) confluì nelle collezioni dei musei civici di Padova ed Este. L'arco di vita dell'insediamento va da un momento finale dell'età del rame agli inizi dell'età del bronzo recente; tuttavia le fasi di più elevata densità abitativa sono databili all'antica e media età del bronzo e sono riferibili, rispettivamente, alla Cultura di Polada e ad aspetti culturali di tipo terramaricolo.

Panoramica del Laghetto della Costa di Arquà Petrarca; la freccia localizza gli scavi del 1901 (foto M. Lasalandra, Este)

Tav. V

Fig B. Scala

Fig A. Scala

L'abitato occupò la zona perispondale sud-occidentale del bacino lacustre; le abitazioni si elevavano al di sopra di assiti sorretti da

Fig. 4: Bronze age settlement at the border of Lago della Costa:

- Archaeological excavations between 1885 and 1906 (F. Cordenons, A. Alfonsi)
- dated to Early-Middle Bronze age ('2000-1600 B':'Cultura di Polada')
- Artefacts found: pottery, decoration and tools, made of deer bone and horns, stone
- Artefacts for cattle breeding (ox)
- deer remains show hunting activities
- Abandonned not because of burning

Late-Glacial and Holocene at Lago della Costa (lake core AP1)

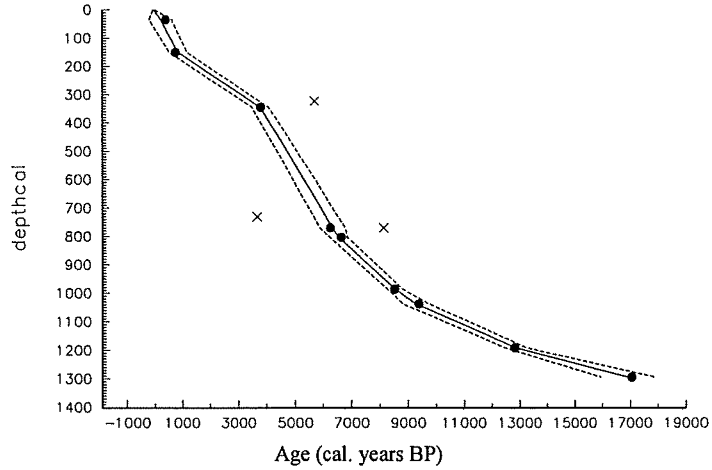
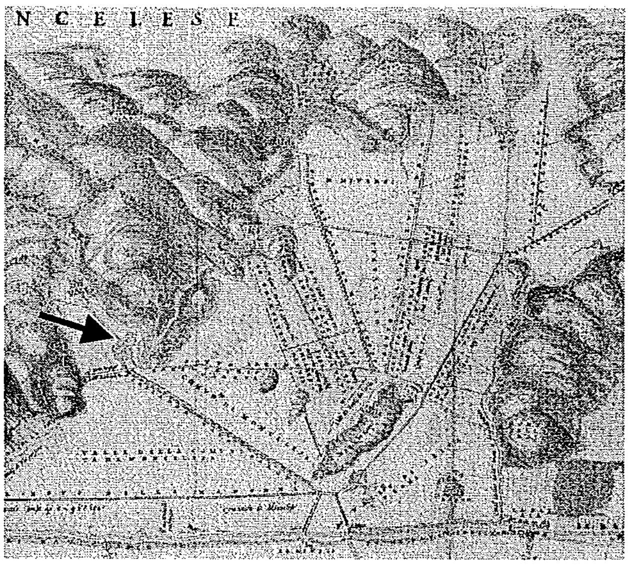


Fig. 5: Radiocarbon dating of the sediment of the lake core Lago della Costa (AP1)

Reclaiming the paludified landscape at the southeastern border of Colli Euganei:



From 1550 onward many drainage channels were built to intensify agriculture in the region: There are no published pollen records from Colli Euganei and surrounding Po Plain with Holocene sediments.

Fig. 6: Map of the SE-part of CE from 1567 showing the intense drainage system

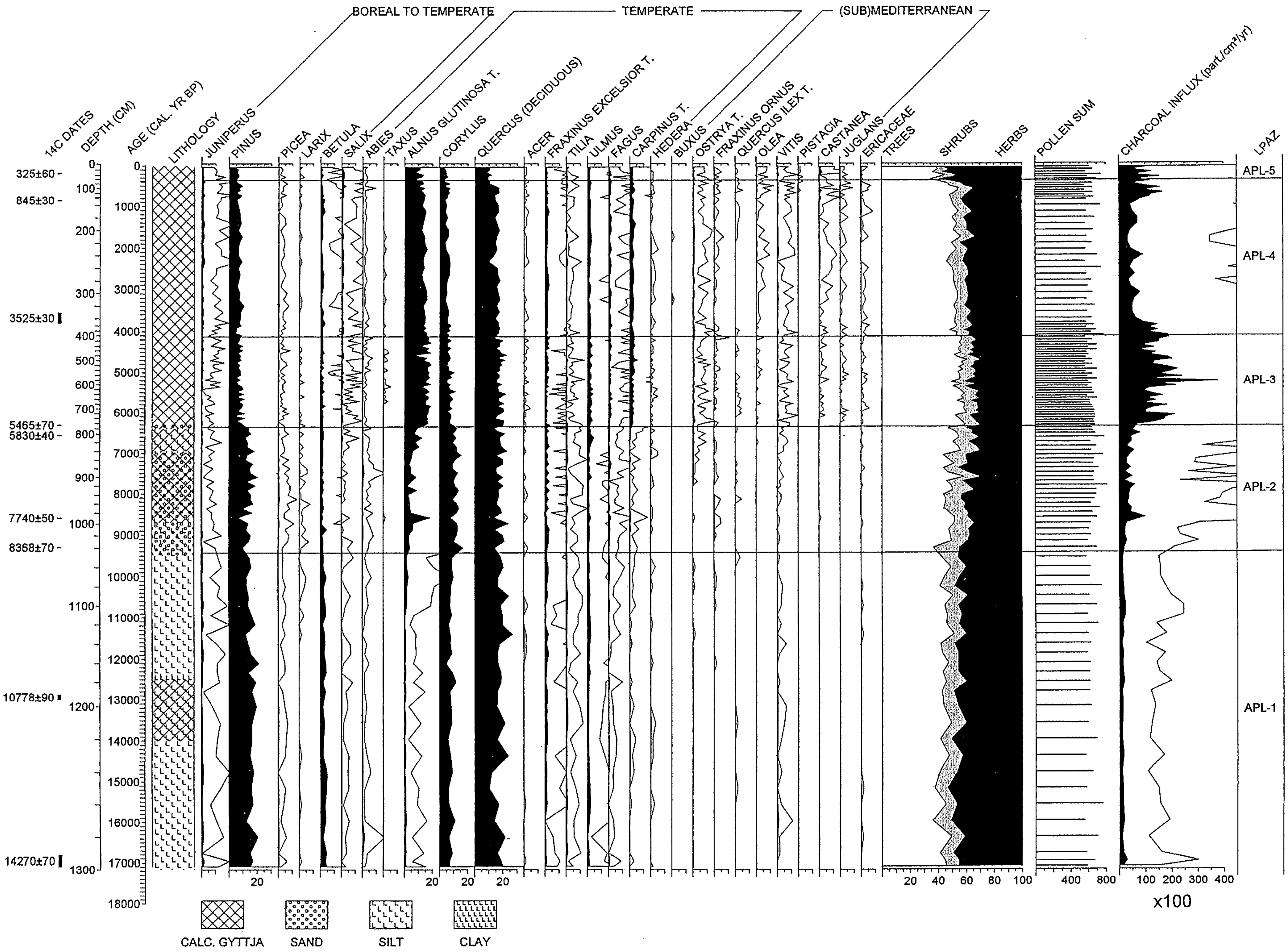
Human impact on vegetation during the Bronze Age in Northern Italy:

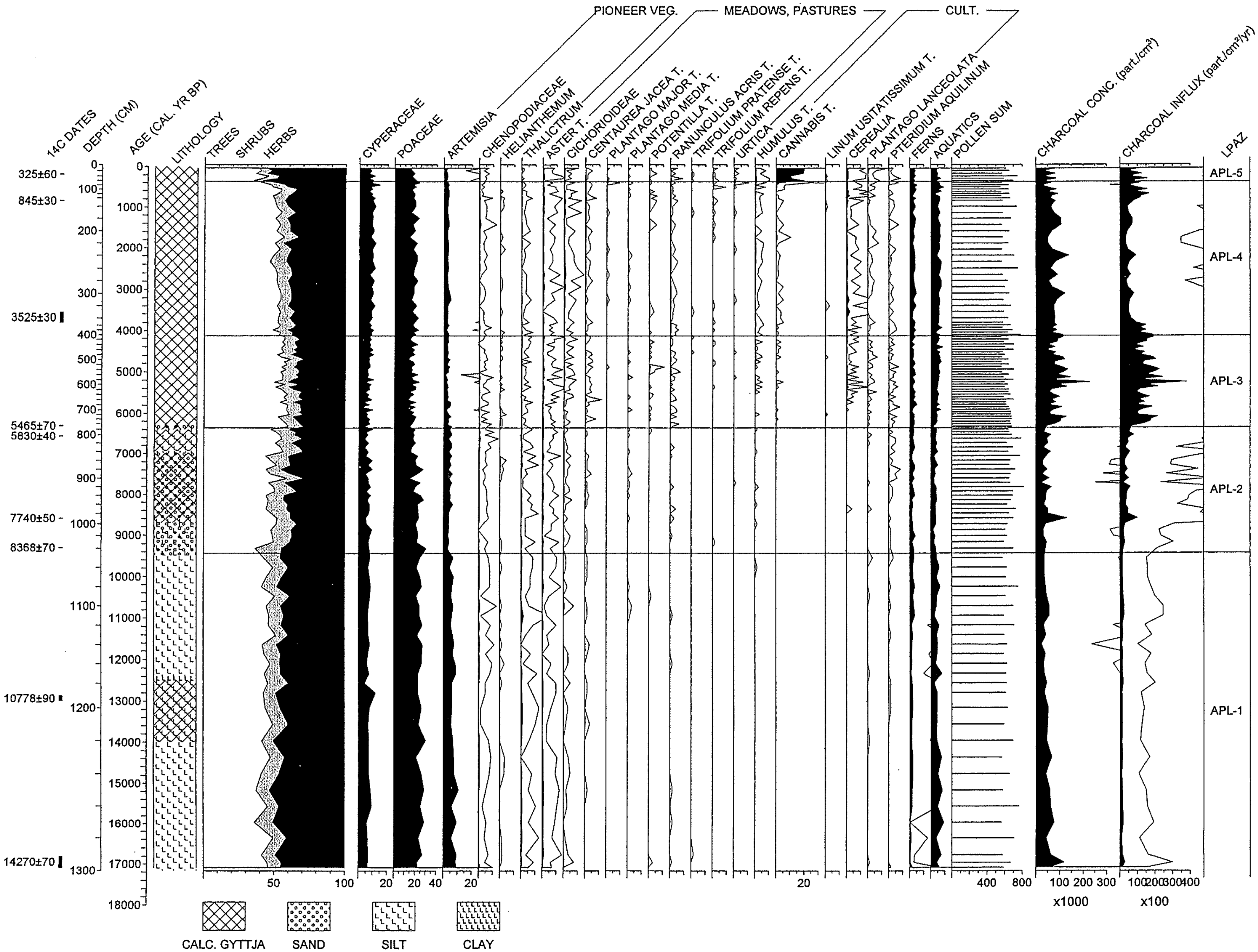
- Pile-dwelling settlements (Pfahlbauten) in wet areas were characteristic for the Early-Middle Bronze ages and were found in all Northern Italy
- During this period intensive agriculture is attested by several archaeological evidences
- Besides cultivation, cattle husbandry was also important (remains of ox and ovine)

Prehistoric societies in Northern Italy typically show strong impact on the environment (e.g. Lago Lucone, V. Valsecchi): Grazing activities (ox and ovine); local cereal cultivation; remains of edible wild plants (e.g. *Vitis*); clearing of the forest for cultivation and pastures: common anthropogenic indicators are *Plantago lanceolata* t., Cerealia etc.

- **One important question for the region of Lago della Costa is:**
  Why was the site not more forested?

⇒ Po Plain was heavily disturbed by river meandering! We assume that vegetation has always been very open on gravel and sand soils.


BOREAL TO TEMPERATE
TEMPERATE
(SUB)MEDITERRANEAN
14C DATES
DEPTH (CM)
AGE (CAL. YR BP)
LITHOLOGY
JUNIPERUS
PINUS
PICEA
LARIX
BETULA
SALIX
ABIES
TAXUS
ALNUS GLUTINOSA T.
CORYLUS
QUERCUS (DECIDUOUS)
ACER
FRAXINUS EXCELSIOR T.
TILIA
ULMUS
FAGUS
CARPINUS T.
HEDERA
BUXUS
OSTRYA T.
FRAXINUS ORNUS
QUERCUS ILEX T.
OLEA
VITIS
PISTACIA
CASTANEA
JUGLANS
ERICACEAE
TREES
SHRUBS
HERBS
POLLEN SUM
CHARCOAL INFLUX (part./cm²/yr)
LPAZ
325±60
845±30
3525±30
5465±70
5830±40
7740±50
8368±70
10778±90
14270±70
APL-5
APL-4
APL-3
APL-2
APL-1
x100
CALC. GYTTJA
SAND
SILT
CLAY


PIONEER VEG.
MEADOWS, PASTURES
CULT.
14C DATES
DEPTH (CM)
AGE (CAL. YR BP)
LITHOLOGY
TREES
SHRUBS
HERBS
CYPERACEAE
POACEAE
ARTEMISIA
CHENOPODIACEAE
HELIANTHEMUM
THALICTRUM
ASTER T.
CICHORIOIDEAE
CENTAUREA JACEA T.
PLANTAGO MAJOR T.
PLANTAGO MEDIA T.
POTENTILLA T.
RANUNCULUS ACRIS T.
TRIFOLIUM PRATENSE T.
TRIFOLIUM REPENS T.
URTICA
HUMULUS T.
CANNABIS T.
LINUM USITATISSIMUM T.
CEREALIA
PLANTAGO LANCEOLATA
PTERIDIUM AQUILINUM
FERNS
AQUATICS
POLLEN SUM
CHARCOAL CONC. (part./cm³)
CHARCOAL INFLUX (part./cm²/yr)
LPAZ
325±60
845±30
3525±30
5465±70
5830±40
7740±50
8368±70
10778±90
14270±70
APL-5
APL-4
APL-3
APL-2
APL-1
x1000
x100
CALC. GYTTJA
SAND
SILT
CLAY

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Memorie Biogeografiche Adriatiche 5
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I DEPOSITI LACUSTRI EUGANEI: ARCHIVIO PALEONTOLOGICO DEL TARDO GLACIALE E DEL PERIODO POSTGLACIALE *

FAUSTO LONA

Direttore dell'Istituto Botanico dell'Università di Parma

Molti naturalisti si sono chiesti quale fosse l'aspetto della Pianura Padana durante l'ultimo periodo glaciale e nel seguente periodo postglaciale. Taluni studiosi di Paleobotanica si sono peritati a darne un quadro della situazione forestale in base ad elementi geobotanici indiretti e qualche volta in base a dati paleontologici pertinenti, più che alla Pianura Padana vera e propria, ai suoi margini settentrionali (Anderson, 1), (Keller, 7), e meridionali (Firbas-Zangheri, 5). Da alcune di tali sintesi, talvolta appena fugacemente tratteggiate, sembrava che la Pianura pur essendo priva, in tale epoca, di latifoglie termofile, fosse almeno coperta da un vero manto di boschi di conifere. Così, ad esempio, da uno studio di Dalla Fior (4) sul contenuto pollinico di una torba profonda tratta da una trivellazione fatta nel suolo dell'Orto Botanico di Padova, è stato anche dedotto che nella Pianura Padana durante il periodo glaciale ci fosse abbondante Abete rosso assieme ad altre conifere. Purtroppo la situazione cronologica di questa torba non è perfettamente autenticata.

SUMMARY

Euganei lake deposits: Paleonthological record of the late glacial and postglacial

Palynological stratigraphycal examination of a deep boaring (15,5 m.) in the ancient Arquà lake sediments (near Colli Euganei: Po Valley) is reported. The pollen diagram reveals to comprehends a long period of the last Glacial and the Postglacial. During the glacial (or late glacial) period the Po-valley near the Colli Euganei was covered with a poor *Pinus-Betula* consortium sporadically bearing also a few *Juniperus*, *Alnus*, *Salix*, *Picea* and, occasionally, even some thermophil as *Corylus*, *Quercus*, etc.

Concerning the real postglacial period it is easy to remark the great diffusion of *Fagus* and *Abies* during the Atlantic period, diffusion that has been progressively restricted towards the present time. Now we can find only a few sporadic bush of *Fagus* on the high (600 mt.) Colli Euganei and no more *Abies*.

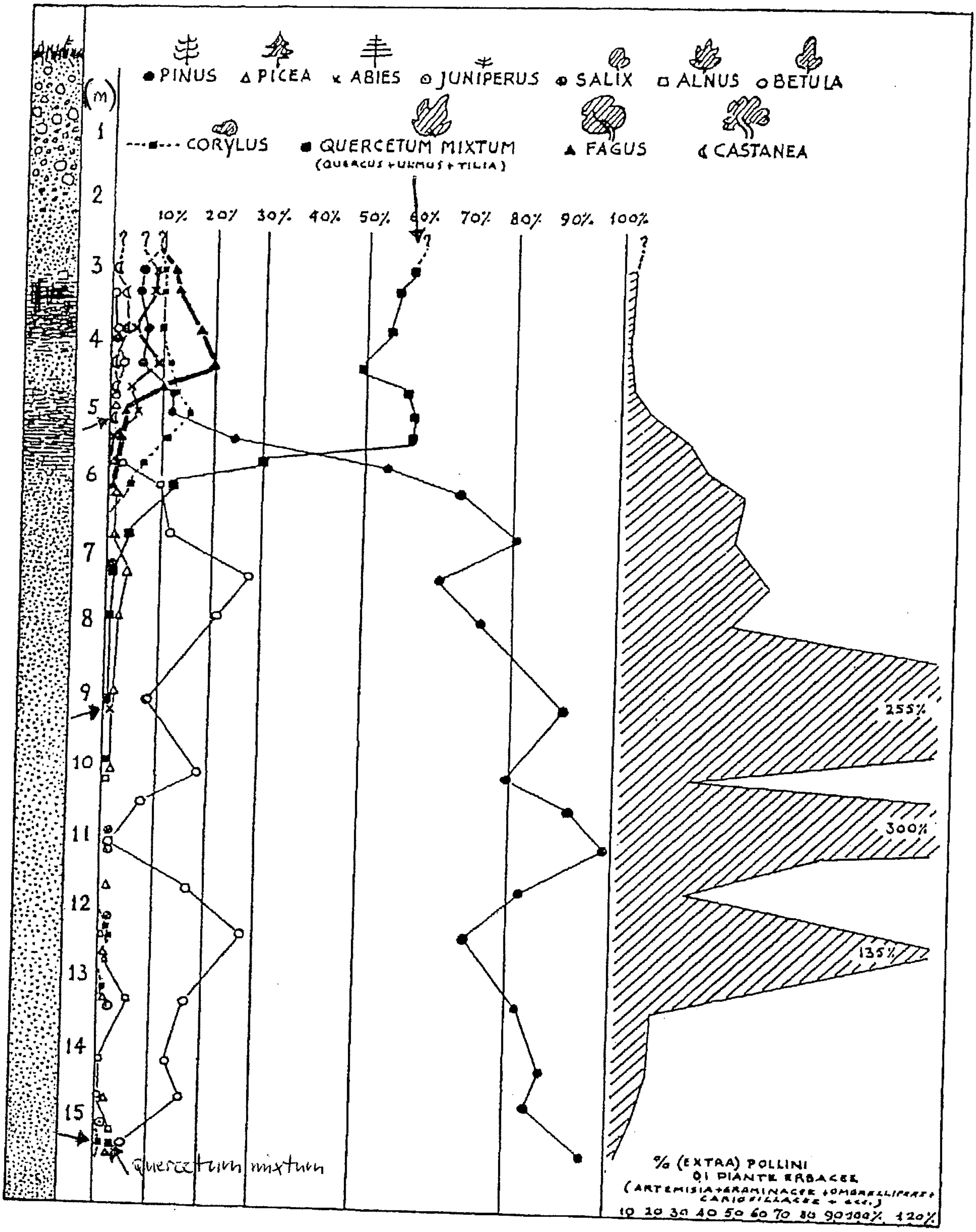


FIG. 1. - Diagrammi della composizione e del contenuto pollinico del deposito lacustre dei Colli Euganei, presso Arquà Petrarca.
All'estrema sinistra: profilo stratigrafico rappresentante il deposito minerogeno cretoso-argilloso (punteggiato) con le due intercalazioni torbose ai livelli 5-6 m. e 3-4 m., e la copertura ghiaiosa fra 0-2 m. circa.
Parte mediana: diagramma pollinico delle essenze forestali rappresentate in percentuale per ogni livello. Le singole essenze od i gruppi di essenze (Querceto misto = *Quercus* - *Ulmus* - *Tilia*) sono indicate con segni convenzionali (vedi in alto alla figura).
A destra: diagramma della frequenza dei pollini di piante erbacee (composite, graminacee, ombrellifere, cariofillacee, ecc.) espressa in percentuale relativa alla somma delle essenze forestali dei corrispondenti livelli.

Last glacial times at Lago della Costa (AP2):

Long-term forest dynamics during the past 26,000 years at Colli Euganei (near Padova, Italy)

Kaltenrieder, P.[1]; Ammann, B.[1]; Ravazzi C.[2] & Tinner, W.[1]

[1] Institute of Plant Sciences, University of Bern, Altenbergrain 21, 3013 Bern, Switzerland.
[2] CNR - Centro Geodinamica Alpina e Quaternaria, Piazza Cittadella 4, 24129 Bergamo, Italy.

Forest dynamics such as immigration, expansion, and decline of tree taxa are of great interest but difficult to observe because of the long time scale involved. We focus on the time period between glacial times and the Late Holocene. It has generally been assumed that the glacial refugia for European deciduous tree species are located in Central or Southern Italy, the Iberian Peninsula and the Balkans.

The research will be linked to a large-scale inter-comparison along both, latitudinal and longitudinal transects through the Po Plain. The aim of this collaboration is a better understanding of the forest and climate dynamics during last glacial and postglacial times as well as the Holocene.

Our study site Lago della Costa (7m a.s.l., 45° 16' N, 11° 45' E) at Arqua Petrarca (Colli Euganei) is a small lake (3 ha) situated in the south eastern part of Colli Euganei (Padova, Southern Po Plain), a hill region of volcanic origin. On silicate sites *Quercus* woods are dominant including some Mediterranean elements; on northern aspects *Castanea sativa* is the main tree species, whereas on calcareous substrate *Ostrya* and *Quercus* stands are prevailing. The site is located outside the maximum extent of the last glaciation. Up to 30m of continuous cores have been recovered from the present and former lacustrine basin. Time control by AMS-radiocarbon dating (on terrestrial plant macrofossils) is important in order to estimate migration rates, establishment times and rates of population expansion. The recovered sediments date back to 22,800 ^{14}C yr BP (ca. 26,000 yr Cal. BP) and consist mostly of calcareous gyttja and lake marl with clay and silt layers. First results by means of pollen, plant macrofossils, LOI, and ostracods show rather complex patterns of varying Full and Late Glacial vegetational composition.

The sediment records of Arqua Petrarca provide a high temporal resolution series which can be compared with the ice-core d^{18}O records (e,g. GRIP, Dansgaard et. al., 1993). Based on our ^{14}C- chronology they appear to fall into the Interstadials 2 and 3 (22kyr/25kyr Cal. BP), if the GRIP core is used for comparison.

During the LGM, the palynostratigraphic record suggests a predominance of cold-steppe vegetation with the main herbaceous taxa of Poaceae, *Artemisia* and Chenopodiaceae. In addition, Pinus (20%) and Juniperus (10%) are the most important woody taxa. It is striking that pollen of thermophilous deciduous tree taxa is regularly present reaching total peak values of ca. 1% per taxa (e.g. *Tilia, Fraxinus, Quercus, Ulmus, Fagus, Carpinus*). Taken together the mixed oak forest pollen types reached ca. 4%. In addition, we found continuous pollen values of *Larix* with an average of 1-2%. In Southern Europe, *Quercus* percentages were higher only in Ioannina in northwest Greece, whereas the values of other thermophilous taxa (e.g. *Tilia, Fraxinus, Ulmus, Fagus, Carpinus*) did not exceed those of Arqua Petrarca neither in Greece nor in the Central and Southern Italian sites. The pollen were recovered from fine-detritus gyttja deposits, which indicates stable local environmental conditions. Our results suggest that the above-mentioned thermophilous taxa survived the last Full Glacial on favorable micro habitats (sheltered, humid sites) of the Colli Euganei region. This conclusion implies that the Colli Euganei are one of the northernmost refugial areas of thermophilous taxa of Europe.

DANSGAARD, W. JOHNSEN, S.J., CLAUSEN, H.B., DAHL-JENSEN, D., GUNDESTRUP, N.S., HAMMER, C.U., HVIDBERG, C.S., STEFFENSEN, J.P., SVEINSBJÖRNSDOTTIR, A.E., JOUZEL, J. & BOND, G., 1993. Evidence for general instability of past climate from a 250-kyr ice-core record. **Nature** 364: 218-220

Fig. 1: Pollen percentage diagram of AP2 (former lake). Empty curves show 10x exaggerations.

Fig. 2: Macrofossil concentration diagram and LOI (550°C and 950°C) of AP2 (former lake). Empty curves show 10x exaggerations. C= Chitin, F= fruits, FS= fruit scales, H= wood, L= leaves, MCS= male catkin scales, N=needles, O= Oogonia, OP= Operculi, P= periderm, S= seeds, SC= scale, SH= shells, SCHUPPE= fish scale, ST&L= Stem and leaves, TI= tissue, TT= teeth, TW= twig, WIRBEL= vertebra, WS= winged fruit

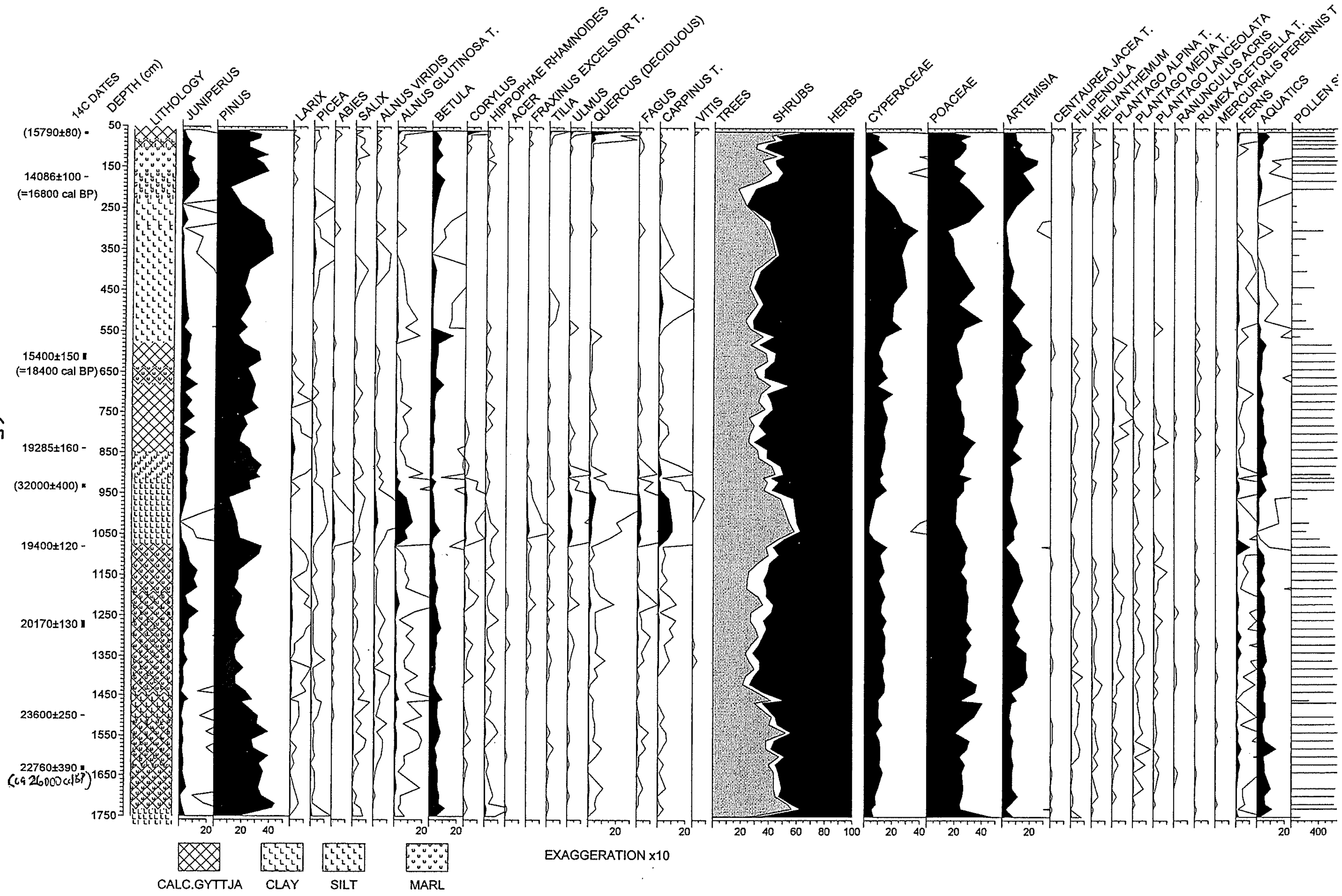

14C DATES
DEPTH (cm)
LITHOLOGY
JUNIPERUS
PINUS
LARIX
PICEA
ABIES
SALIX
ALNUS VIRIDIS
ALNUS GLUTINOSA T.
BETULA
CORYLUS
HIPPOPHAE RHAMNOIDES
ACER
FRAXINUS EXCELSIOR T.
TILIA
ULMUS
QUERCUS (DECIDUOUS)
FAGUS
CARPINUS T.
VITIS
TREES
SHRUBS
HERBS
CYPERACEAE
POACEAE
ARTEMISIA
CENTAUREA JACEA T.
FILIPENDULA
HELIANTHEMUM
PLANTAGO ALPINA T.
PLANTAGO MEDIA T.
PLANTAGO LANCEOLATA
RANUNCULUS ACRIS
RUMEX ACETOSELLA T.
MERCURIALIS PERENNIS T.
FERNS
AQUATICS
POLLEN S
(15790±80)
14086±100
(=16800 cal BP)
15400±150
(=18400 cal BP)
19285±160
(32000±400)
19400±120
20170±130
23600±250
22760±390
(c4 26000 cal BP)
50
150
250
350
450
550
650
750
850
950
1050
1150
1250
1350
1450
1550
1650
1750
EXAGGERATION x10
CALC.GYTTJA
CLAY
SILT
MARL

Fig. 1

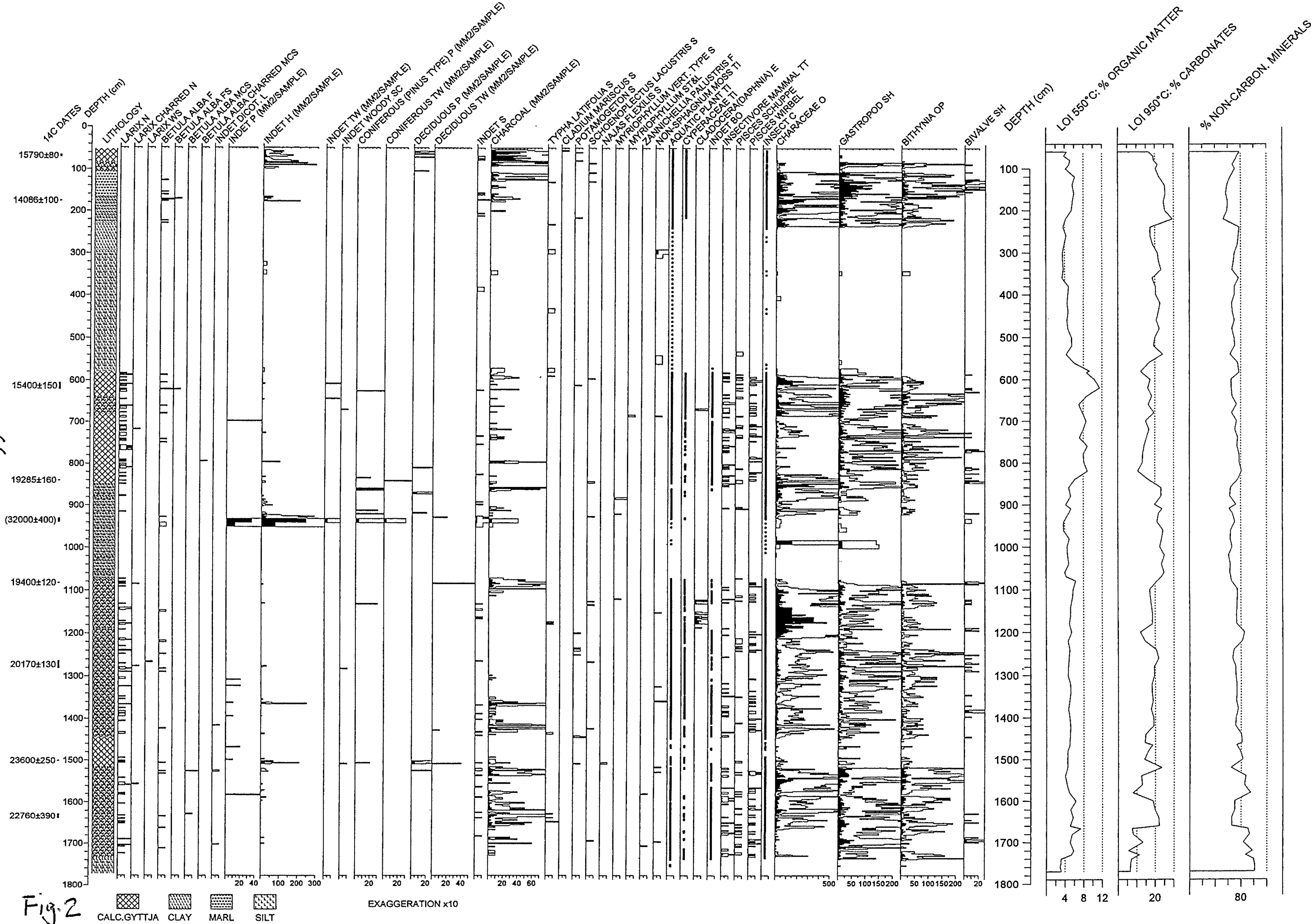
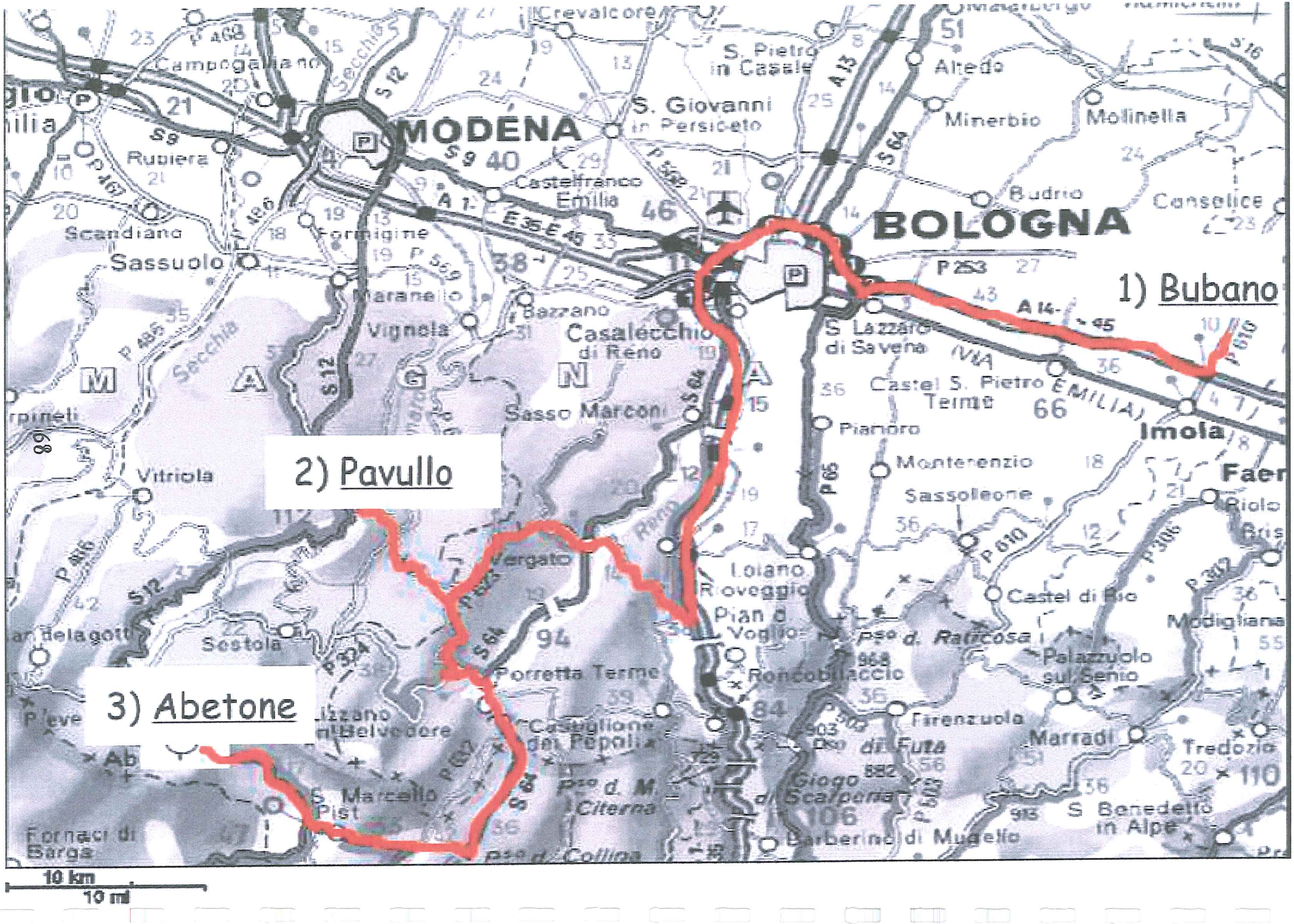

14C DATES
DEPTH (cm)
LITHOLOGY
LARIX N
LARIX CHARRED N
LARIX WS
BETULA ALBA F
BETULA ALBA FS
BETULA ALBA MCS
BETULA ALBA CHARRED MCS
INDET DICOT. L
INDET P (MM2/SAMPLE)
INDET H (MM2/SAMPLE)
INDET TW (MM2/SAMPLE)
INDET WOODY SC
CONIFEROUS (PINUS TYPE) P (MM2/SAMPLE)
CONIFEROUS TW (MM2/SAMPLE)
DECIDUOUS P (MM2/SAMPLE)
DECIDUOUS TW (MM2/SAMPLE)
INDET S
CHARCOAL (MM2/SAMPLE)
TYPHA LATIFOLIA S
CLADIUM MARISCUS S
POTAMOGETON S
SCHOENOPLECTUS LACUSTRIS S
NAJAS FLEXILIS S
MYRIOPHYLLUM VERT. TYPE S
ZANNICHELLIA PALUSTRIS F
NON-SPHAGNUM MOSS TI
AQUATIC PLANT TI
CYPERACEAE TI
CLADOCERA(DAPHNIA) E
INDET BO
INSECTIVORE MAMMAL TT
PISCES SCHUPPE
PISCES WIRBEL
INSECT C
CHARACEAE O
GASTROPOD SH
BITHYNIA OP
BIVALVE SH
DEPTH (cm)
LOI 550°C: % ORGANIC MATTER
LOI 950°C: % CARBONATES
% NON-CARBON. MINERALS
15790±80
14086±100
15400±150
19285±160
(32000±400)
19400±120
20170±130
23600±250
22760±390
CALC.GYTTJA
CLAY
MARL
SILT
EXAGGERATION x10

Fig. 2

99



1) Bubano
2) Pavullo
3) Abetone
MODENA
BOLOGNA
10 km
10 mi

Veget Hist Archaeobot (2006) 15: 357–371
DOI 10.1007/s00334-006-0055-9

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A new Late-glacial site with Picea abies in the northern Apennine foothills: an exception to the model of glacial refugia of trees

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Abstract We describe a new palaeobotanical site at Bubano quarry on the easternmost Po plain, northern Italy. Pollen and macrofossils from river and marsh sediments demonstrate the occurrence of *Picea* in a *Pinus sylvestris* forest growing in a radius of some tens of kilometres south of the sedimentation place, at the beginning of the Lateglacial interstadial. The Late-glacial and Holocene history of *Picea* in the northern Apennines is reconstructed on the basis of the palaeobotanical record. The sharp climatic continentality increase eastwards across the northern Apennines from the Tyrrhenian to the Adriatic coast is considered significant for the survival of *Picea* during the Late-glacial. The most critical phase of survival is related to the moisture changes and consequent *Abies* competition associated with the last glacial-interglacial transition and the early Holocene. The residual spruce populations expanded during the middle Holocene. The history of *Picea* in the northern Apennines is a case of ineffective interglacial spread of tree populations from pre-existing stands of LGM (Last Glacial Maximum) and Late-glacial age.

Keywords Plant migration . Quaternary refugia . Apennines . Late-glacial . *Picea abies*

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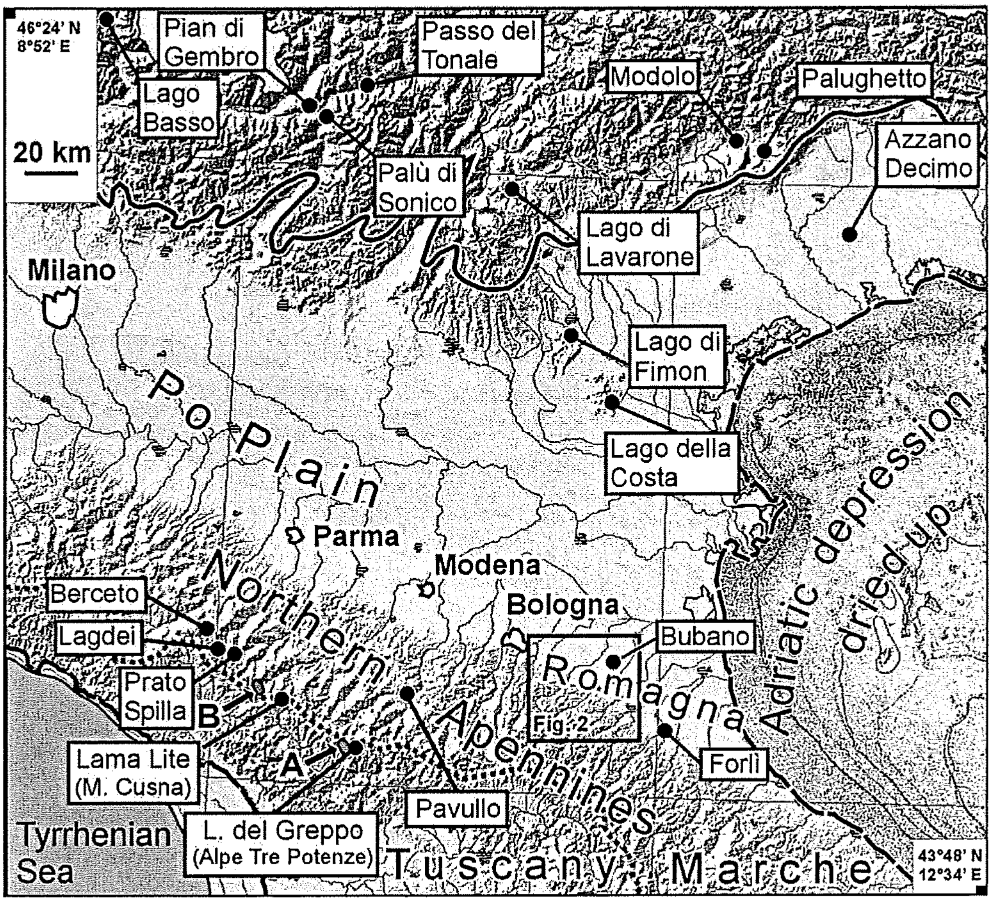

Fig. 1 Location of the Italian sites mentioned in the present paper. The solid line shows the present distribution limit of *Picea abies* at the southern Alpine border. Two isolated spruce spots known in the northern Apennines (Chiarugi 1936, 1958) are marked **A** (massif of Alpe delle Tre Potenze –Monte Cimone) and **B** (Passo del Cerreto, close to themassif ofMonte Cusna). The broken line shows the present coast. A sea level of -85mhas been adopted (from Lambeck et al. 2004) to show the Adriatic depression dried up and the coast of the Tyrrhenian Sea at about 14,500 cal b.p.

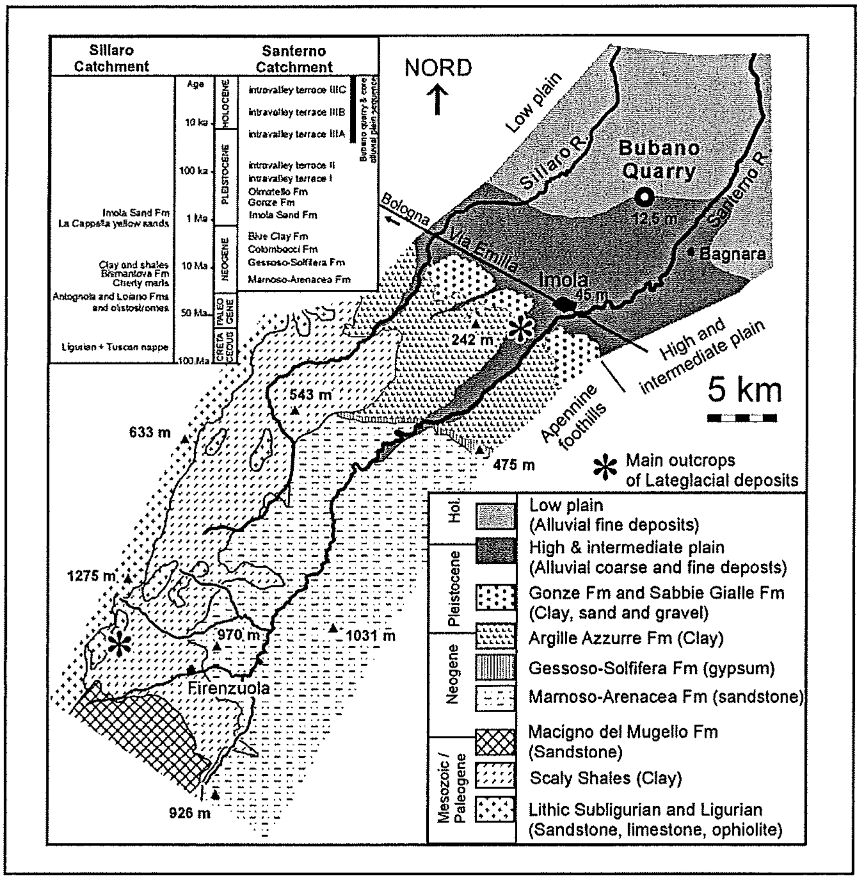

Fig. 2 Geological setting of the region of Imola, including the plain, Apennine foothills and Romagna Apennines (catchments of rivers Santerno and Sillaro); 2b: Stratigraphic columns of the Sillaro and Santerno river catchments

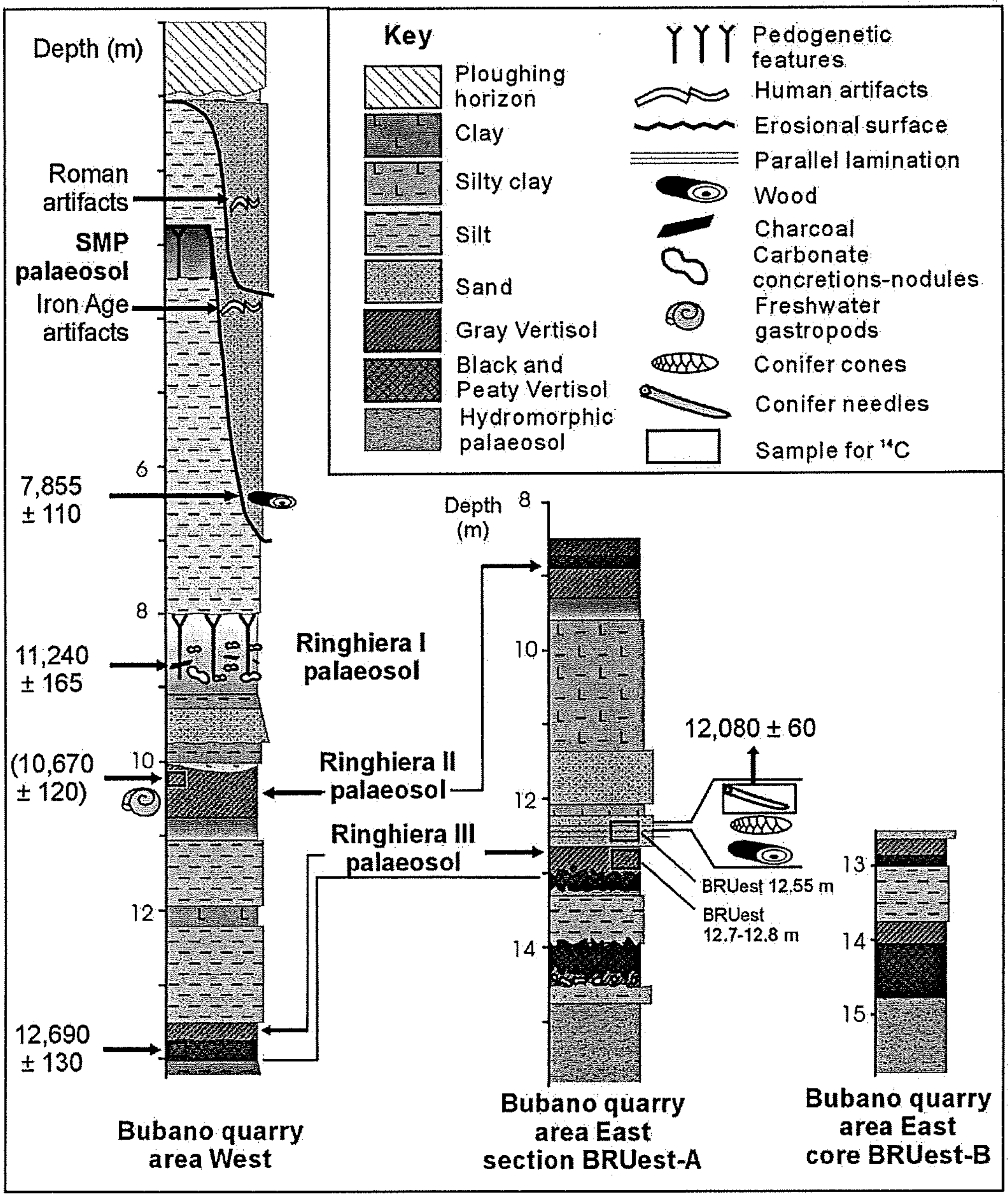

Fig. 3 Stratigraphy and correlation of the sections BRUwest and BRUest-A, and the core BRUest-B in the Bubano quarry. SMP = San Martino Palaeosol 2004).

Fig. 4 The exposure BRUest in the Bubano quarry (16 Dec. 2004)

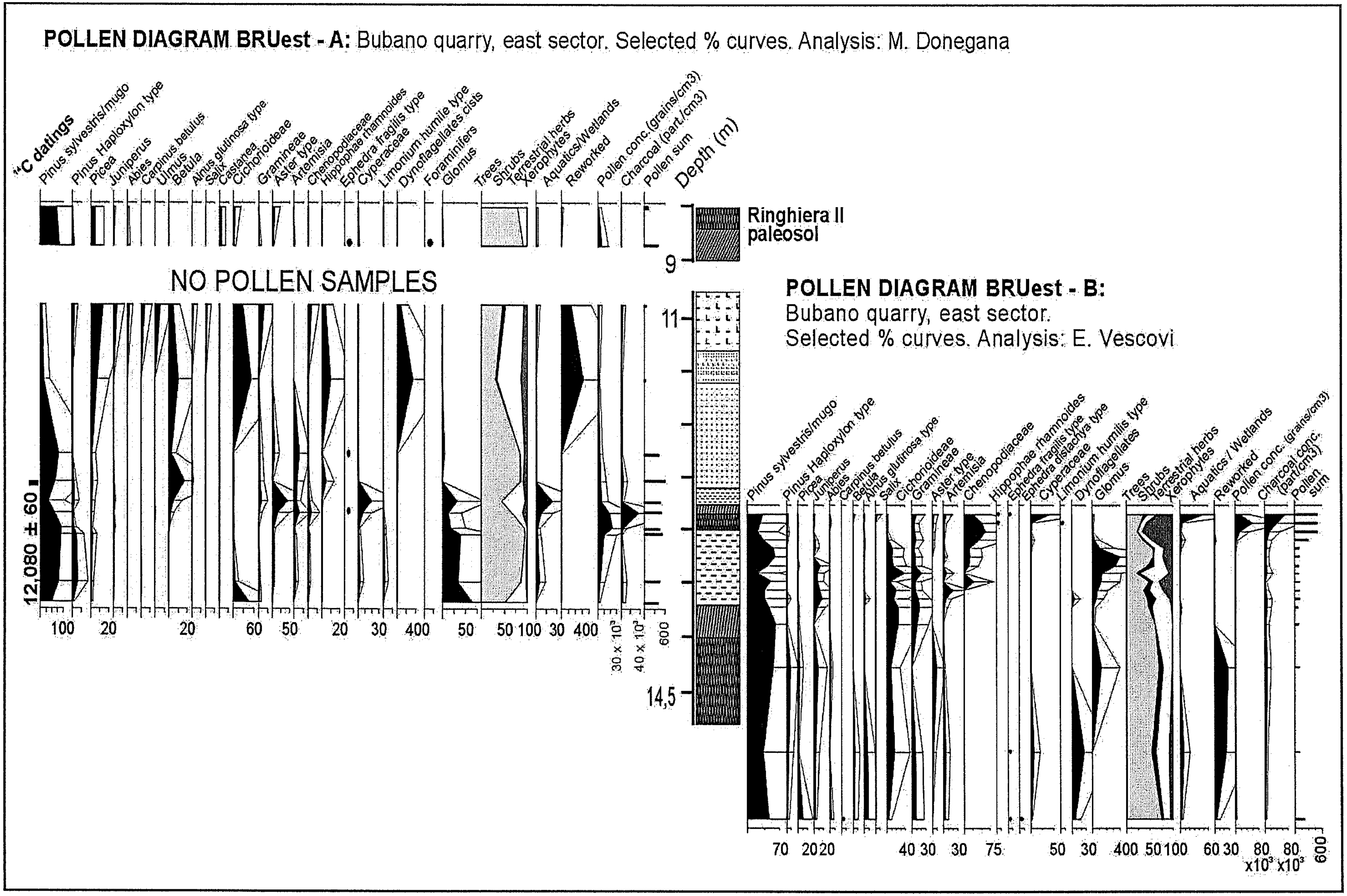

Fig. 5 Pollen diagrams from the section BRUest-A (*left*) and the core BRUest-B (*right*). Lithological patterns as in Fig. 3

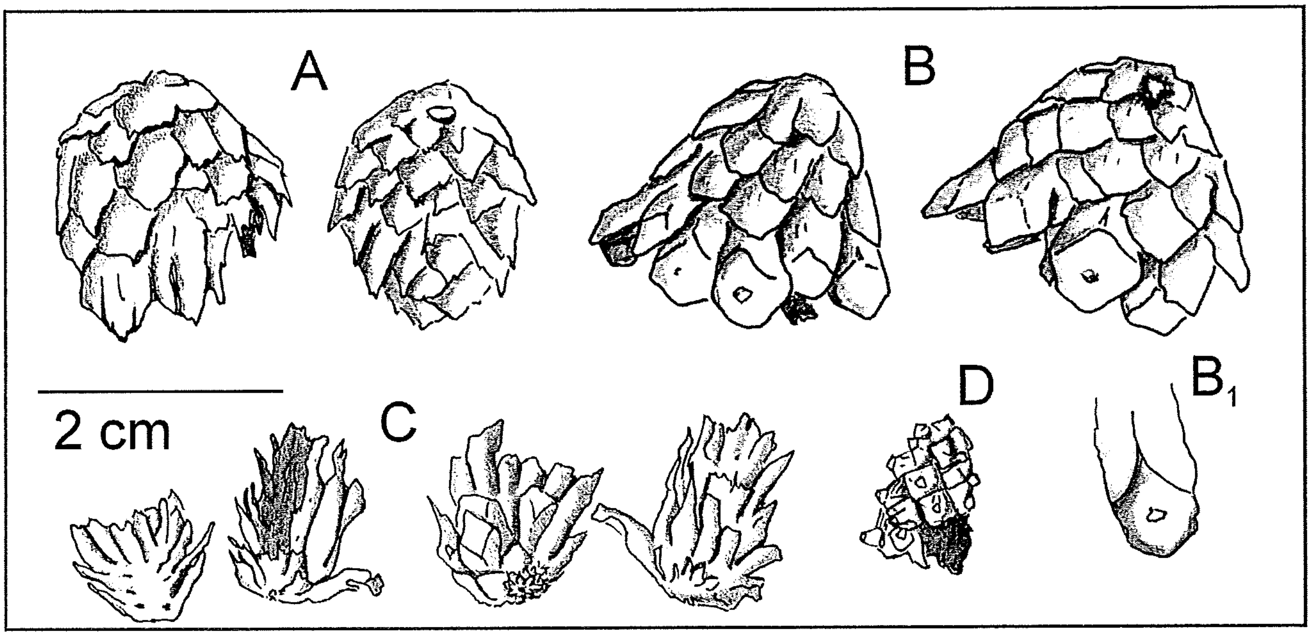

Fig. 6 Cone fragments of *Picea* (**A**) and *Pinus sylvestris* (**B, D**), detail of scale and apophysis (shield at the outer end of the cone scales) of *Pinus*

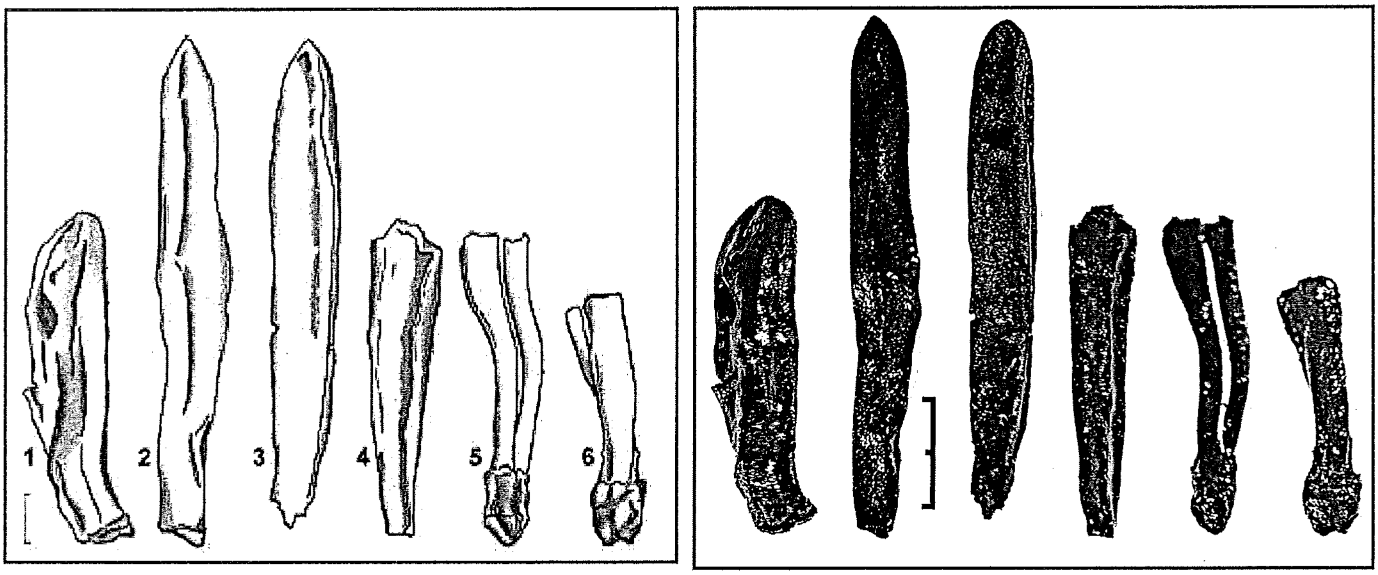

Fig. 7 Needles of *Picea* (1–4) and 2-needle short shoot of *Pinus* (5–6). From BRUest 12.55 m, dated 12080±60 b.p. Scale: 1 cm

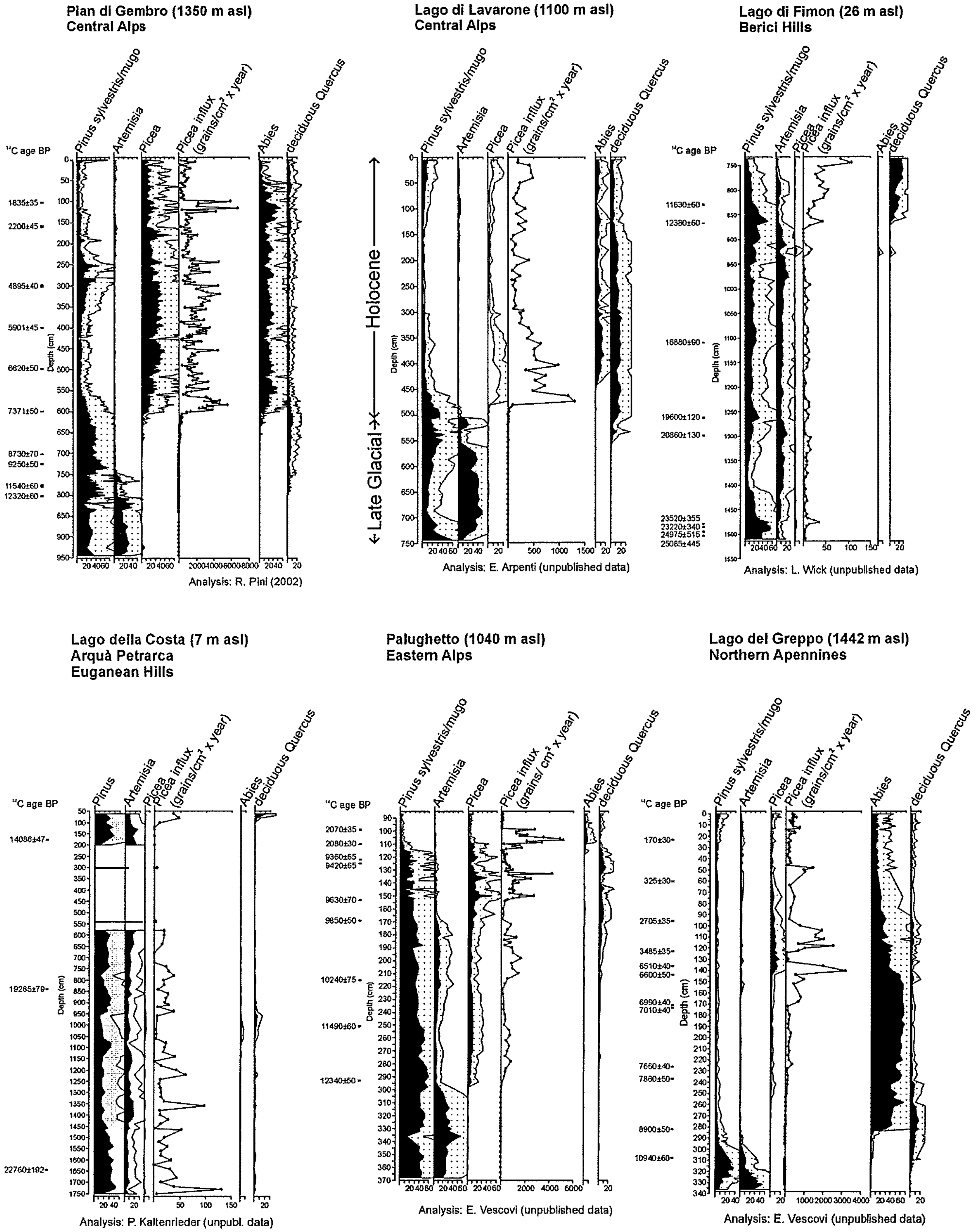

Fig. 9 Short pollen diagrams from sites recently investigated in the eastern part of northern Italy, showing selected pollen percentage curves and influx (site information in Fig. 1)

Vegetation history of a site in the northern foothills of the Apennines (Pavullo nel Frignano)

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Long sedimentary cores were retrieved in 2003 from the former swamp of Pavullo by using a Streif-Livingstone coring device. Ca. 12 m of sediments cover more than 14000 years as revealed by ^{14}C-AMS dates of terrestrial plant macrofossils. Open Late-Glacial forests or woods established before 14000 cal BP and were dominated by *Pinus* (probably *P. sylvestris*) and *Juniperus*. Thermophilous trees such as *Quercus, Ulmus,* and *Tilia* expanded already during the Late-Glacial (ca. 14000 cal BP), but did not form closed forests. This changed only at the onset of the Holocene at ca. 11500 cal BP, when *Abies alba* expanded and forests became finally dense. *Abies alba* was the dominant species over millennia, its decline at ca. 6000-5500 cal BP was associated with a marked opening of forests, an increase of human activities (e.g. *Plantago lanceolata*), and the expansion of deciduous forest trees such as *Fagus* and *Quercus*. Vegetational composition did not change substantially during the past 5000 years, and cultivated tree taxa such as *Juglans* and *Castanea* played only a transient or marginal role.

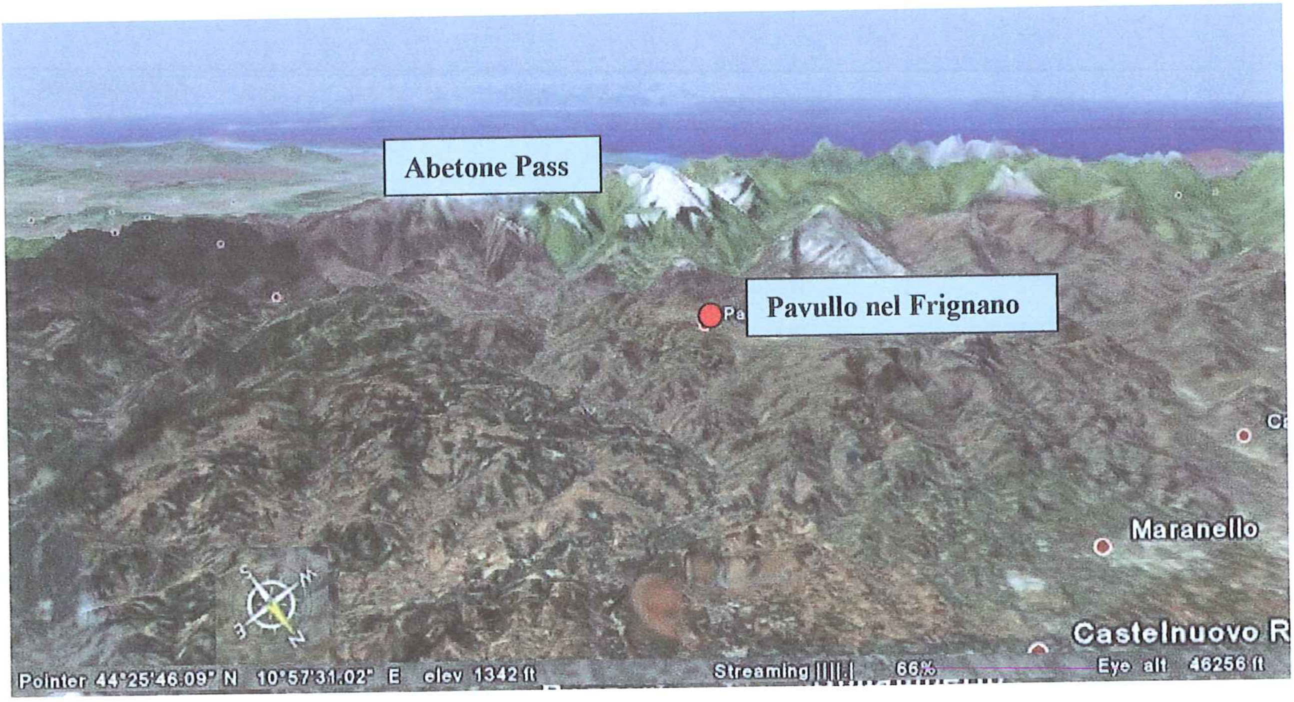


Fig.1 View of the Northern Apennines (image from Google Earth)

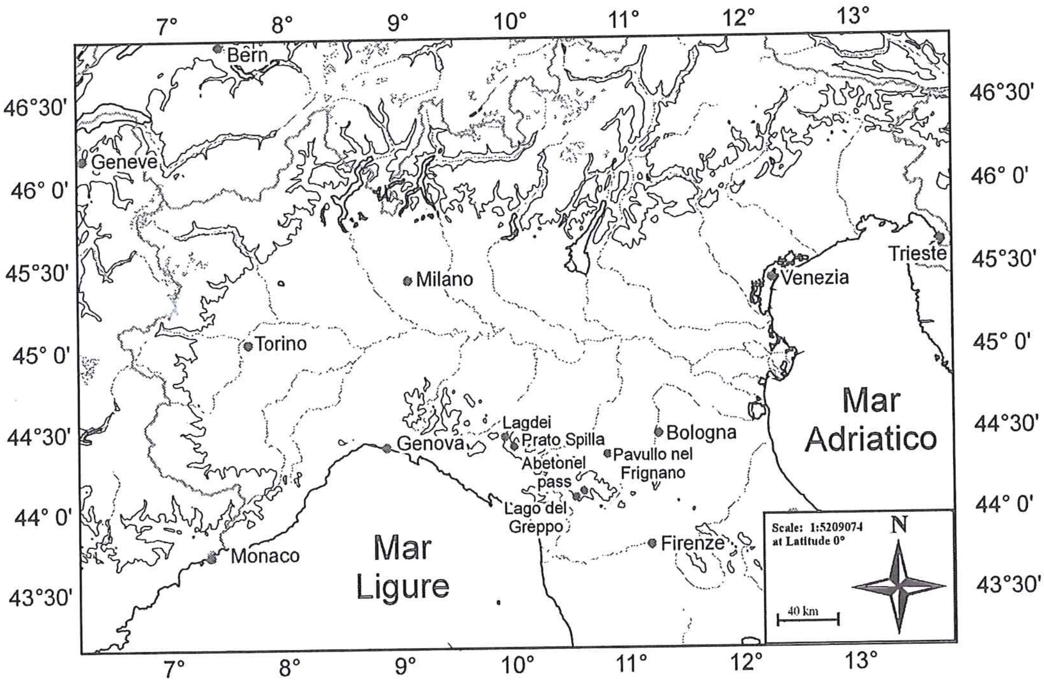


Fig.2 Location of the site

Lab nr	Depth (cm)	Analysed fraction	^{14}C yrs BP	Cal age BP (2σ range)	Age in diagram cal BP
Poz-16181	472-473	wood	3400 ± 30	3567 - 3718	3650
Poz-16182	606-607	branch	5060 ± 40	5669 - 5911	5817
Poz-11238	690	wood	5930 ± 40	6665 - 6878	6754
Poz-14770	775-776	wood	7740 ± 40	8431 - 8590	8515
Poz-16184	866-870	wood	9180 ± 50	10238 - 10493	10344
Poz-16186	1086-1087	wood	12100 ± 60	13806 - 14095	13951

Tab. 1 AMS-radiocarbon dates from Pavullo nel Frignano

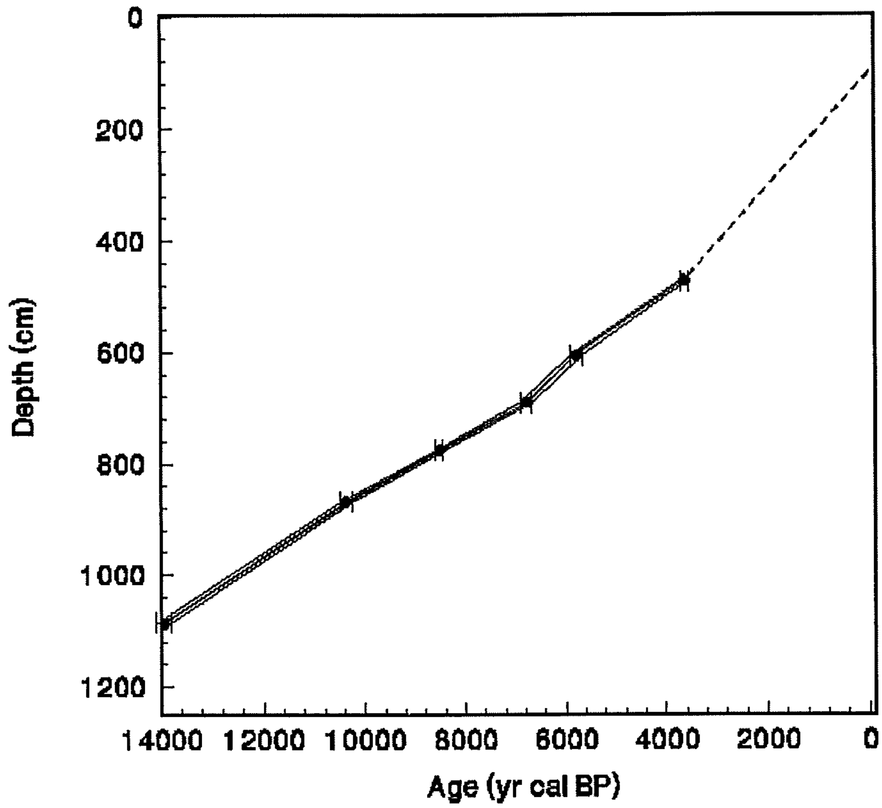
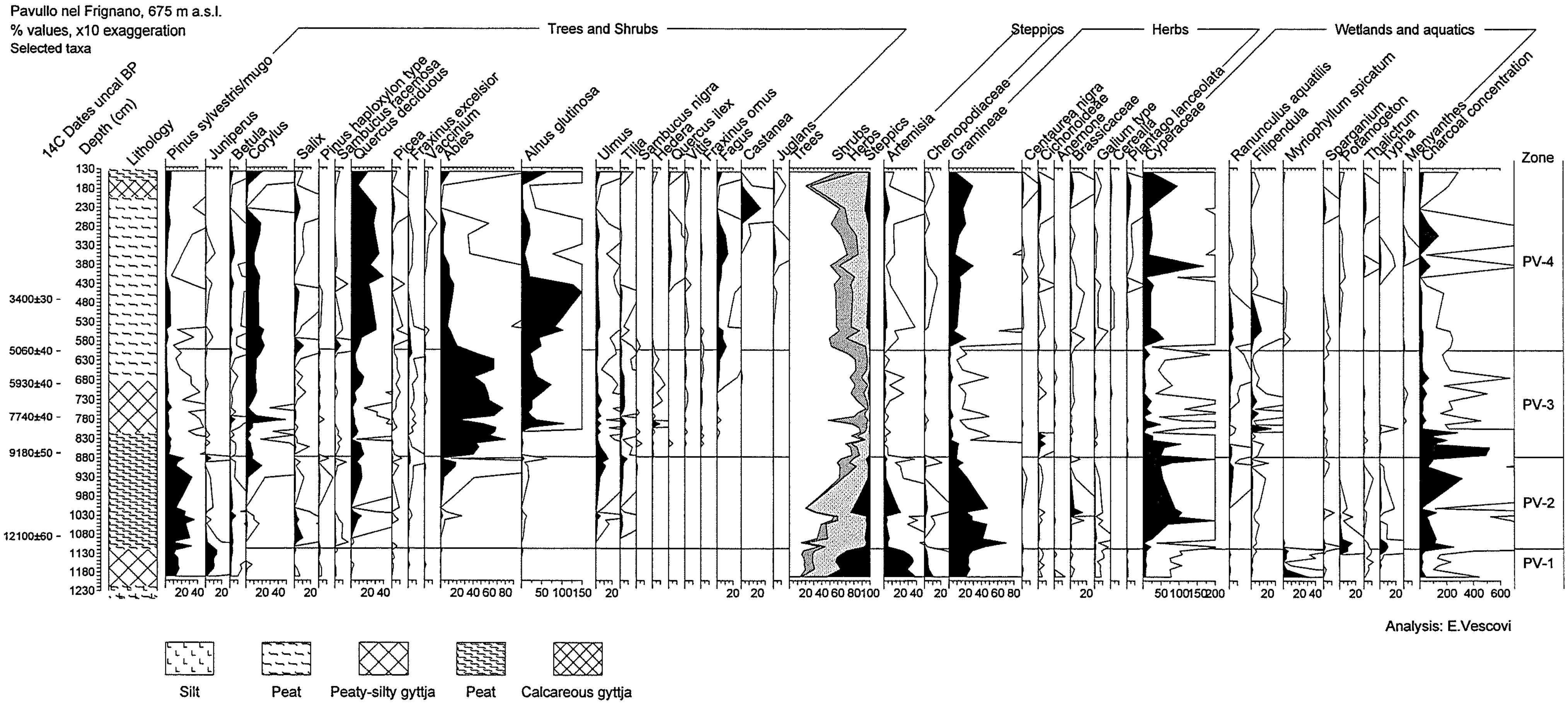


Fig.3 Depth-age model based on linear interpolation of calibrated radiocarbon years from Pavullo nel Frignano.



Pavullo nel Frignano, 675 m a.s.l.
% values, x10 exaggeration
Selected taxa
Trees and Shrubs
Steppics
Herbs
Wetlands and aquatics
14C Dates uncal BP
Depth (cm)
Lithology
Pinus sylvestris/mugo
Juniperus
Betula
Corylus
Salix
Pinus haploxylon type
Sambucus racemosa
Quercus deciduous
Picea
Fraxinus excelsior
Vaccinium
Abies
Alnus glutinosa
Ulmus
Tilia
Sambucus nigra
Hedera
Quercus ilex
Vitis
Fraxinus ornus
Fagus
Castanea
Juglans
Trees
Shrubs
Herbs
Steppics
Artemisia
Chenopodiaceae
Gramineae
Centaurea nigra
Cichorioideae
Anemone
Brassicaceae
Galium type
Cerealia
Plantago lanceolata
Cyperaceae
Ranunculus aquatilis
Filipendula
Myriophyllum spicatum
Sparganium
Potamogeton
Thalictrum
Typha
Menyanthes
Charcoal concentration
Zone
PV-4
PV-3
PV-2
PV-1
3400±30
5060±40
5930±40
7740±40
9180±50
12100±60
Analysis: E.Vescovi
Silt
Peat
Peaty-silty gyttja
Peat
Calcareous gyttja

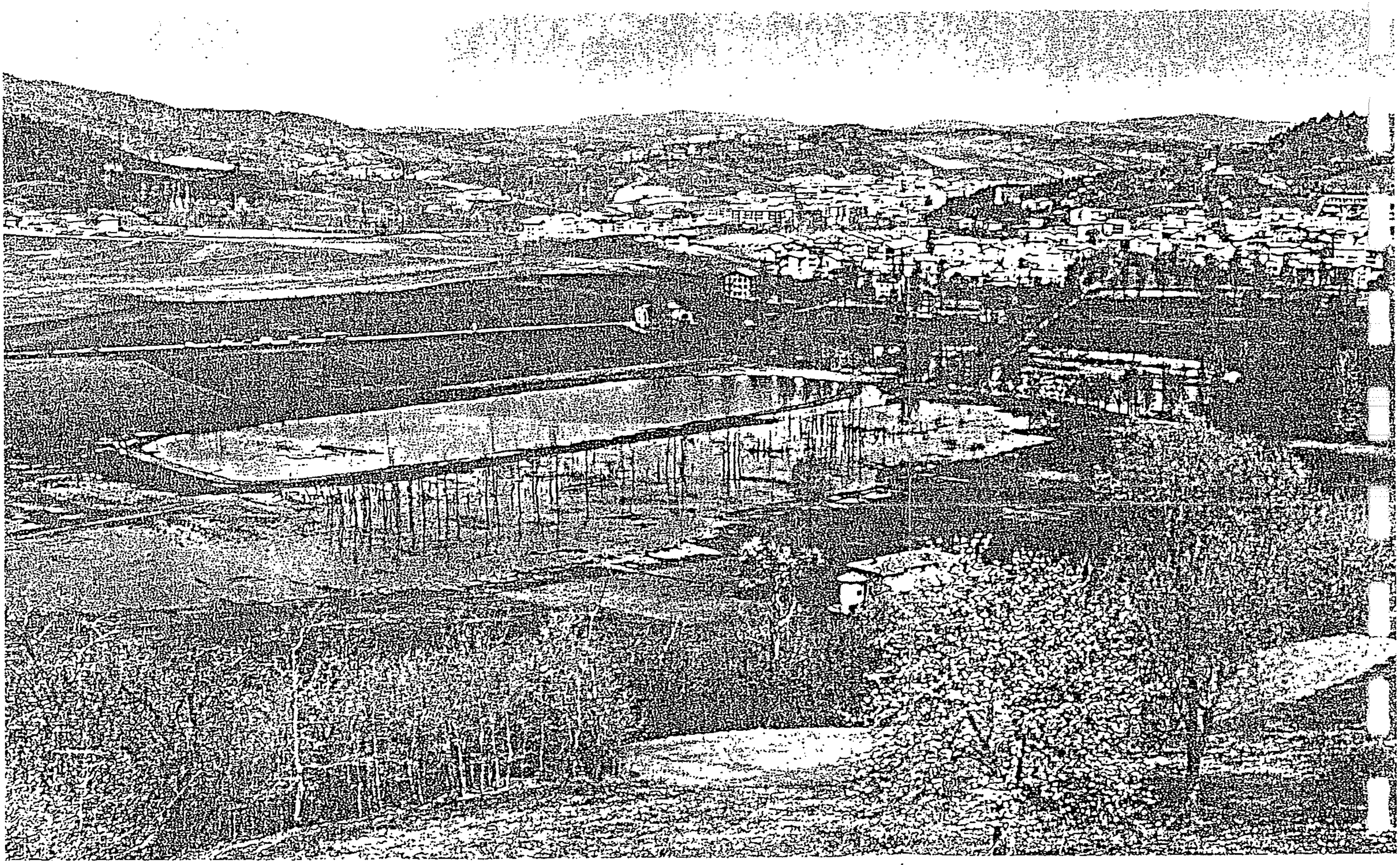


Fig 5 Historical picture of Pavullo (ca. 1980)


1) Abetone
2) Lago del Greppo
3) Lago di Massaciuccoli
4) Lago dell'Accesa
La Spezia
Sarzana
Riomaggiore
Marina di Carrara
Forte dei Marmi
Viareggio
Massarosa
Lucca
Montecatini Terme
Pistoia
Prato
Firenze
Altopascio
Fucecchio
Empoli
Montelupo Fiorentino
Castel del Bosco
Ponsacco
Livorno
A 12 E 80
Castiglioncello
Rosignano Solvay
Cecina
Volterra
Poggibonsi
TOSCANA
Siena
Pomarance
Monterotondo Marittimo
Follonica
Piombino
Punta Ala
Grosseto
SS 1/E 80
Montalcino
San Giovanni Valdarno
Marcello Pistoiese
Vaglia
Dicomano
n Sea
20 km

Late-Glacial and Holocene Vegetation History at Lago del Greppo Refugia of Picea

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The Late-glacial and Holocene vegetation history of the Northern Apennines has not been addressed in detail until recent time. The few pollen diagrams that had been published before the 1980s lacked fundamental information (e.g. ^{14}C datings, temporal and taxonomic resolution). Recent studies provide more reliable and detailed information, but high-resolution records equipped with ^{14}C datings on terrestrial plant macrofossils are still rare. Moreover most records cover only parts of the Holocene and only two sequences have a pre-holocenic record (Lagdei and Prato Spilla).

The Northern Apennines have been regarded as an area of potential refugia of some arboreal species (e.g. *Picea*). Nowadays *Picea abies* is present only in to two small areas near the divide between Parma and Tuscany (Toscana). One small population grows above the *Abies* belt at Alpe Tre Potenze, above the Abetone pass, between 1450 m and 1850 m of altitude. The area was investigated by Chiarugi in 1935 who on the basis of pollen data from lakes and mire hypothesized that spruce probably survived during the LGM in the Northern Apennines.Lago del Greppo (1442 m asl) is one of those lakes located on a small shelf on the northern slope of Monte Poggione. The bedrock is mainly made by the Macigno Formation . The present climate regime is cold temperate. Greppo lake is today surrounded by forests dominated by *Fagus sylvatica*, *Abies alba* and *Picea excelsa*, one of the two surviving spot of spruce in the Appenines. In September 2003 two parallel cores were taken in the peat bog in the south-western part of Lago del Greppo. Using a Streif modified Livingstone piston corer (Merkt and Streif 1970) we reached a maximum depth of 350 cm. A short core was taken from the centre of the lake.

After the coring, a careful description of the stratigraphy of the cores was done and the cores were sampled for pollen, loss-on-ignition (LOI), ^{14}C and ancient DNA analysis. The chronology, stratigraphy and pollen results are summarised in the pollen diagrams and provide useful information about the vegetation history of this site during the past 14000-13000 years. Late-Glacial forests established before 13000 cal BP and were dominated by *Pinus* and *Betula*, whereas more thermophilous taxa such as *Corylus*, *Quercus*, *Salix*, *Tilia* and *Ulmus* were already present. *Abies* and *Picea* expanded at the onset of the Holocene at ca. 11500 cal BP. *Fagus sylvatica* expanded as the last important species at ca. 6500 cal BP after the decline of *Abies*. It is striking to see how low human impact was throughout the Holocene and how closed the forests remained until the most recent time (ca. 1700-1800 AD).

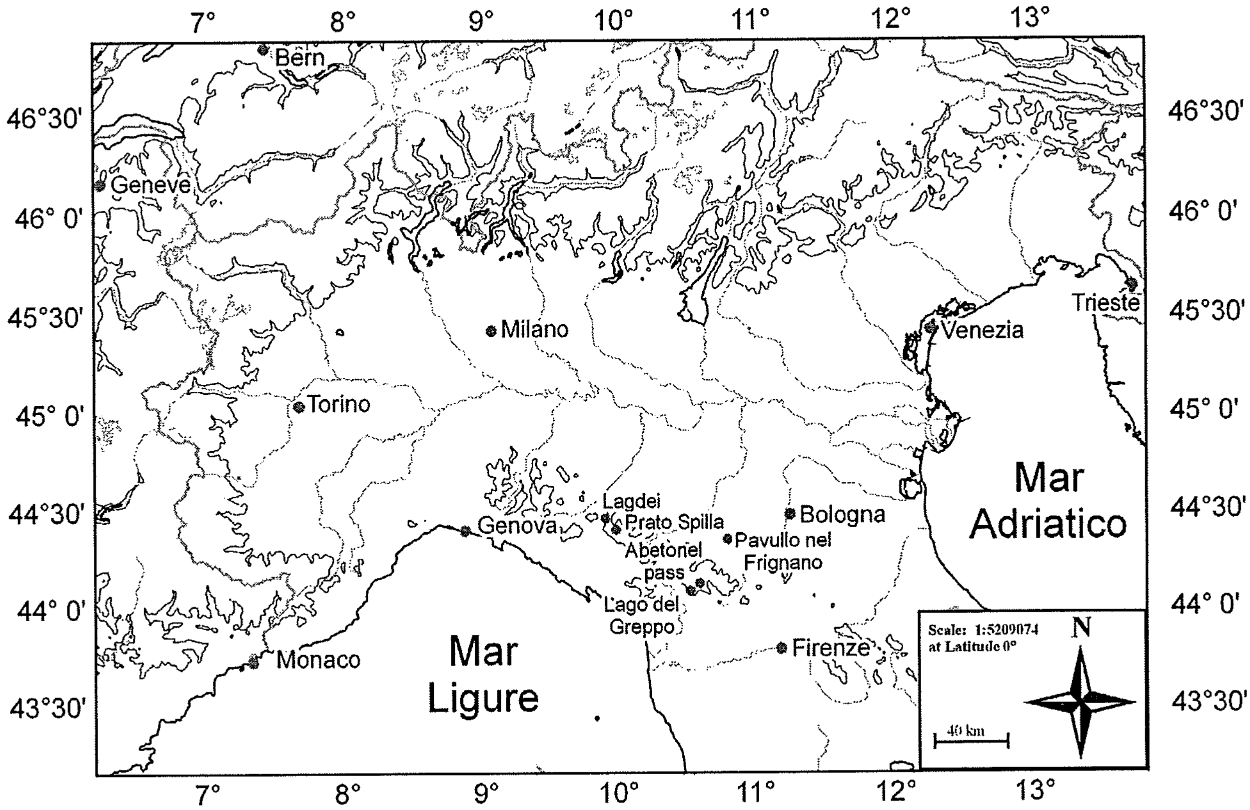


Fig.1 Location of the site

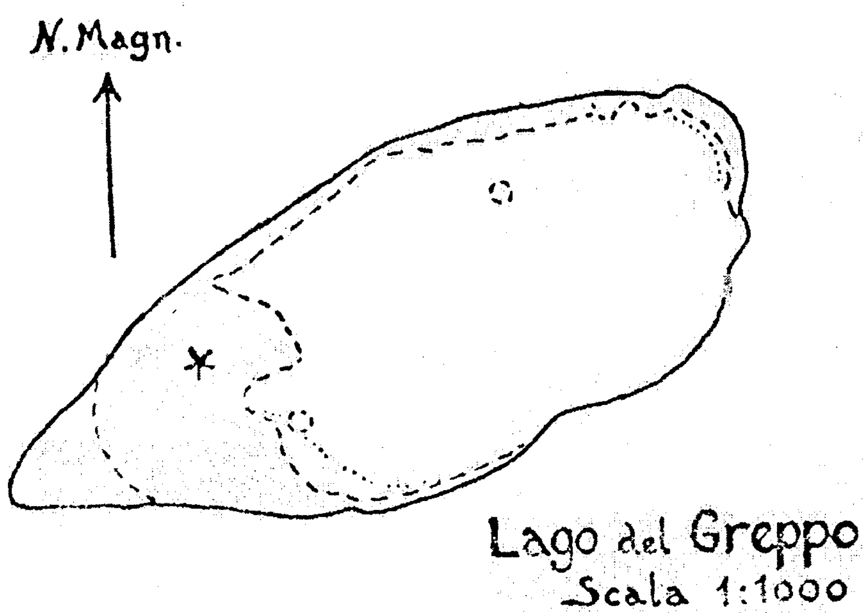


Fig.2 Draft of Lago del Greppo(from Chiarugi, 1936)

Lab nr	Depth (cm)	Analysed fraction	^{14}C yrs BP	Est. age (Age cal BP)	Age in diagram (Age cal BP)
Poz-9851	23	cone scale of *Abies*	170±30	-888 - 857	-15
Poz-6511	60	twig of shrub	325±30	-254 - 1447	597
Poz-9849	96	*Abies* needles	2705±35	2047 - 3450	2749
Poz-11173	122	needles of *Abies*	3955±35	4227 - 5740	4983
Poz-9922	144	cone scale and needles of *Abies*	6600±50	6108 - 7556	6832
Poz-6515	171	needles of *Abies*	6990±40	7170 - 8824	7948
Poz-6510	173	needles of *Abies*	7010±40	7162 - 8818	7988
Poz-6516	226	needles of *Abies*	7660±40	7684 - 9304	8494
Poz-6517	239	needles of *Abies*	7860±50	7818 - 9711	8765
Poz-6518	284	needles of *Abies*	8900±50	9758 - 11913	10835
Poz-6520	310	needles of *Juniperus*	10940±60	11554 - 13548	12551

Tab1 AMS-radiocarbon dates from Lago del Greppo

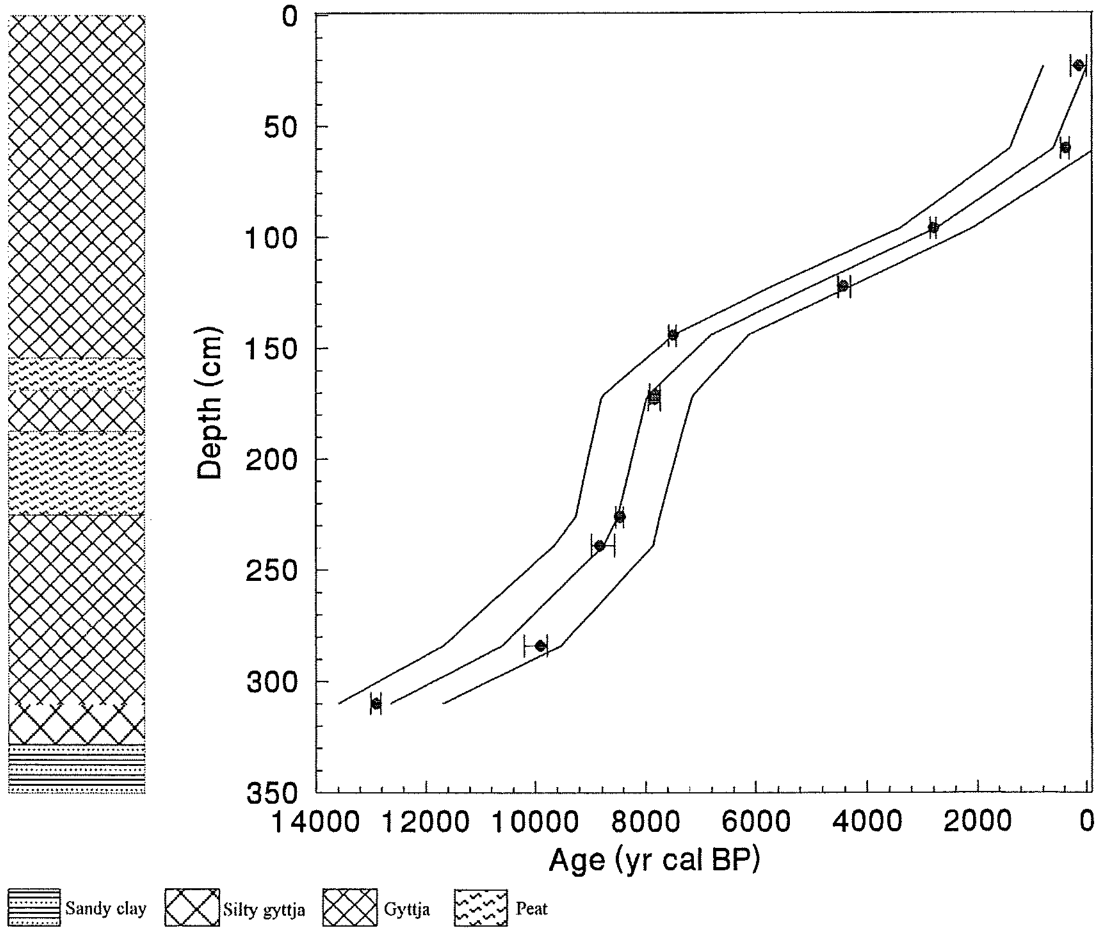


Fig.3 Depth age model

Fig 4 Pollen diagram from Lago Baccioli and Lago del Greppo (from Chiaurgi, 1936)

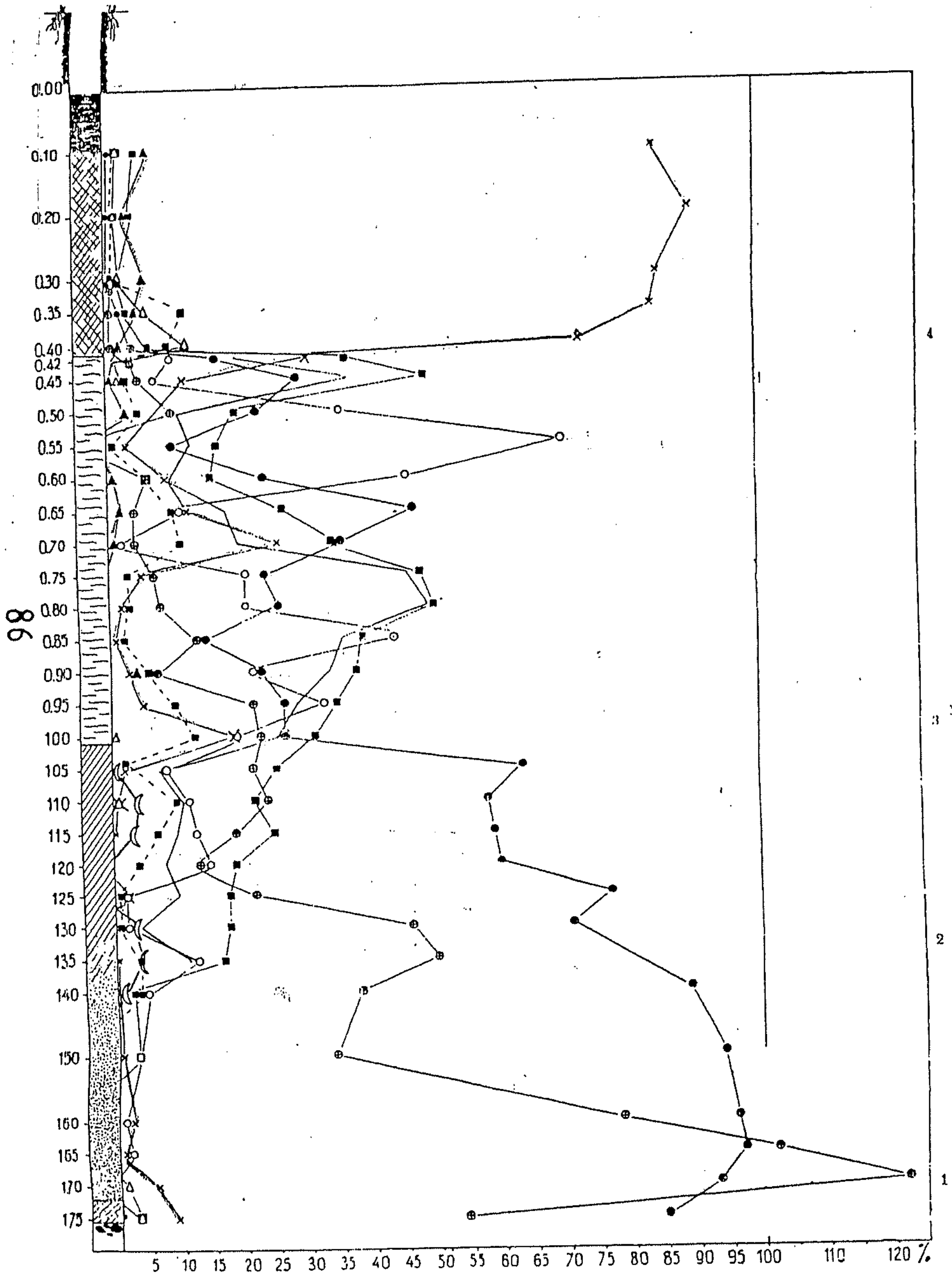


Fig. 3. — Diagramma pollinico della torbiera e dei sedimenti lacustri del Lago Baccioli (m. 1295). I numeri a destra indicano gli orizzonti limiti, come nella fig. 12.

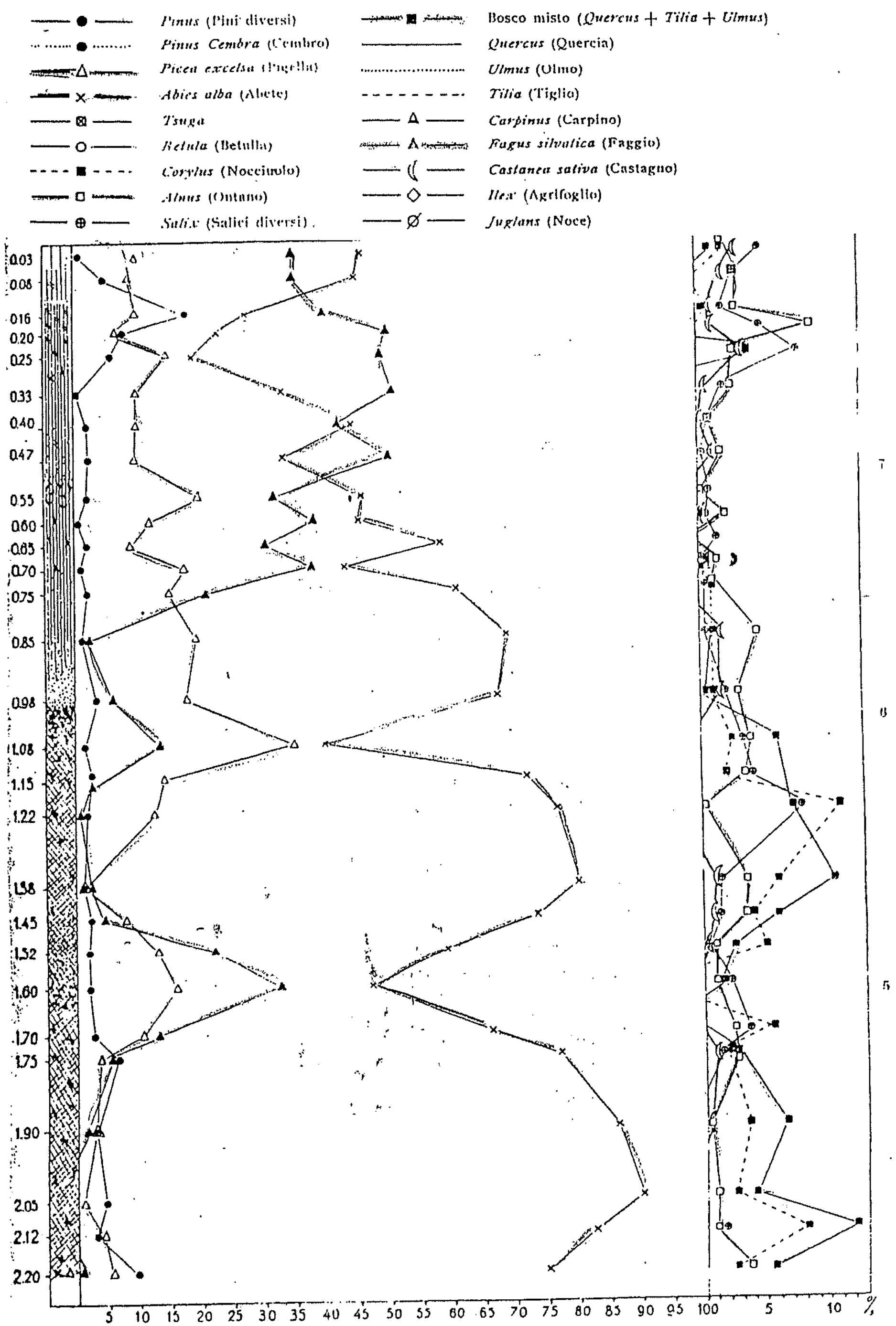
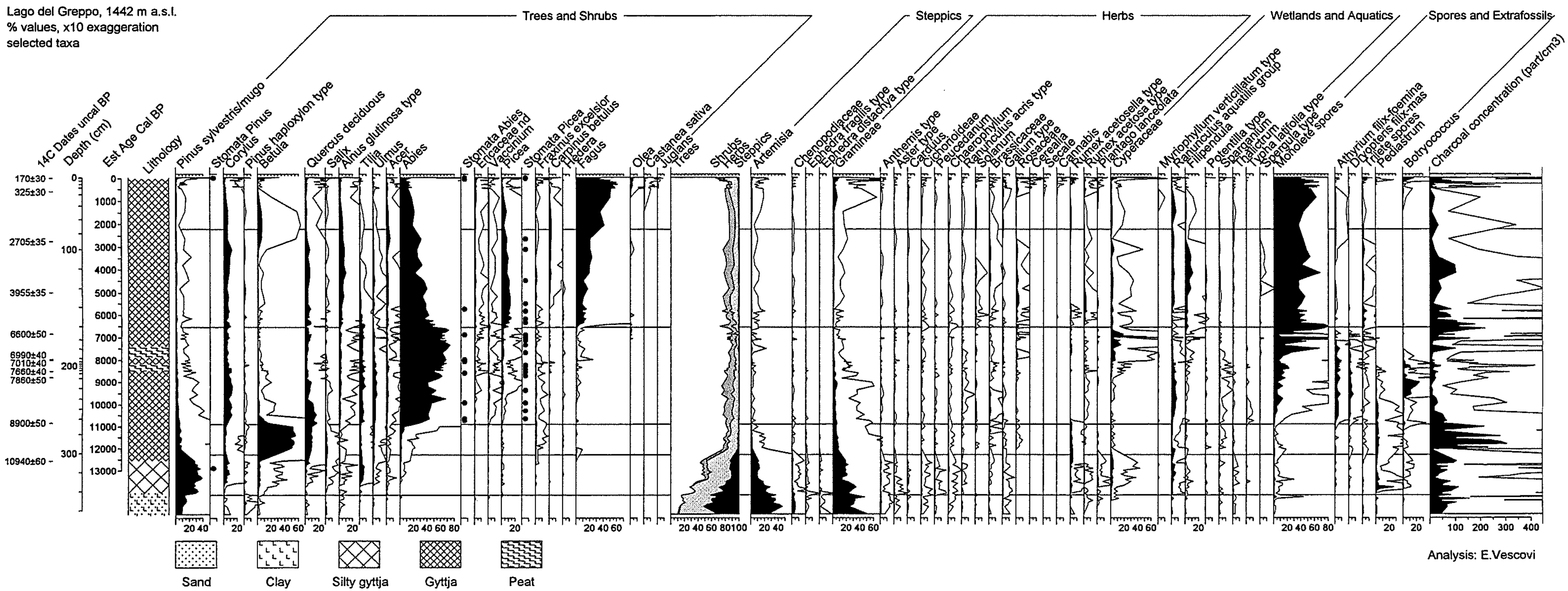


Fig. 5. — Diagramma pollinico della torbiera del Lago del Greppo (m. 1442). I numeri a destra indicano gli orizzonti limite, come nella fig. 12.


Lago del Greppo, 1442 m a.s.l.
% values, x10 exaggeration
selected taxa
Trees and Shrubs
Steppics
Herbs
Wetlands and Aquatics
Spores and Extrafossils
14C Dates uncal BP
Depth (cm)
Est Age Cal BP
Lithology
Pinus sylvestris/mugo
Stomata Pinus
Corylus
Pinus haploxylon type
Betula
Quercus deciduous
Salix
Alnus glutinosa type
Tilia
Ulmus
Acer
Abies
Stomata Abies
Ericaceae nd
Vaccinium
Picea
Stomata Picea
Fraxinus excelsior
Carpinus betulus
Hedera
Fagus
Olea
Castanea sativa
Juglans
Trees
Shrubs
Herbs
Steppics
Artemisia
Chenopodiaceae
Ephedra fragilis type
Ephedra distachya type
Gramineae
Anthemis type
Aster type
Carduus
Cichorioideae
Peucedanum
Chaerophyllum
Ranunculus acris type
Solanum
Brassicaceae
Galium type
Rosaceae
Cerealia
Secale
Cannabis
Rumex acetosella type
Rumex acetosa type
Plantago lanceolata
Cyperaceae
Myriophyllum verticillatum type
Ranunculus aquatilis group
Filipendula
Potentilla type
Sparganium
Thalictrum
Typha latifolia type
Spergula type
Monolete spores
Athyrium filix-foemina
Dryopteris filix-mas
Trilete spores
Pediastrum
Botryococcus
Charcoal concentration (part/cm3)
170±30
325±30
2705±35
3955±35
6600±50
6990±40
7010±40
7660±40
7860±50
8900±50
10940±60
Sand
Clay
Silty gyttja
Gyttja
Peat
Analysis: E.Vescovi

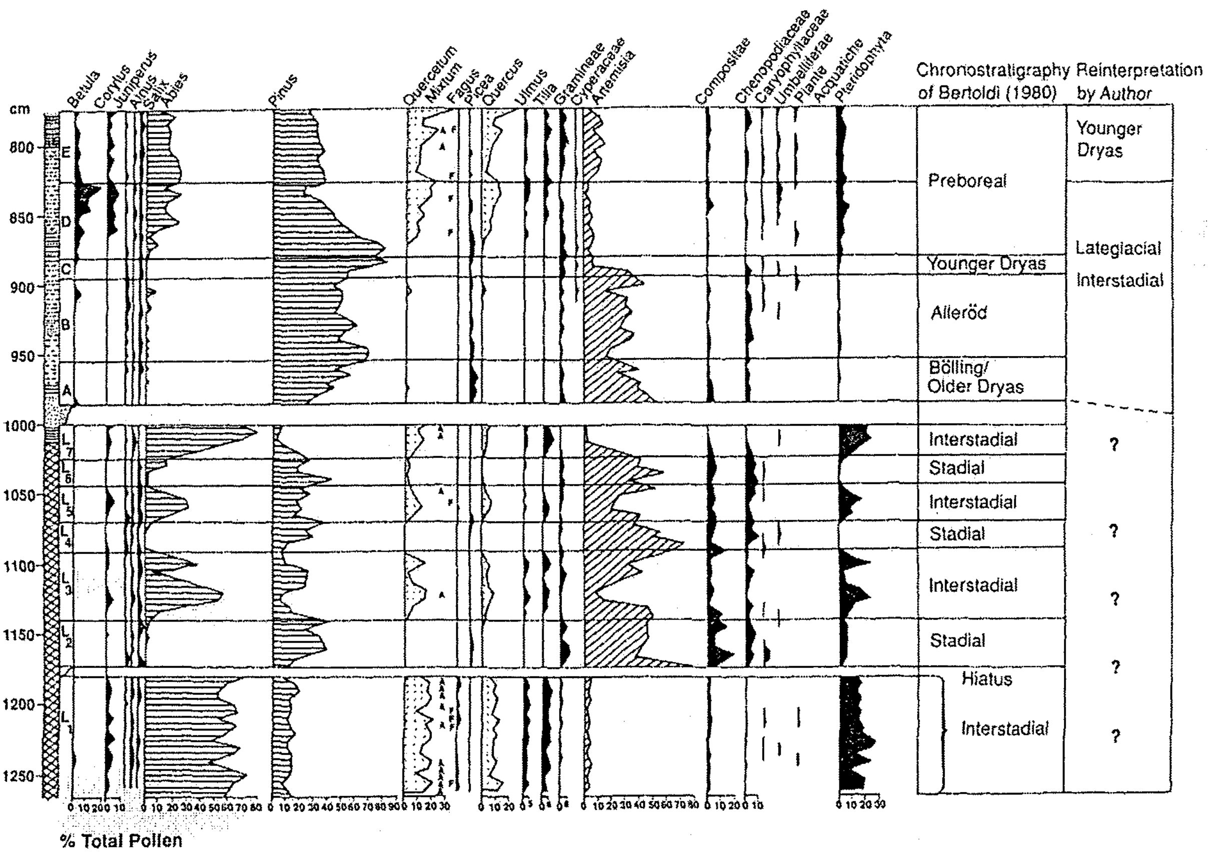


Fig 6 Pollen diagram of lowermost sediments of Lagdei (1254 m a.s.l.), Appennino Parmense (from Bertoldi, 1980)

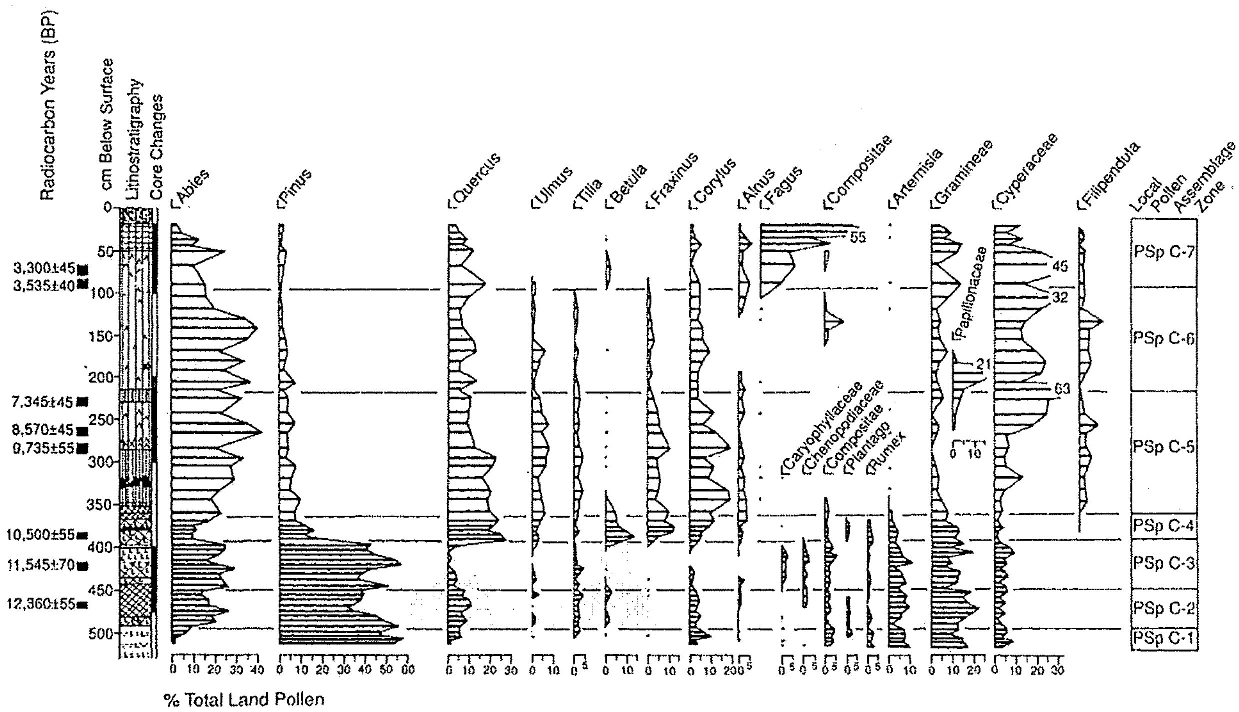


Fig 7 Pollen diagram from Prato Spilla C (1350 m a.s.l.), Appennino Parmense (from Lowe, 1952)

Palaeoenvironmental aspects of the basin of Lago di Massaciuccoli

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The Massaciuccoli Lake basin (NW Tuscany) has been considered for a long time the most important biostratigraphical archive for the investigation on the landscape history of the Ligurian and North Tuscany coastal area.

The basin (fig. 1) is situated few kilometers far from the sea shoreline, between the mouths of the Arno River and the Magra River and is characterised by complex dune systems and by numerous inland wetlands, today widely reduced by repeated drainage practices for agricultural exploitation. The recent asset has a relatively recent development, probably starting at the end of the Post-glacial sea level rise. The territory has been interested by numerous marine ingressions, and has passed through lagoon and fresh water marsh phases (Federici, 1993).

The climate is essentially Mediterranean, influenced by the proximity of the sea that mitigates the temperature excursions, making this area a natural conservative refuge for many interesting species and maintains relict palaeo-microecosystems, such as the interesting *Sphagno-Droseretum rotundifoliae* Tomei, Guazzi, Barsanti (1997).

The Massaciuccoli Lake basin is formed by a mosaic of different habitats, that varies according to the distance from the sea, the depth of the water table and the nature of the soils. It is therefore a generalization to identify this area simply as a wetland and consider it as a homogeneous environment.

Currently, the flora and vegetation of this plain are very variable (Arrigoni, 1990; Corti, 1955; Gellini et al., 1986; Montelucci, 1964; Garbari, 2000; Tomei et al., 1986, 1995), in accordance with the coexistence of various habitats. The coastal sandy soils are characterized by the presence of *Cakile maritima* Scop., and *Ammophila littoralis* (Beauv.) Rothm. The fresh water areas are inhabited by *Phragmites australis* (Cav.) Trin., *Cladium mariscus* (L.) Pohl, *Typha angustifolia* L., and *Carex elata* All. On the consolidated dunes, *Juniperus oxycedrus* L. subsp. *macrocarpa* (S. et S.) Ball, and *J. communis* L. appear, followed by *Quercus ilex* L. in the most drained soils. In the interdunal areas, the vegetation is formed by thickets of *Quercus robur* L. and *Carpinus betulus* L.; *Fraxinus oxycarpa* Bieb., or alternatively *Populus alba* L. together with *Alnus glutinosa* (L.) Gaertner, and *Ulmus minor* Miller, are diffused on the wet soils.

In 1998, a 90 m long drilling (MSC) carried out in the Massaciuccoli Lake basin (fig. 1) offered material for geological investigations (Antonioli et al., 2000; Lambeck et al., 2004) and pollen analysis, improving the knowledge of the Late Pleistocene and Holocene vegetation history around this coastal plain.

In this core, continental and marine sediments, the latter sandy or gravely in nature, alternate as in all the Versilian plain: between 90 and 70 m, the MSC stratigraphical sequence is characterised by marine levels dated back to MIS 5.5; between 70 and 30 m silt and clay deposits suggest a continental environment; from 30 to 9 m marine sands newly appear in the sequence and denote an Holocene marine ingression in the Massaciuccoli basin; from 9 to 7 m sandy muds characterise the sequence and point out to lagoonal deposition; the upper 7 m of the core are represented by alternating peat and clay layers indicating freshwater environments. The alternation of continental and marine deposition is to refer to variations of the sea level that can provoke marine ingressions and influence the depth of the water table, with the consequent formation of swampy or lagoonal brackish environments (Antonioli et al., 2000).

Other two shorter cores drilled near the lake banks allow improving the study of the most recent basin history (fig. 1).

The interest in this study is double: 1. the general reconstruction of the history of the territory, as already said; 2. the local vicissitudes of the human communities, for long time living around the lake.

1. The first pollen survey on the MSC core (Menozzi et al., 2003; fig. 2) revealed that the arboreal cover has never disappeared in the area, although it underwent changes, especially quantitative. Deciduous broadleaved trees, such as *Quercus*, are continuously represented, even when cooler elements, such as *Pinus mugo-sylvestris*, dominated. Therefore, the analysis reveals that the global climate changes have not assumed in this area the marked character observable in other parts of central Italy.

Sea level variations deeply affected this coastal plain producing the spread of salty or fresh water bodies and the decrease of the arboreal cover.

The supposed occurrence of wetlands along this part of the coast has been well evidenced, whereas the Mediterranean evergreen vegetation resulted very scanty represented, anyhow less than it was expected.

2. The area has been inhabited at least since the Middle and Upper Palaeolithic period, as testified

by the artefacts found in the sand quarry of Massaciuccoli; other materials document the practically uninterrupted human presence in the area till today. During the Roman times, the territory was subjected to repeated drainages, and interested by quarry activities. A villa dating to I century A.D., including a thermal complex, terraces, and wide green spaces is located at Massarosa (LU), near the lake bank.

In the pollen spectra, human impact is evident particularly at 4000-3000 years B.P., when traces of cutting activities were accompanied by noticeable pollen percentages of *Vitis* suggesting an early agricultural practice favouring this native plant.

It is also probable that the diffusion of the Mediterranean evergreen vegetation in the Holocene was favoured by exploitation of deciduous woodlands.

The comparison among the results of the pollen analyses of the three cores underlines the patchiness of the landscape: particularly, wetlands are very differently evidenced. The same is observed with regards to human impact, which however includes grapevine favouring or cultivation.

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Fig. 1: Geographical location of the Massaciuccoli basin. Stars indicate the drilling points.

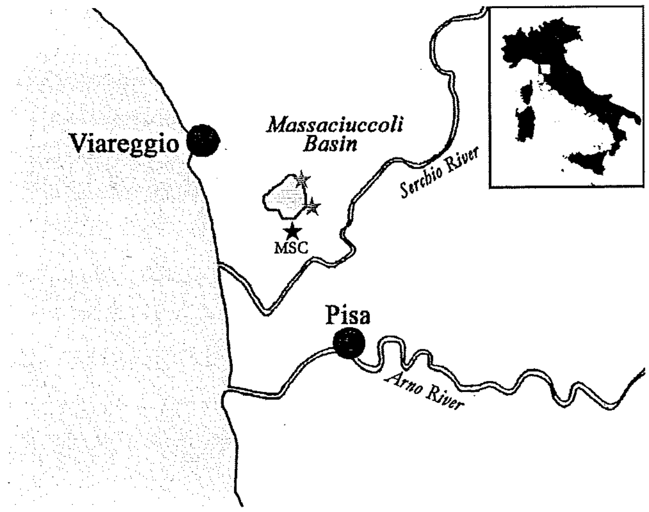
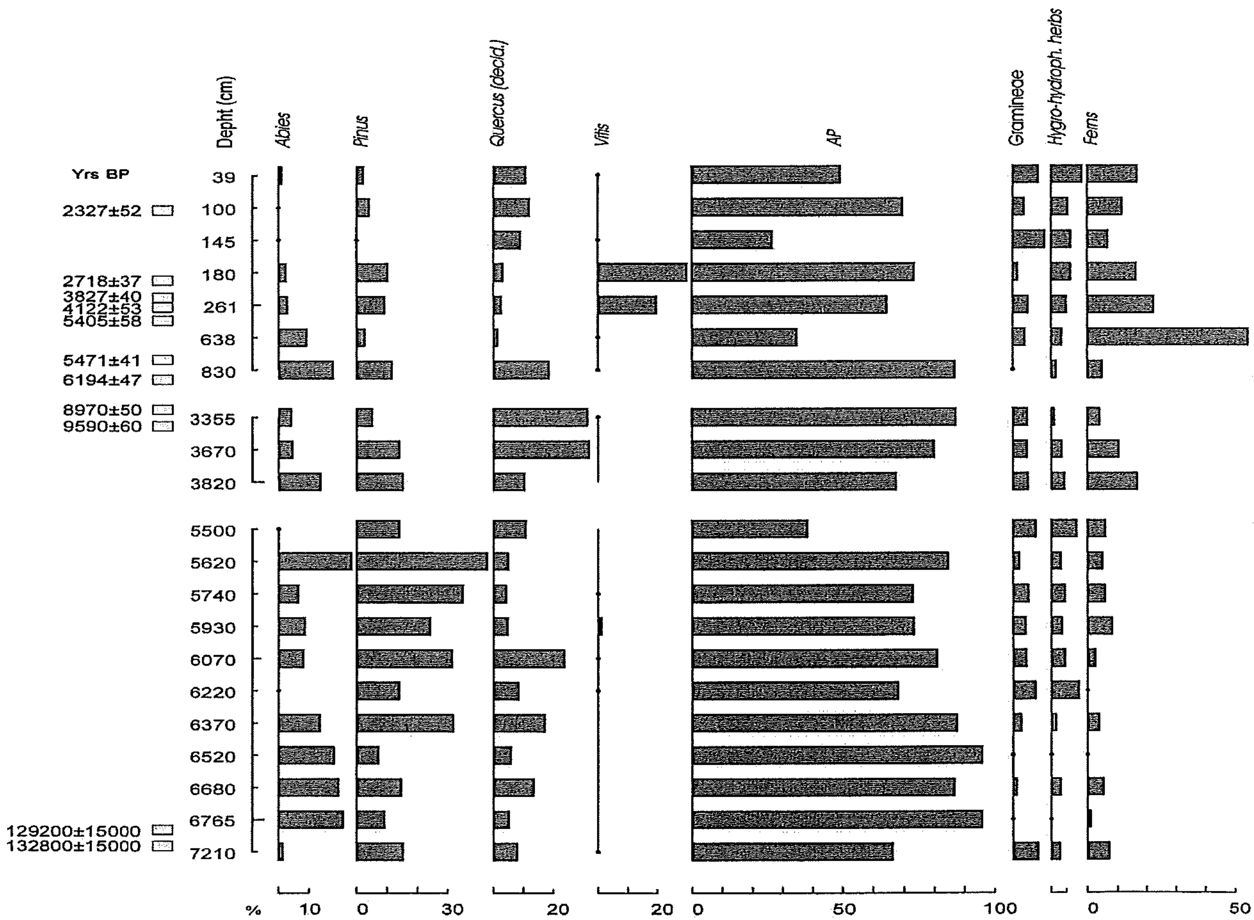


Fig. 2: Selected *taxa* in the Massaciuccoli core from Menozzi et al., 2003.



Long term fire and vegetation dynamics of Mediterranean ecosystems: a case of study from 'Lago di Massaciuccoli' (Tuscany, Italy)

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Keywords: *Abies alba*, biodiversity, climatic change, deforestation, extinctions, fire ecology, *Quercus ilex*

Source: Colombaroli *et al.*, *Journal of Ecology* (submitted)

In the Mediterranean area, one of the most fire-prone regions of the world, fire is an important ecological factor of disturbance, influencing post-fire vegetation dynamics for decades to centuries. We use well-dated high-resolution sedimentary proxies (e.g. pollen, charcoal) to reconstruct the vegetation and fire history of the Early Holocene period at "Lago di Massaciuccoli", a lake located in the Mediterranean vegetation belt. Though fire is considered a natural ecosystem factor, fire regimes during the Holocene were at least partly altered by human activity. By investigating the early Holocene (before mass expansion of agriculture) we address the response of vegetation under quasi-natural conditions.

The detailed study of the paleo-records by time-series analyses revealed a significant link between fire and vegetational dynamics (e.g. increase of shrubs and declines of trees with fires) around 6000 cal. BP. Surprisingly, our results suggest that evergreen oaks (which are conventionally regarded as fire-tolerant) were partly disfavored by fire. Moreover, prior to fire, fire-sensitive Southern and Central European species - that are absent today in the Mediterranean lowlands (e.g. *Abies alba*) - were wide-spread around the site. Silver fir (*Abies alba*) declined synchronously with evergreen oaks after fire disturbance. The relative transition (high diverse forest ecosystems to less diverse shrubland communities) is also evidenced by ordination methods. By comparing our pollen series with diatom assemblages, we try to address the possible origin of fire. Evidences of eutrophication of the lake starting from ca. 6000 cal BP (*Abies* decline) can be explained with fire impact (post fire-erosion and in-washed ashes) or lake level lowering, possibly related to climate change (e.g. less precipitations).

We conclude that long-term data may complement modern ecological observations on the role and behaviour of Mediterranean species in fire-prone environments. Assessing the long-term sensitiveness of species to fire also provides information about possible future scenarios, assuming that climate change will affect the intensity and frequency of fire events. In this sense this study provides useful data for reality checks of quantitative simulations for predictions of vegetational dynamics under global change conditions.

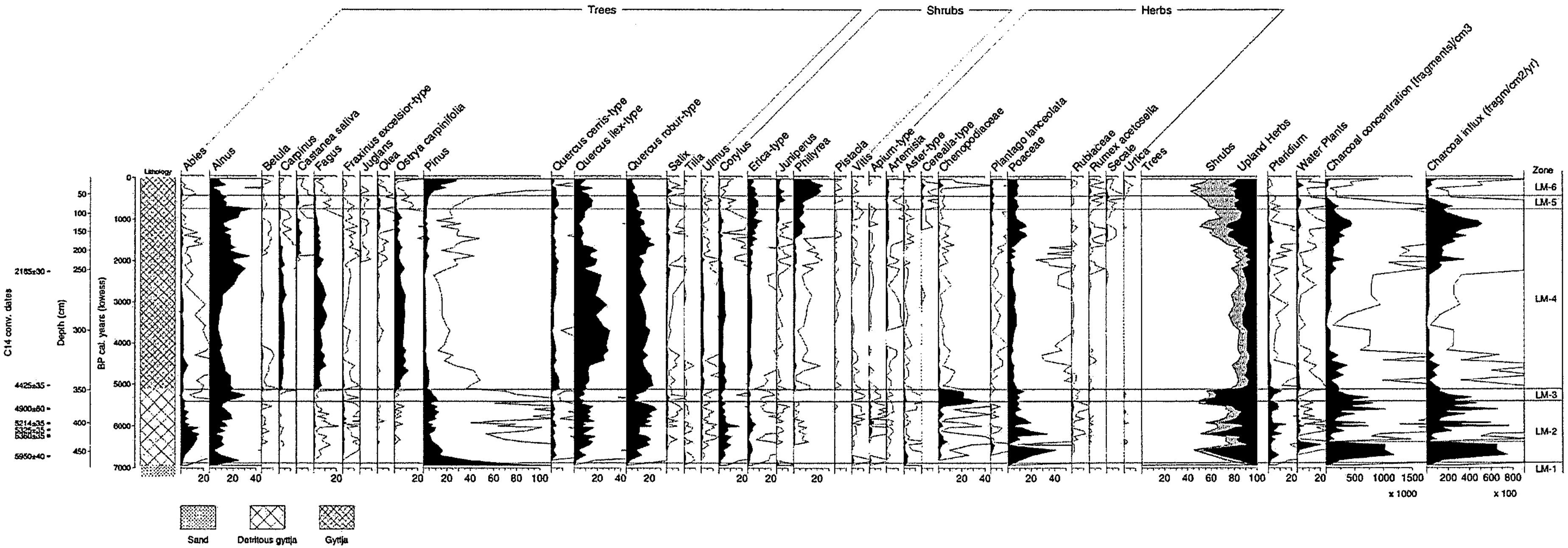

Figure 1 The sequence from Lago di Massaciuccoli, (percentages values, selected taxa)

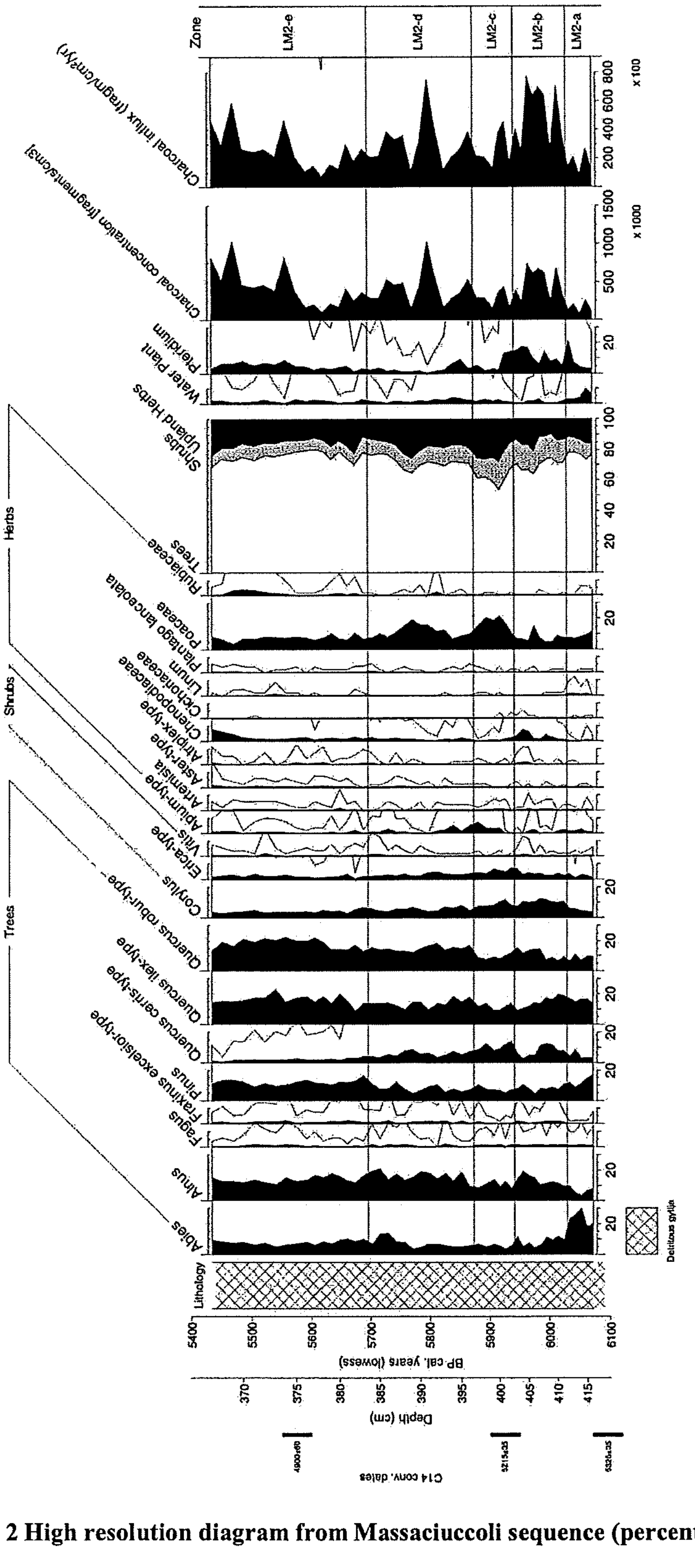

Figure 2 High resolution diagram from Massaciuccoli sequence (percentages, selected taxa)

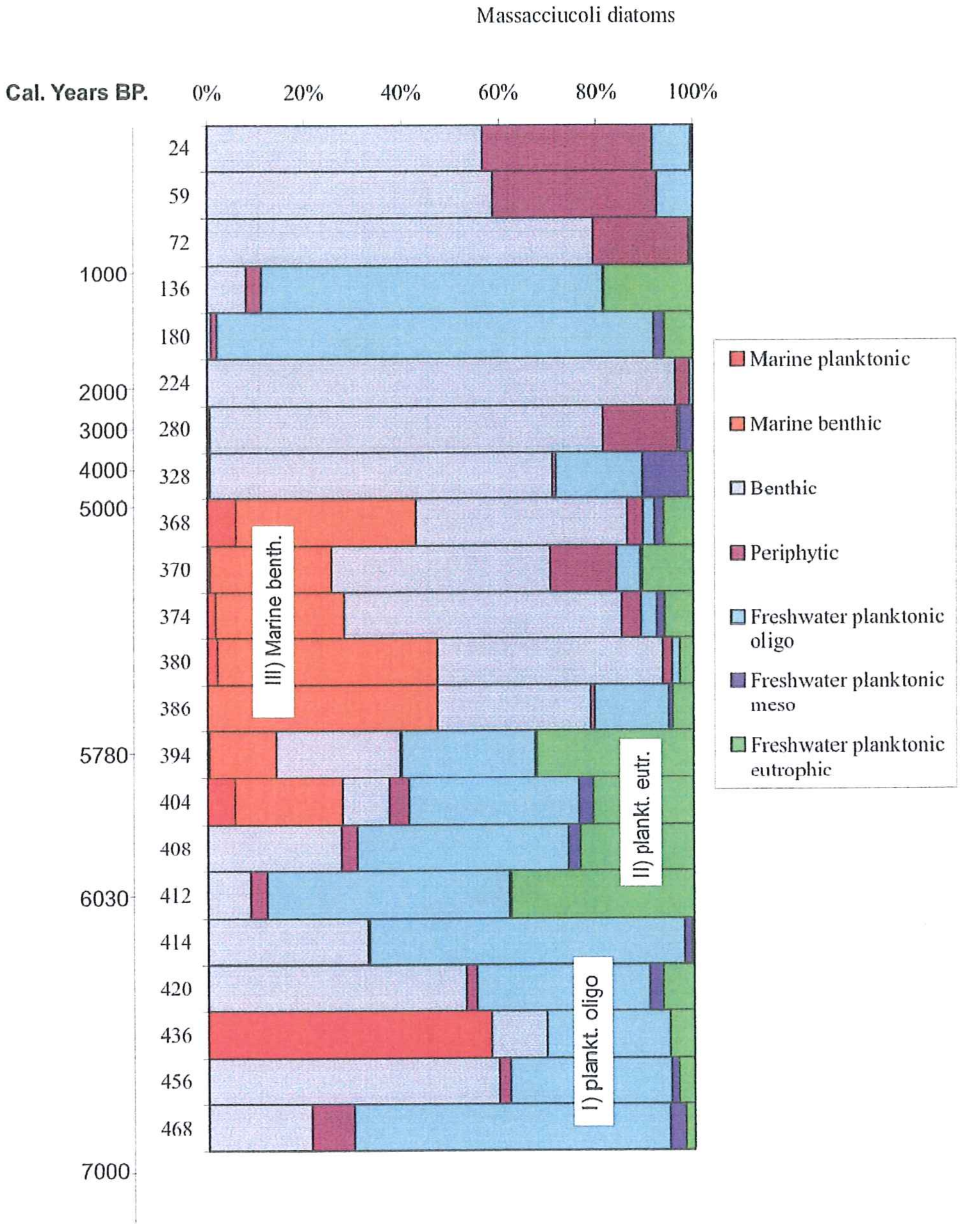

Figure 3 Preliminary diatom profile from Massaciuccoli (from A. Marchetto)

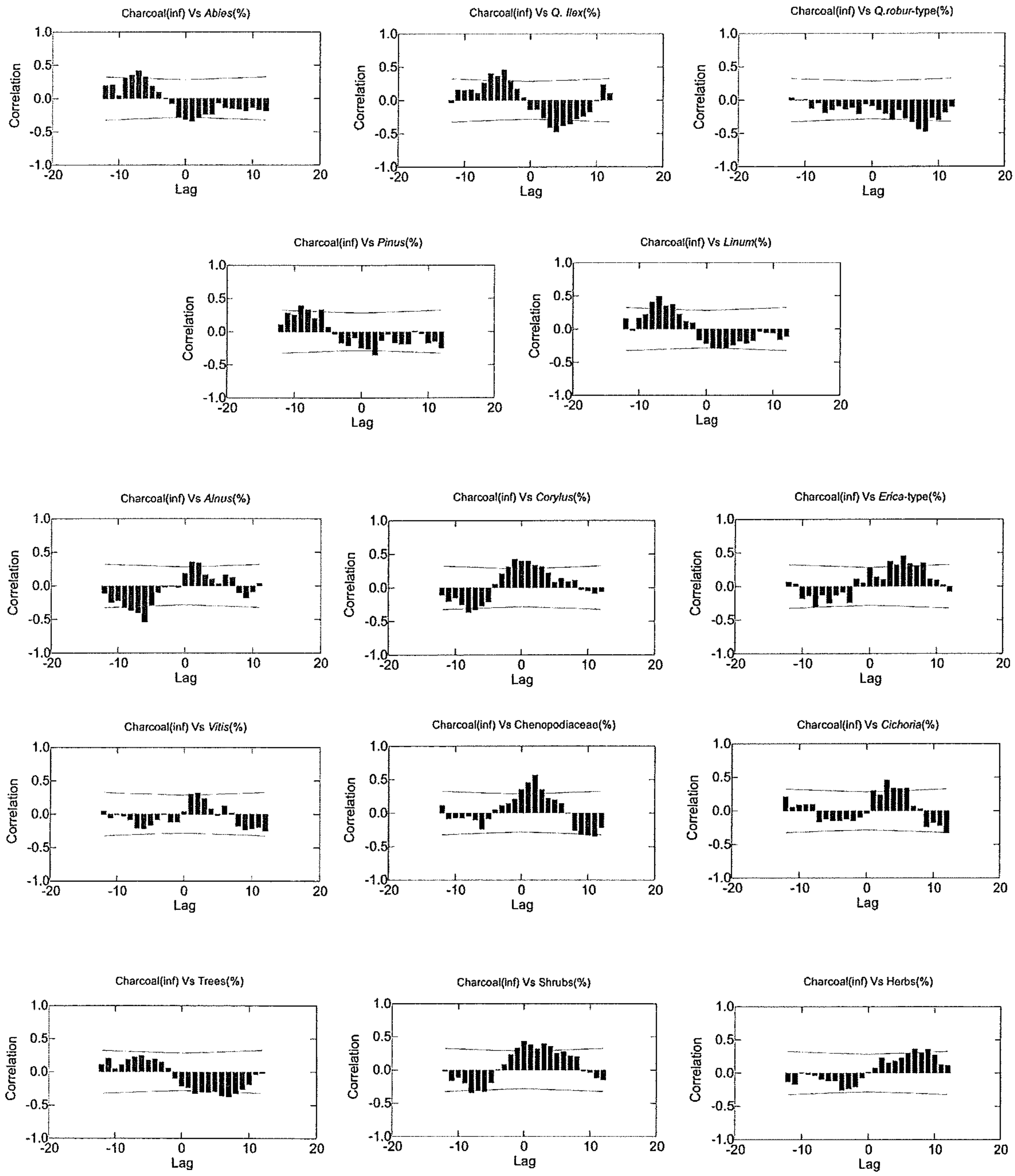

Figure 4 Cross correlation functions - species affected and advantaged by fire

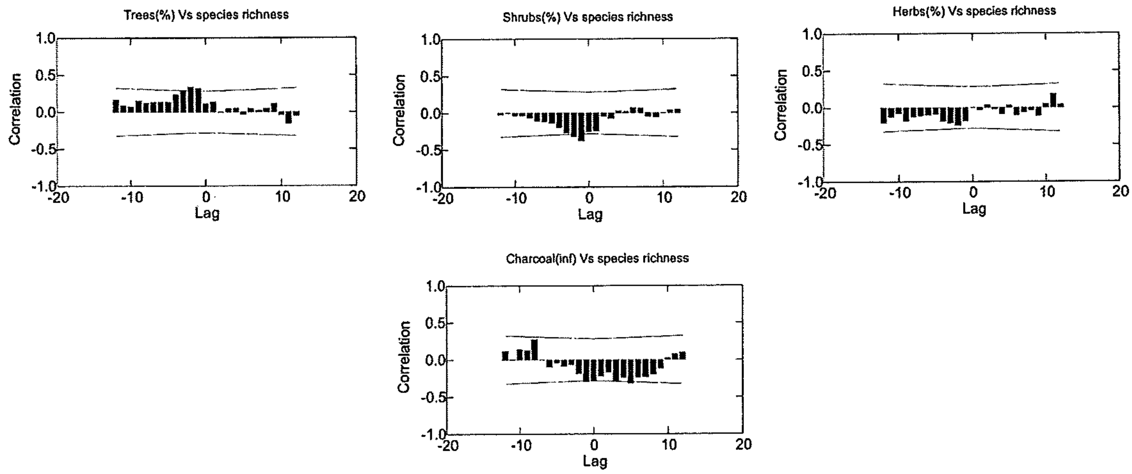

Figure 5 Cross correlation functions - charcoal and species richness

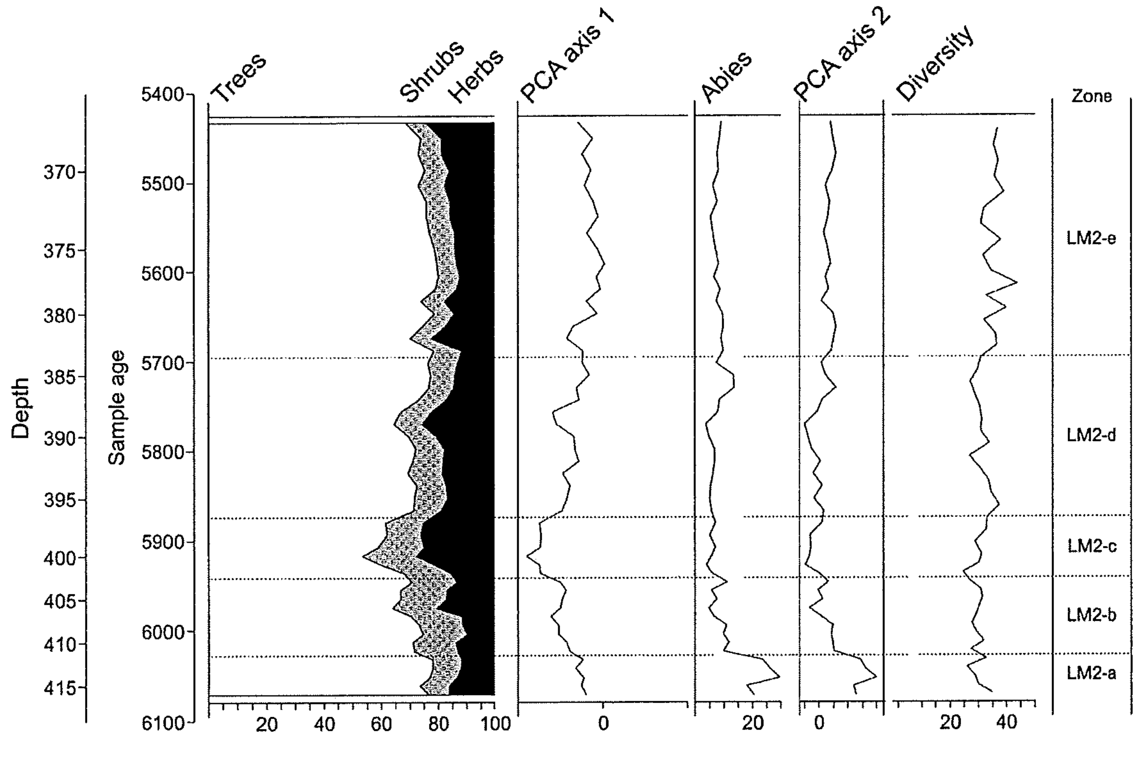

Figure 6 PCA axis and Pollen richness from Lago di Massaciuccoli (6100-5400 cal. BP)

Vegetation history, climate and human impact over the last 15000 years at Lago dell'Accesa (Tuscany, Central Italy)

RUTH DRESCHER-SCHNEIDER, JACQUES-LOUIS DE BEAULIEU AND MICHEL MAGNY

The site

Lago dell'Accesa (157 m a.s.l., 42°59'11'' N, 10°53'00'' E) is located 10 km south of the town of Massa Marittima, in the Grosseto province, 50 km SE of Siena and some 13 km from the sea (Fig. 1). It lies on the southern border of the Colline Metallifere, with altitudes up to1060 m a.s.l. (Le Cornate 1060 m a.s.l.).

The depth of the lake is 39 m, its surface about 16 ha and its catchment area covers ca. 5 km^2, and is of karstic origin. It is fed to the west by a sub aquatic thermal spring (called L'inferno) and its outlet to the east marks the beginning of the Bruna River. The water of the lake and of the Bruna river was previously used to wash minerals coming from the island of Elba, from the copper mines at Montecatini and Montecastelli in the Cecina valley and for the local alum and copper mines.

Results

The pollen diagram provides a record of vegetation and climatic change spanning over 15000 years. The Full- and Late-Glacial section covers over 6 m of sediment between a depth of 1220 cm to the bottom of the core at 1845 cm.

The oldest pollen spectra show a **Lateglacial steppe vegetation** typical of central and southern Italy during this period with high values of *Juniperus*, accompanied by *Ephedra*, *Hippophaë*, *Salix* and an herb layer dominated by *Artemisia,* Poaceae and Chenopodiaceae. The **transition** from the steppe vegetation to the Lateglacial Interstadial (LGI) coincideds with the deposition of the Tufi Biancastri tephra dated to 14560 cal B.P. at Lago Grande di Monticchio. The **Lateglacial Interstadial**, interrupted by two – according to Magny et al. (submitted) three – cooling events, is dominated by open deciduous oak forests. The transition **LGI/Younger Dryas** is characterised by the collapse of the deciduous oaks woods, confirmed by the decrease in the pollen concentration. The **Younger Dryas** is represented by 150cm of sediment and characterised by a steppe vegetation.

The **Holocene** vegetation is characterised by alternating dominance of deciduous oaks and *Quercus ilex*. The three zones characterised by *Q. ilex* are accompanied by peat layers marking lake-level lowering at ca 8600-7900, 4600-4300 and 3700-2800 cal B.P. Between approximately 9000 and 6000 cal B.P. extensive *Abies*-forests existed on the Colline Metallifere located 15-20 km to the north and northeast of the lake. Local fir populations may also have existed by the lake.

Human impact starts at approximately 8000 cal B.P. during the Neolithic period, and increases at ca 4300 cal B.P. *Castanea* and *Juglans* pollen is recorded from ca 2800 cal B.P. The impact of the Etruscan settlement near the lakeshore is shown in the increasing values of arable crops, species of secondary forest canopy (Ericaceae, *Pinus, Pistacia, Myrtus*) and anthropogenic indicators (Chenopodiaceae, *Plantago lanceolata, Rumex* etc).

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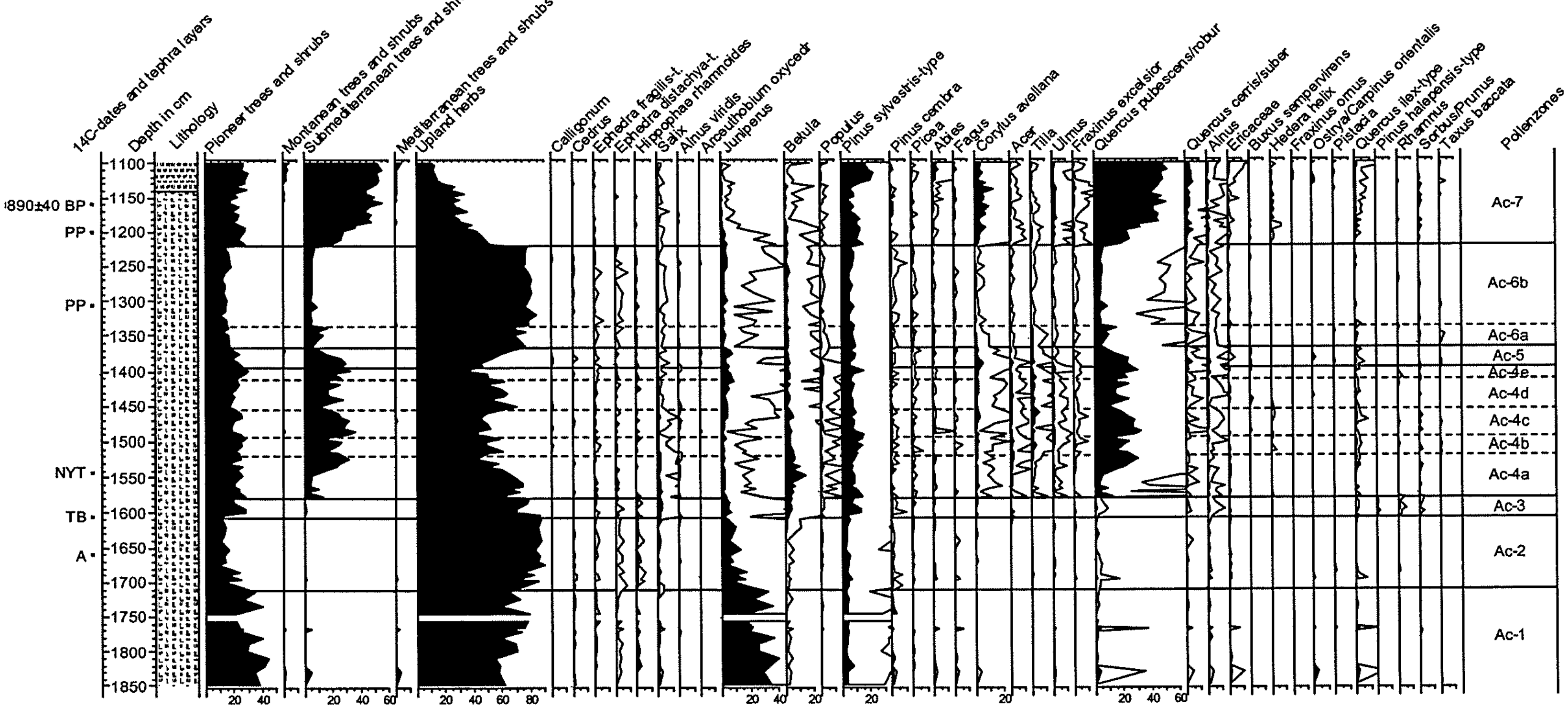
Magny M., de Beaulieu J.-L., Drescher-Schneider R., Vannière B., Walter-Simonnet A.-V., Millet L., Bossuet G., Peyron O. (submitted) Climatic oscillations in central Italy during the Last Glacial-Holocene transition: the record from Lake Accesa. J. Quat. Science.

LAGO DELL'ACCESA, AC3/4, 157 m a.s.l.

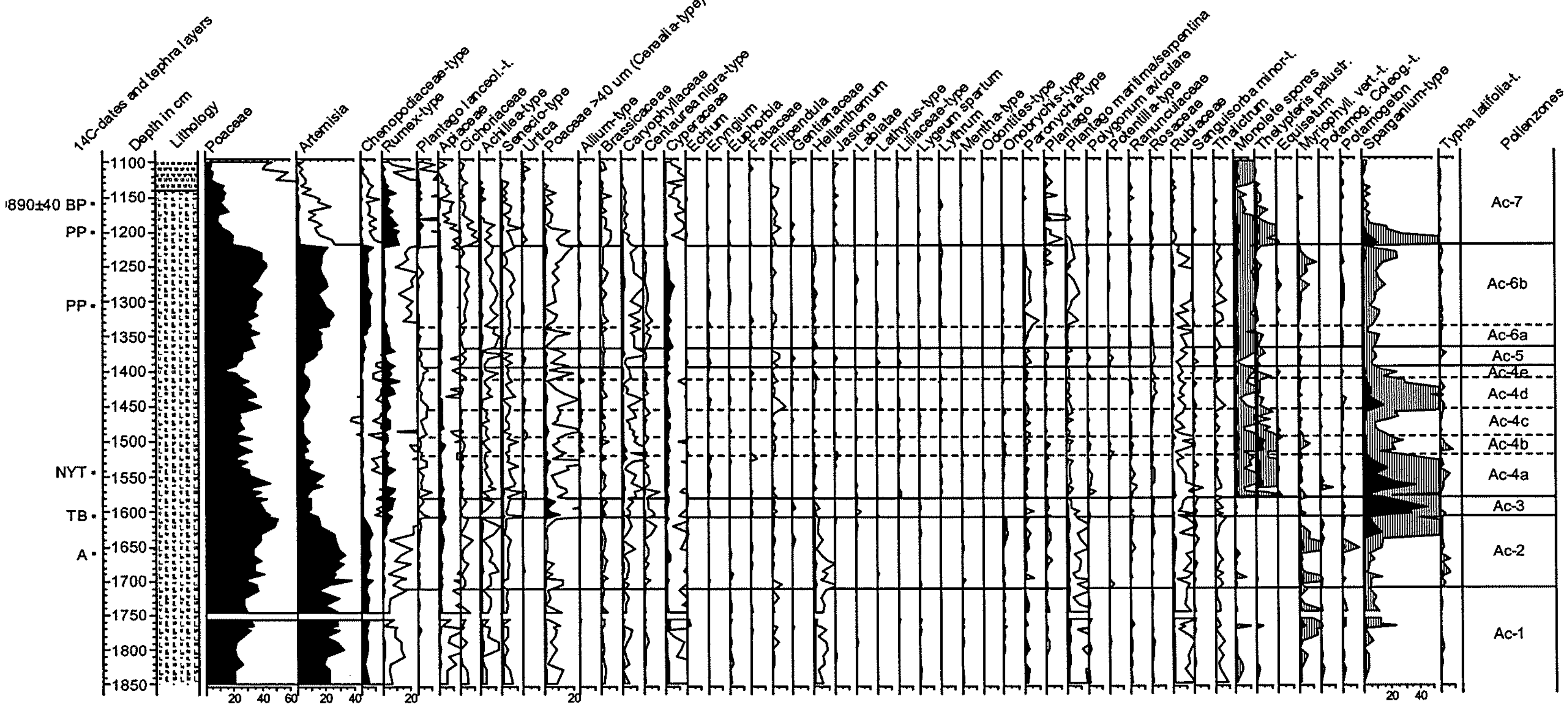
Late-Glacial, trees and shrubs



analyses R.Drescher-Schneider, J.-L. de Beaulieu

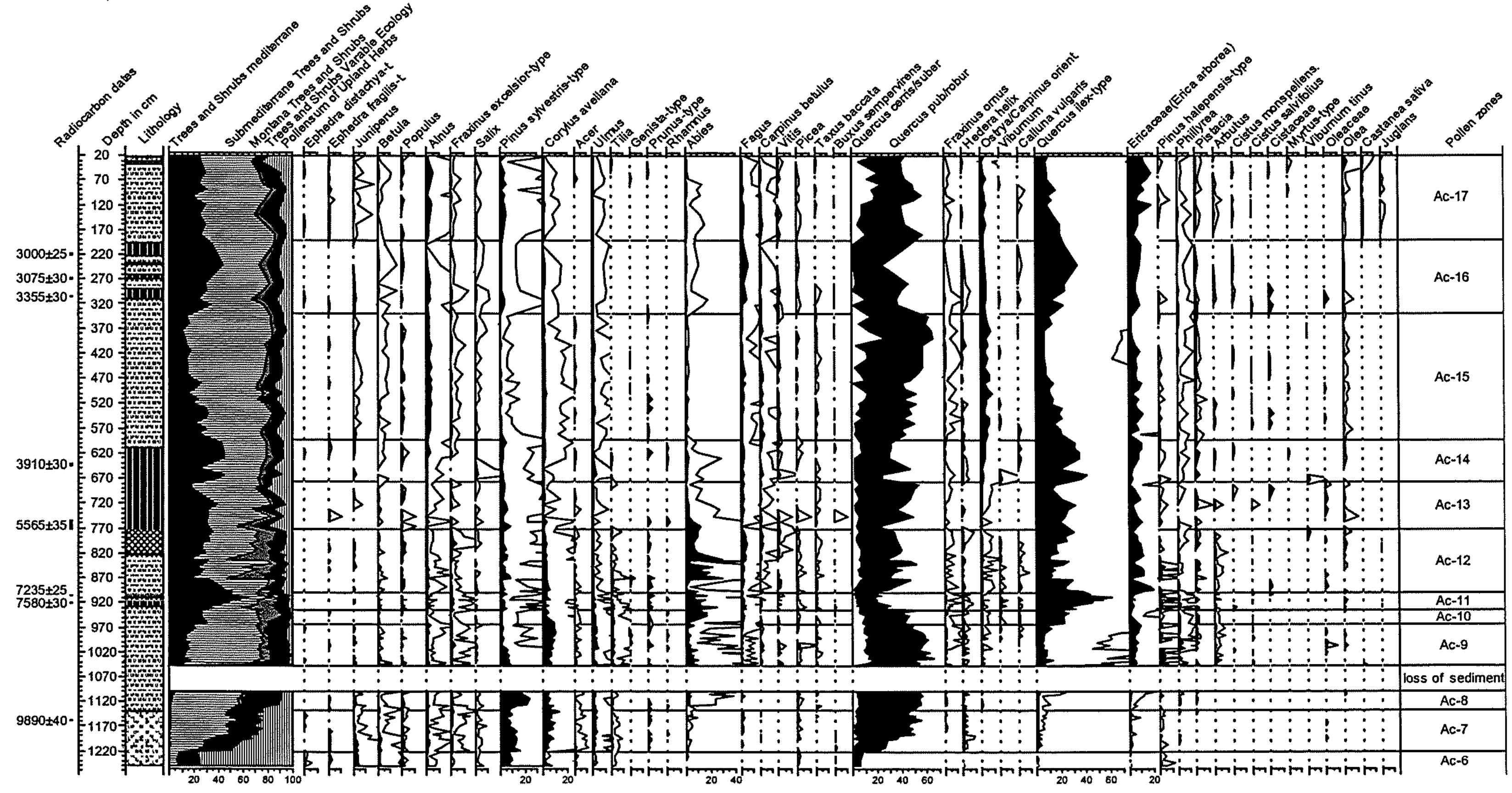
LAGO DELL'ACCESA, AC3/4, 157 m a.s.l.

Late-Glacial, upland herbs, Pteridophyta and water plants



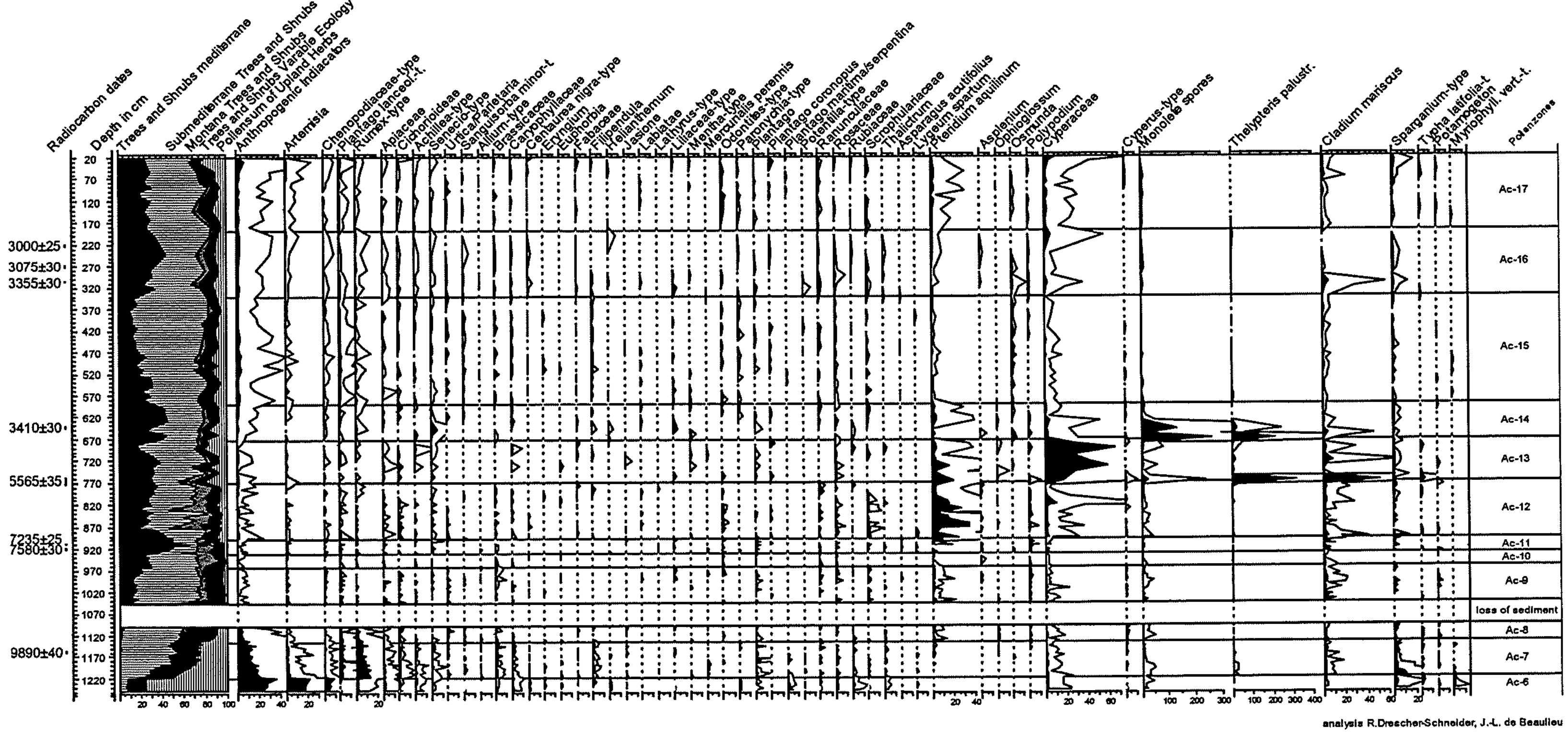
analyses R.Drescher-Schneider, J.-L. de Beaulieu

LAGO DELL' ACCESA, 157 m a.s.l.
Holocene, trees and shrubs



analysis R.Drescher-Schneider, J.-L. de Beaulieu

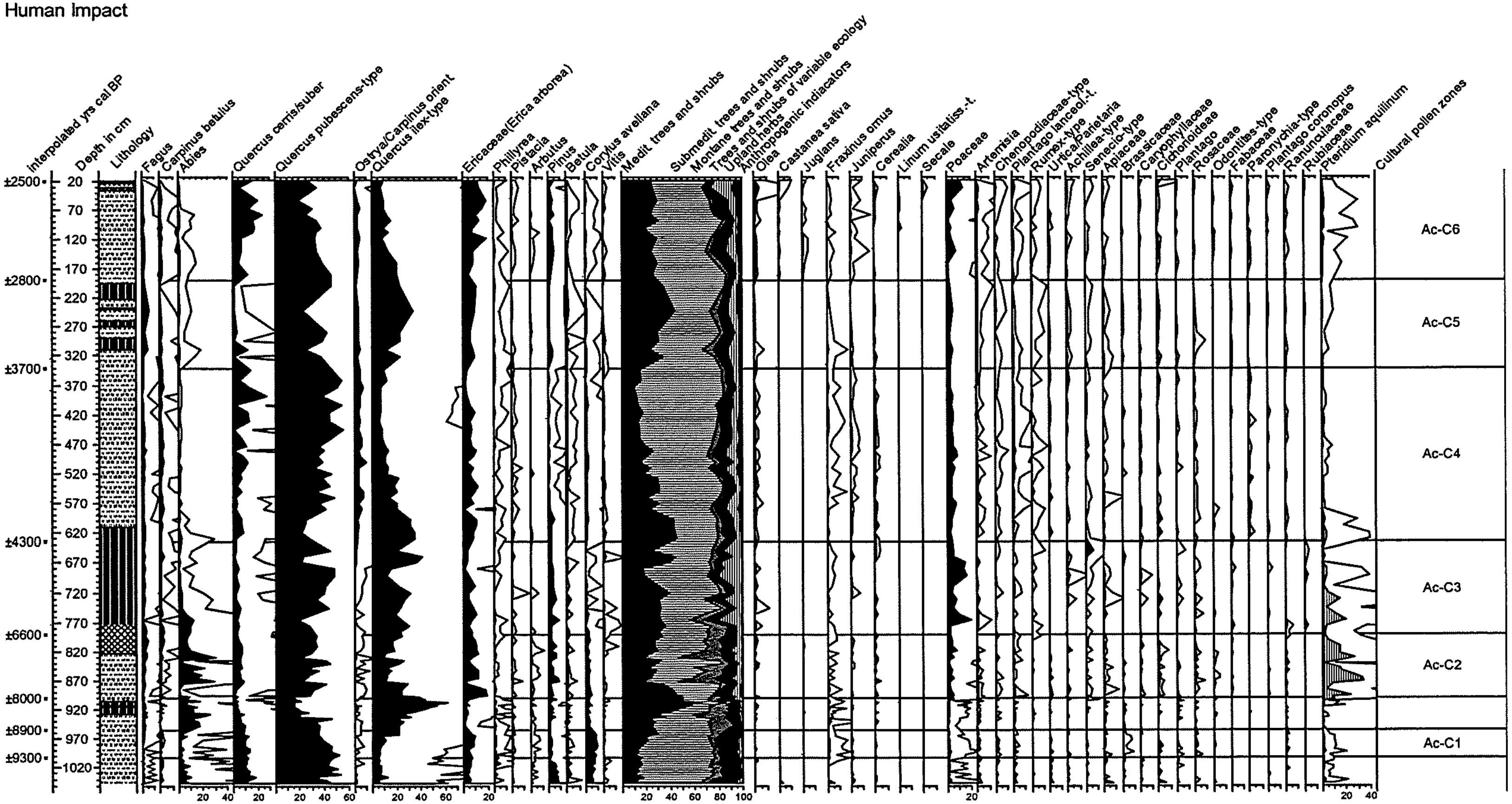
LAGO DELL' ACCESA, 157 m a.s.l.
Holocene, upland herbs, Pteridophyta and water plants



analysis R.Drescher-Schneider, J.-L. de Beaulieu

LAGO DELL'ACCESA, AC3/4, 157 m a.s.l.

Human Impact



analysesR.Drescher-Schneider, J.-L. de Beaulieu

Interactions between fire and vegetation at Lago dell'Accesa (Tuscany, Italy) 8500-7500 years ago

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Keywords: early Holocene, charcoal, deforestation, evergreen forests, fire, human impact

In May 2005, eight meters of lake sediment were cored with a Niederreiter system in the deepest part of Lago dell'Accesa. This project involves a close collaboration between University of Bern (vegetation and fire history), CNRS Marseille (vegetation history), Besançon (lake level change, fire ecology), ETH Zurich (seismic and sedimentological analyses).

The overview pollen and microscopic charcoal investigations cover the past 11.000 years and refine previous paleoecological results (Drescher-Schneider, 2005). The expansion of deciduous mixed oak forests occurred at the beginning of the Holocene. Evergreen oaks expanded at ca. 8500 cal BP and were co-dominant since then. Increased disturbances of the forest ecosystems started during the Late Mesolithic at ca 8200 cal. BP. and continued through the Neolithic period. Most surprisingly, after the Neolithic, forests remained less disturbed until the Roman period.

Pollen and microscopic charcoal was sampled contiguously for the period between ca 8500 and 7500 cal. BP, with a mean resolution of 14.5 years/cm. The purpose of this approach is to investigate the interaction between fire and vegetation, during the first drastic decline of evergreen forests (*Q. ilex*) that occurred at ca. 8.2 cal. BP. Charcoal and pollen records suggest that increasing fire frequency caused a replacement of evergreen forests of holm oak by more diverse and open environments involving the expansion of shrubs and grasses. Finally, forests gradually recovered with deciduous *Quercus* partly replacing *Quercus ilex*. These results are quantitatively endorsed by cross correlation analyses (e.g. charcoal increases significantly correlated with decreases of pollen of *Q. ilex* and pollen richness and with increases of pollen of fire-adapted resprouters such as *Corylus, Erica* and grasses). No significant link was found between fire (charcoal) and human indicators (pollen of *Plantago, Artemisia*). Compared to the previously published sequence from the border of the lake, *Abies* is present with low percentages, suggesting that silver fir was present probably with single stands on wetter spots near the lakeshores.

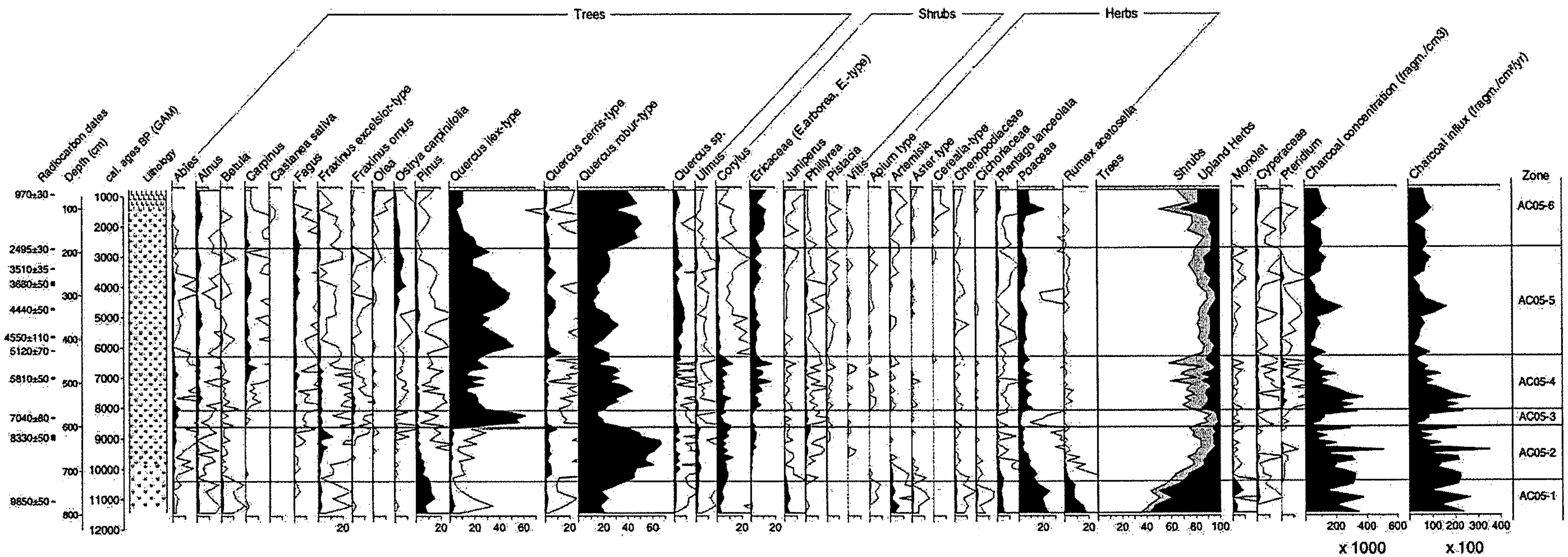

Figure 1 Pollen diagram (percentages, selected taxa) and charcoal influx from the lake core of Lago dell'Accesa

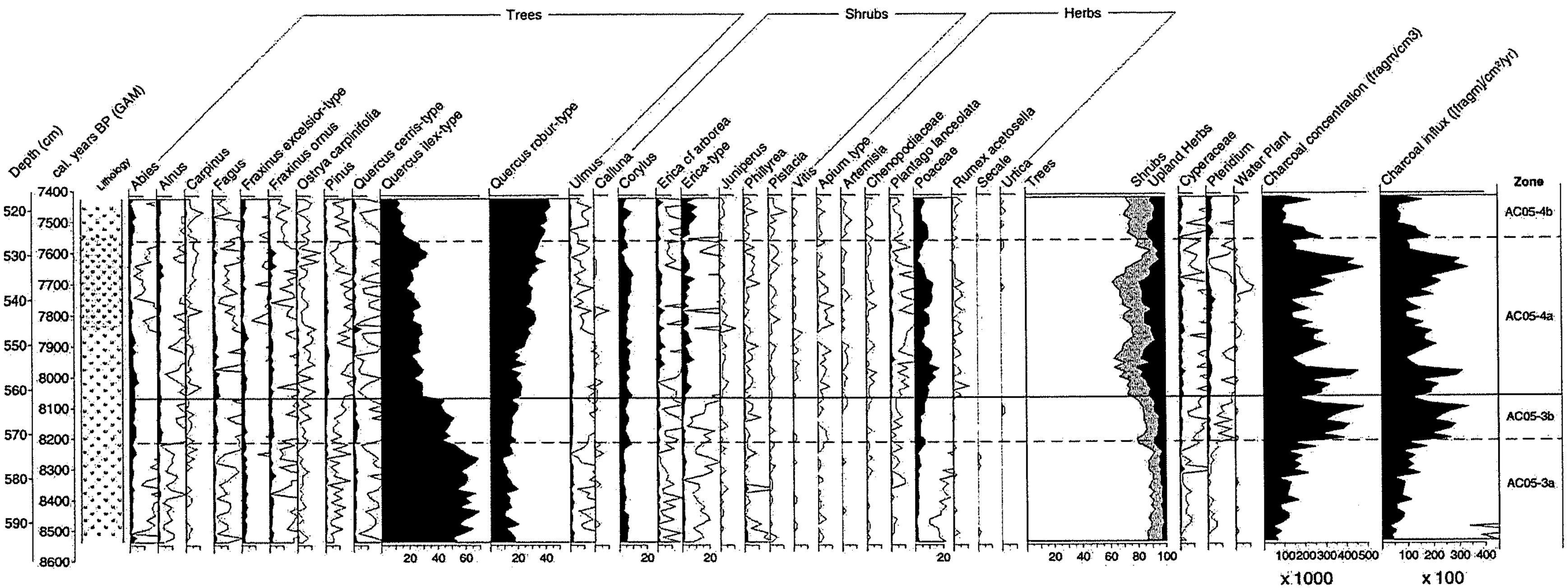

Figure 2 High resolution pollen diagram (percentages, selected taxa) and charcoal influx from the lake core of Lago dell'Accesa

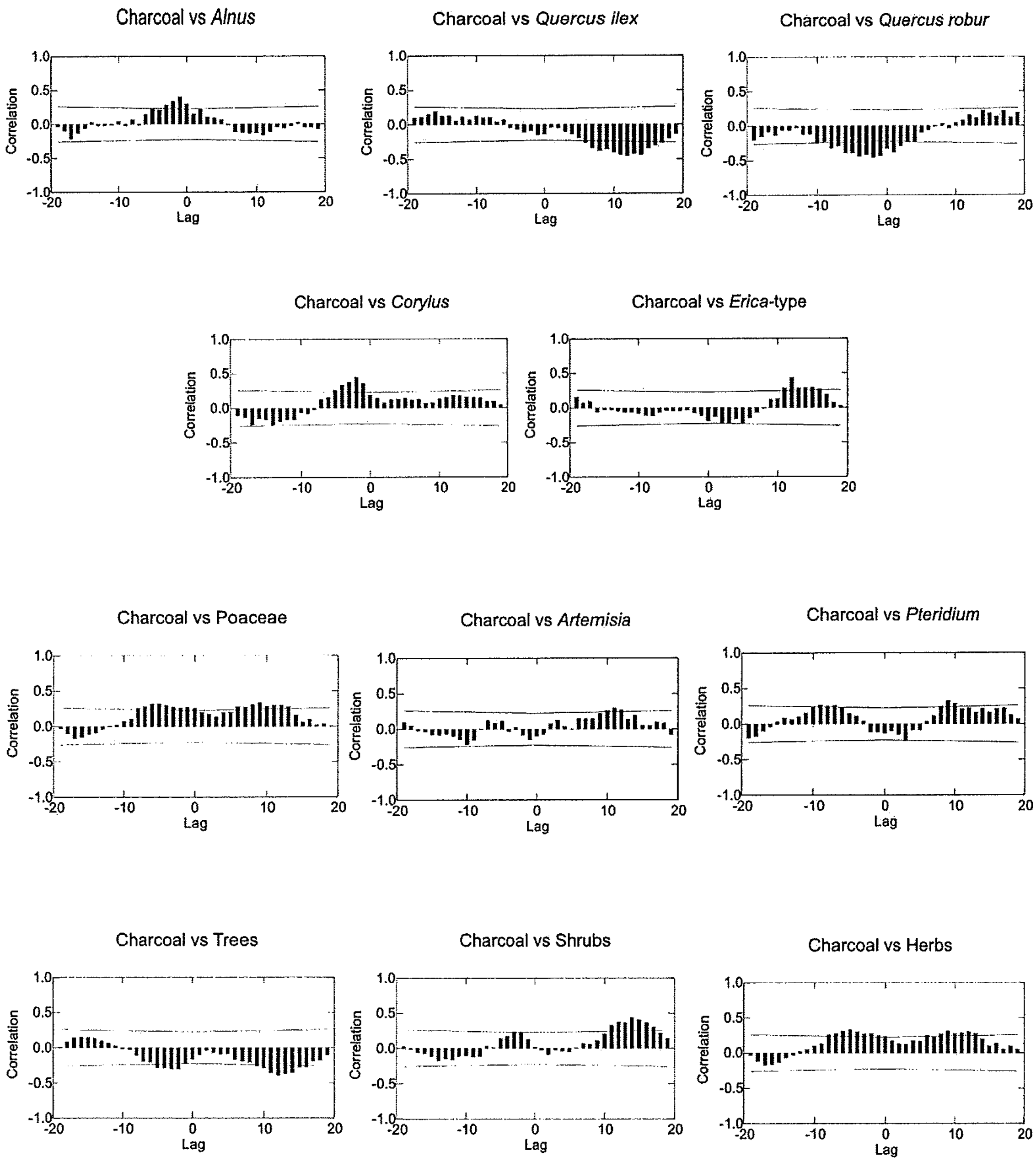

Figure 3 Times series analyses. Charcoal influx and species percentages (detrended).

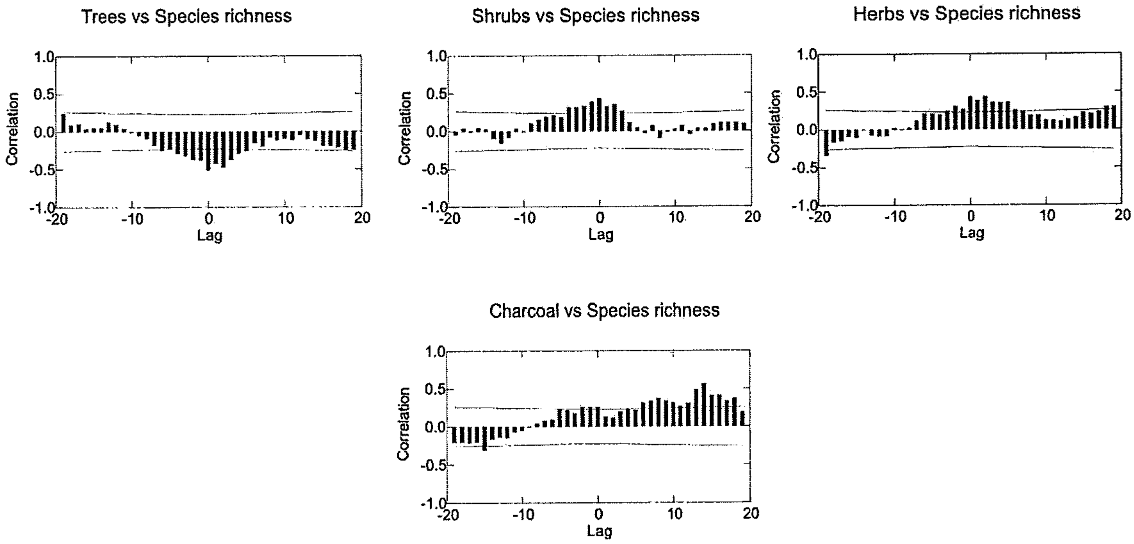

Figure 4 Time series analyses: pollen richness and charcoal (influx)

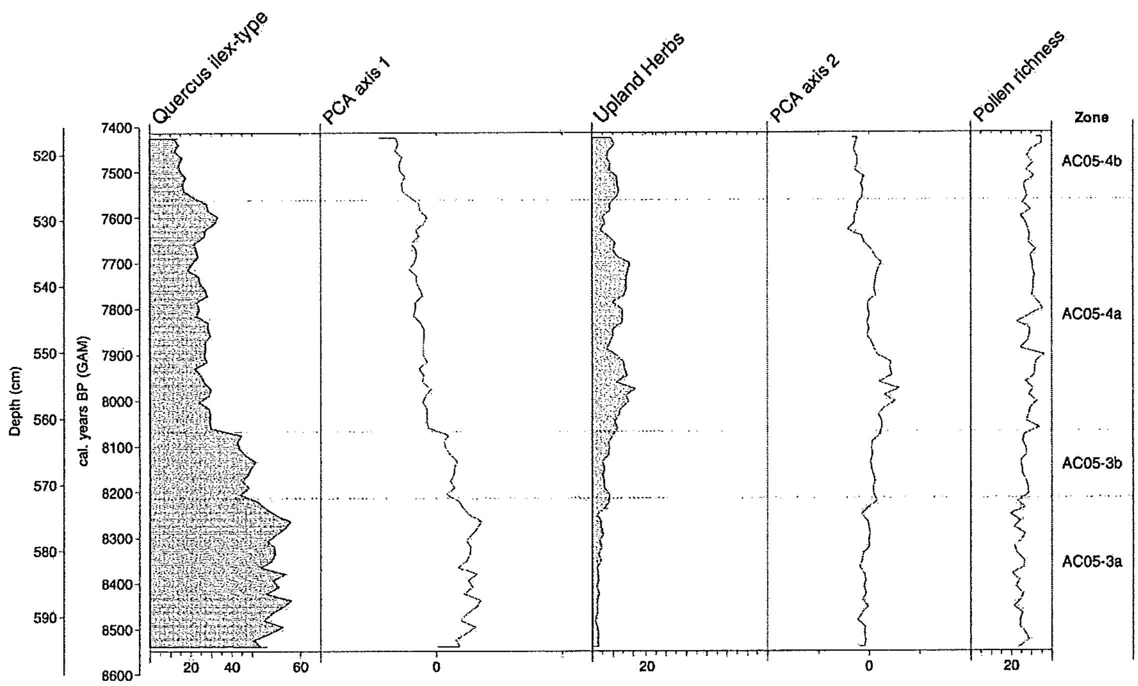

Figure 5 Lago dell'Accesa. Ordination diagram for the high resolution sequence.

Climatic oscillations in central Italy during the Last Glacial-Holocene transition: the record from Lake Accesa

Michel Magny[1A], Jacques-Louis de Beaulieu[2], Ruth Drescher-Schneider[3], Boris Vannière[1], Anne-Véronique Walter-Simonnet[4], Laurent Millet[1], Gilles Bossuet[1], Odile Peyron[1]

Source: Magny, M. *et al.* 2006. *Journal of Quaternary Science* 21: 1-10.

Abstract

This paper presents an event stratigraphy based on data documenting the history of vegetation cover, lake-level changes and fire frequency as well as volcanic eruptions over the Last Glacial - early Holocene transition from a terrestrial sediment sequence recovered at Lake Accesa in Tuscany (north-central Italy). On the basis of an age-depth model inferred from 13 radiocarbon dates and 6 tephra horizons, the Oldest Dryas – Bølling warming event was dated to ca 14560 cal BP and the Younger Dryas event to ca 12700-11650 cal BP. Four sub-millennial scale cooling phases were recognised from pollen data at ca 14300-14200, 13900-13700, 13400-13100 and 11350-11150 cal BP. The last three may be Mediterranean equivalents to the Older Dryas (GI-1d), Intra-Allerød (GI-1b) and PBO cooling events defined from the GRIP ice-core and indicate strong climatic linkages between the North Atlantic and Mediterranean areas during the last Termination. The first may correspond to Intra Bølling cold oscillations registered by various palaeoclimatic records in the North Atlantic region. The lake-level record allows one to observe that the sub-millennial scale climatic oscillations which punctuated the last deglaciation were associated in central Italy with different successive patterns of hydrological changes from the Bølling warming to the 8.2 cold reversal.

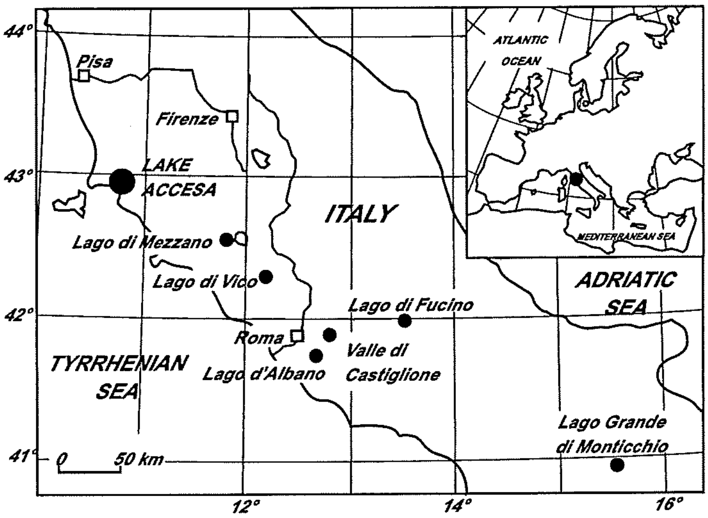

Figure 1. Geographical location of Lake Accesa and reference sites in central Italy.

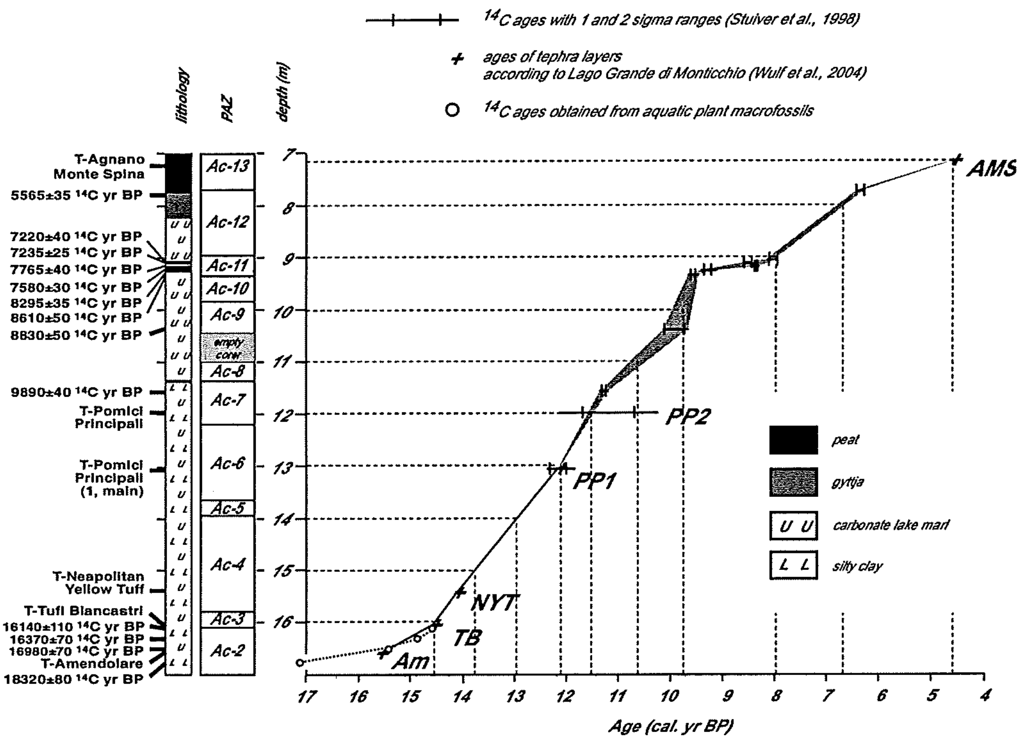

Figure 2. Age-depth curve established for core AC3/4 of Lake Accesa. The radiocarbon ages have been calibrated using IntCal 5 (Stuiver et al., 1998). Note that the period before 14550 cal BP (Oldest Dryas pollen zone) and that between ca 9300 and 8000 cal BP were characterised by a low sedimentation rate. Despite several attempts, the portion 1100-1050 cm could not be taken with a Russian peat corer due to too high a water content in the sediments. The additional information that radiocarbon ages were obtained from macrofossils of aquatic plants below level 1600 cm has been indicated by white circles. They provided a curve close to that based on tephrochronology.

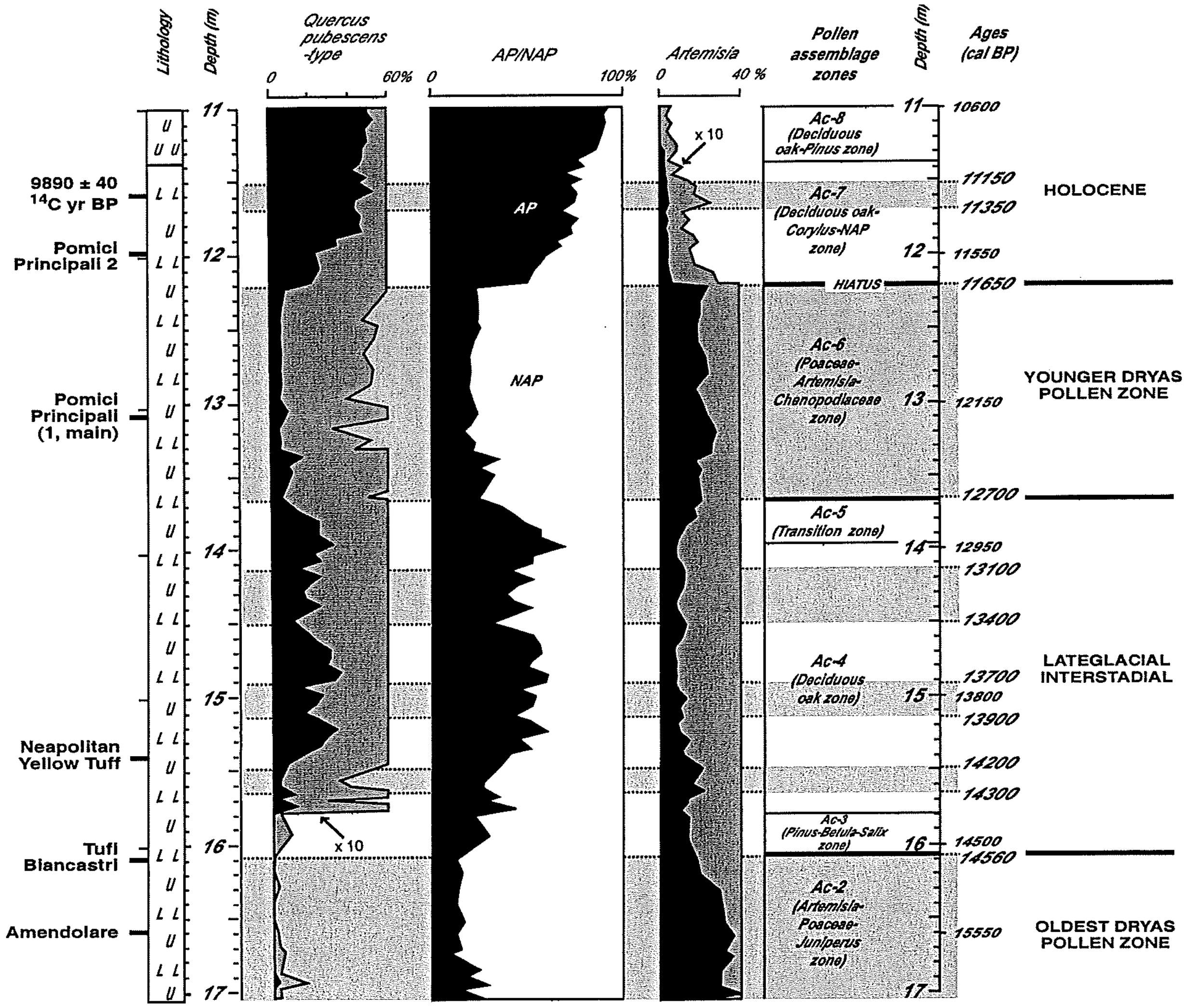

Figure 3. Simplified pollen diagram of core AC3/4 of Lake Accesa (after Drescher-Schneider et al., in press). Horizontal grey bands mark cooling phases identified from increase in *Artemisia* and NAP values and declines of *Quercus pubescens type* percentages. Ages in cal. yr BP have been indicated on the basis of the age-depth curve in Figure 2.

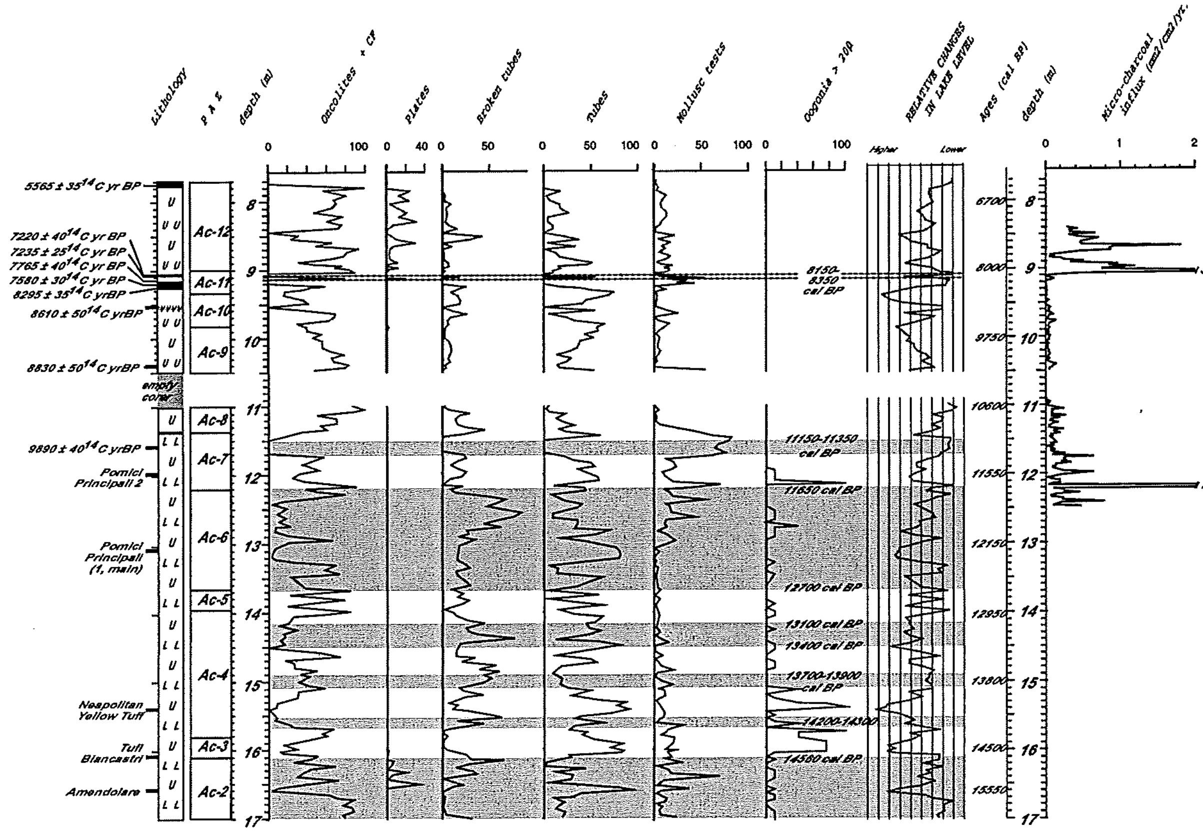

Figure 4. Sediment diagram documenting lake-level fluctuations and fire history from core AC3/4 of Lake Accesa. The curve of lake-level fluctuations was constructed on the basis of the difference between the total scores of concretion morphotypes indicating low lake-level conditions (i.e. oncolites and cauliflower-type) and those indicating high lake-level conditions (i.e. plates and tubes). Horizontal grey bands with ages in calibrated years BP correspond to cooling phases as defined from pollen data (see Fig. 3). Ages in cal. yr BP have been indicated on the basis of the age-depth curve in Figure 2. Note that the highstand which developed between ca 8350-8100 cal BP briefly interrupted a period of low sedimentation rate. Due to insufficient sediment volume, the charcoal influx could not be reconstructed below level 1250 cm.

depth (cm)	radiocarbon age	calibrated age (1 sigma)	calibrated age (2 sigmas)	Laboratory reference	material
774-775	5565 ± 35 BP	6397-6310 cal. BP	6408-6296 cal. BP	VERA-2137	peat
904-905	7220 ± 40 BP	8152-7971 cal. BP	8161-7963 cal. BP	VERA-2357	peat
906-907	7235 ± 25 BP	8153-8000 cal. BP	8159-7979 cal. BP	VERA-2139	peat
915-916	7765 ± 40 BP	8594-8481 cal. BP	8605-8434 cal. BP	VERA-2358	peat
920-921	7580 ± 30 BP	8408-8379 cal. BP	8420-8353 cal. BP	VERA-2140	peat
924-925	8295 ± 35 BP	9405-9265 cal. BP	9431-9141 cal. BP	VERA-2359	peat
935-936	8610 ± 50 BP	9624-9530 cal. BP	9690-9501 cal. BP	Poz-9969	peat
1040-1041	8830 ± 50 BP	10121-9744 cal. BP	10157-9699 cal. BP	Poz-9970	peat
1158-1159	9890 ± 40 BP	11316-11240 cal. BP	11393-11220 cal. BP	VERA-2807	wood fragments
1610-1611	16140 ± 110 BP	19448-19207 cal. BP	19489-19058 cal. BP	VERA-2812	aquatic plant macrofossils
1630-1631	16370 ± 70 BP	19744-19445 cal. BP	19809-19370 cal. BP	VERA-2813	aquatic plant macrofossils
1652-1653	16980 ± 70 BP	20205-19997 cal. BP	20303-19926 cal. BP	VERA-2814	aquatic plant macrofossils
1676-1677	18320 ± 80 BP	22059-21628 cal. BP	22141-21373 cal. BP	VERA-2815	aquatic plant macrofossils

★ St Cergue

Table 1. Radiocarbon dates obtained from the Lateglacial and early Holocene sediment sequence of core Accesa 3/4.

depth (cm)	SEM observations and chemical composition of glass shards and phenocrystals		equivalent volcanic eruptions	age	literature
714	trachyte	sanidine, feldspars, biotite, rare pyroxene greyish glass shards	Agnano Monte Spina (1, 2 and 3)	4130 ± 50 BP 4650 varve yr BP	Wulf et al. 2004 di Vito et al. 1999 Calanchi et al. 1998
1200	trachyte	feldspars, biotite, rare pyroxene	Pomici Prinicipali (2, discreet)	9760 ± 300 BP	di Vito et al. 1999 Rolandi et al. 1998
1305	trachyte	feldspars, biotite, rare pyroxene	Pomici Principali (1, main)	10320 ± 50 BP 12180 varve yr BP	Wulf et al. 2004 Allen et al. 1999 Paterne et al. 1988
1542	potassic trachyte	sanidine, magnetite, plagioclase, pyroxene, biotite	Neapolitan Yellow Tuff	12 300 ± 300 BP 14120 varve yr BP	Schmidt et al. 2002 Wulf et al. 2000 Alessio et al. 1971
1605	trachyte	feldspars, pyroxene, biotite	Tufi Biancastri	14557 varve yr BP	Wulf et al. 2004
1660	trachyte	feldspars, pyroxene, biotite	Amendolare	15550 varve yr BP	Wulf et al. 2004

★ St Cergue

Table 2. Chemical and mineralogical characteristics of tephra layers in the Lateglacial and early Holocene sediment sequence of core Accesa 3/4 from petrographic and SEM observations and X-ray diffraction analysis.

Tephra's name	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O5	Cl	F	S	Cr_2O_3	Total	Sample name	Situation	Reference
	59.91	0.51	18.06	3.53	0.12	0.69	2.33	5.22	9.61					0.04	100	AMS	On land	Siani et al., 2004
	59.38	0.57	18.02	3.74	0.17	0.52	2.59	4.41	9.60	0.24	0.68		0.01	0.08	100	140 cm	Marine	Siani et al., 2004
	59.65	0.57	18.01	3.68	0.14	0.53	2.58	4.58	9.44	0.08	0.64		0.05	0.04	100	160 cm	Marine	Siani et al., 2004
Agnano	58.78	0.55	18.05	4.00	0.19	0.56	2.67	4.60	9.61	0.19	0.73		0.04	0.03	100	175 cm	Marine	Siani et al., 2004
Monte Spina	59.83	0.48	18.85	3.65	0.14	0.73	2.74	4.34	8.59	0.13	0.65	0.00			100	TM-5a	Lacustrine	Wulf et al., 2004
(1, 2 and 3)	60.74	0.46	18.76	3.31	0.13	0.60	2.48	4.30	8.56	0.10	0.69	0.00			100	TM-5b	Lacustrine	Wulf et al., 2004
	58.16	0.45	19.87	3.62	0.13	0.65	3.19	5.33	7.96	0.12	0.62	0.05			100	TM-5c	Lacustrine	Wulf et al., 2004
	60.80	0.47	18.74	3.23	0.15	0.58	2.24	5.09	8.16	0.09	0.59	0.00			100	TM-5d	Lacustrine	Wulf et al., 2004
	60.65	0.51	18.66	3.19	0.15	0.61	2.32	4.53	8.23	n.a.	n.a.	n.a.	n.a.	n.a.	99	714 cm	Lacustrine	This study
	56.28	0.72	18.12	5.06	0.17	1.16	4.02	3.86	9.49	0.31	0.70		0.05	0.05	100	305 cm	Marine	Siani et al., 2004
	56.79	0.62	18.42	4.73	0.13	1.13	4.06	3.88	9.46	0.20	0.44		0.05	0.08	100	310 cm	Marine	Siani et al., 2004
Pomici Principali	55.69	0.77	18.34	5.92	0.14	2.13	5.04	3.50	7.67	0.39	0.53	0.00			100	TM-7a	Lacustrine	Wulf et al., 2004
	58.38	0.49	19.78	4.17	0.13	1.00	3.50	3.89	9.02	0.16	0.62	0.00			101	TM-7b	Lacustrine	Wulf et al., 2004
	54.38	0.61	19.97	4.85	0.11	1.75	5.31	3.48	8.58	n.a.	n.a.	n.a.	n.a.	n.a.	99	1200	Lacustrine	This study
	55.84	0.69	18.56	4.62	0.12	1.1	4.24	3.84	9.79	n.a.	n.a.	n.a.	n.a.	n.a.	99	1305	Lacustrine	This study
	59.70	0.49	18.49	3.44	0.26	0.69	2.95	4.37	9.46	0.04	0.00		0.05	0.05	100	395 cm	Marine	Siani et al., 2004
Neapolitean	61.66	0.43	18.35	2.87	0.15	0.44	2.18	4.91	8.49	0.05	0.62	0.00			100	TM-8a	Lacustrine	Wulf et al., 2004
Yellow Tuff	56.77	0.60	18.51	5.32	0.14	1.63	4.83	3.50	8.00	0.36	0.44	0.00			100	TM-8b	Lacustrine	Wulf et al., 2004
	60.55	0.47	18.46	3.12	0.15	0.74	3.12	4.19	8.11	n.a.	n.a.	n.a.	n.a.	n.a.	99	1542	Lacustrine	This study
Tufi Biancastri	63.39	0.37	18.32	2.03	0.3	0.38	1.94	4.71	8.16	0.04	0.45	0			100	TM-9	Lacustrine	Wulf et al., 2004
	63.34	0.25	18.29	2.17	0.27	0.41	1.86	4.32	8.01	n.a.	n.a.	n.a.	n.a.	n.a.	99	1605	Lacustrine	This study
	58.78	0.56	18.38	4.08	0.10	0.94	3.01	4.12	9.98					0.03	100	LAM white	On land	Siani et al., 2004
Lagno	59.07	0.61	18.45	4.16	0.09	0.73	3.15	3.92	9.78					0.04	100	LAM black	On land	Siani et al., 2004
Amendolare	58.77	0.58	18.29	3.90	0.12	0.84	3.02	4.33	9.36	0.15	0.58		0.01	0.04	100	434 cm	Marine	Siani et al., 2004
	61.94	0.42	18.5	2.29	0.12	0.43	2.27	4.85	8.73	0.06	0.5	0			100	TM-10b	Lacustrine	Wulf et al., 2004
	60.46	0.46	18.49	3.82	0.15	0.82	2.98	3.97	8.3	0.14	0.53	0			100	TM-10d	Lacustrine	Wulf et al., 2004
	61.32	0.41	18.42	2.78	0.11	0.56	2.82	3.68	9.51	n.a.	n.a.	n.a.	n.a.	n.a.	100	1660	Lacustrine	This study

Table 3. Results of microscope chemical analyses of tephra layers observed in the Lateglacial and early Holocene sediment sequence of core Accesa 3/4.

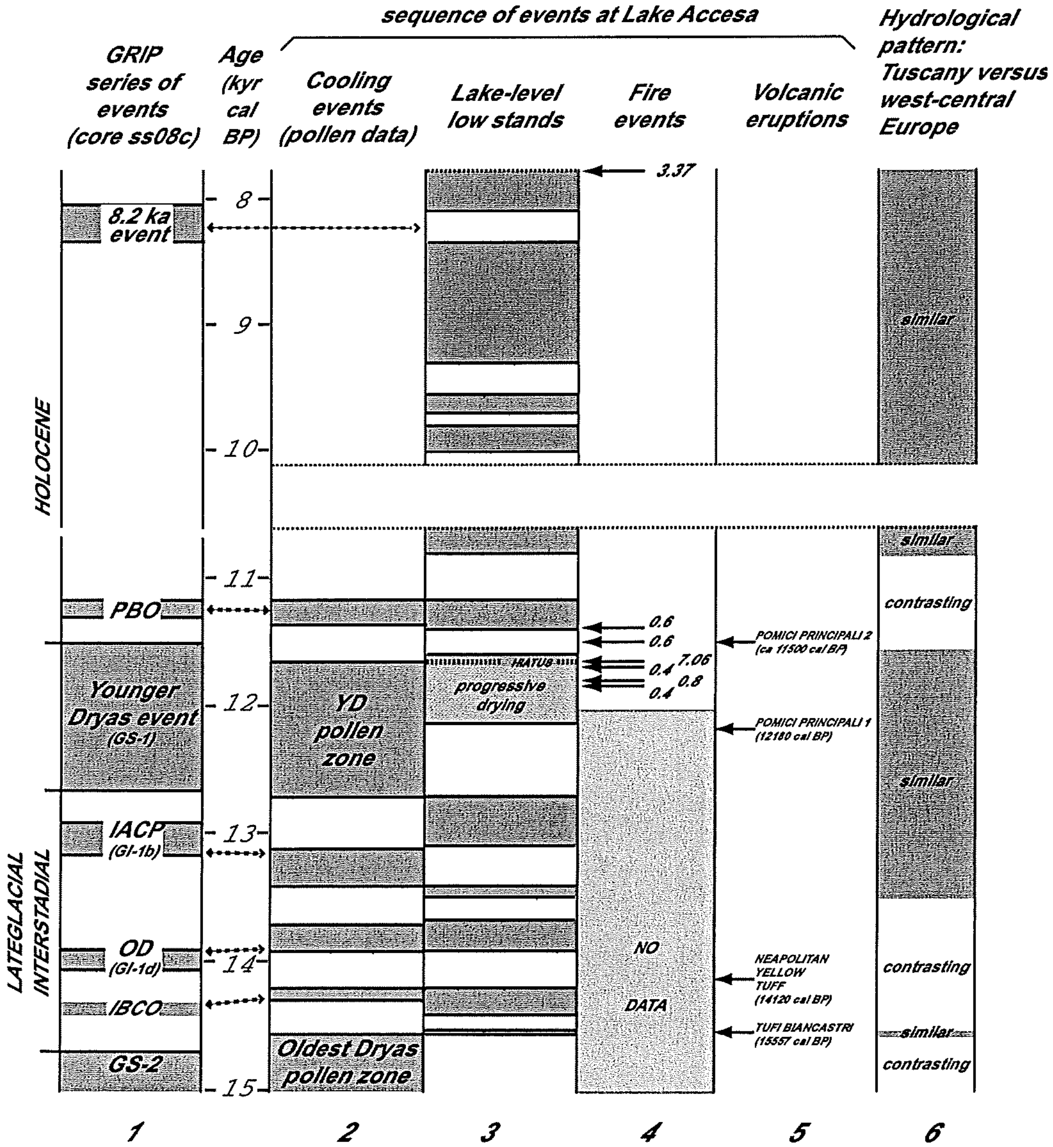

Table 4. Comparison of the sequence of events recognised at Lake Accesa with the series of events defined from the GRIP ice-core ss08c (Lowe, 1994 ; Björck et al., 1998). IACP : Intra-Allerød cold period ; OD : Older Dryas cold oscillation. Note that an additional Intra-Bølling cool oscillation (IBCO) has been indicated (see text). Cooling events inferred from pollen data (see Figure 3) and low lake-level phases reconstructed from sediment analysis (see Figure 4) are indicated by grey boxes in columns 2 and 3 respectively. In column 4, fire events correspond to major peaks of the micro-charcoal influx (> 0.4 mm2/cm2/yr). The numbers refer to the charcoal influx as shown in Figure 4. Volcanic eruptions are presented in column 5 according to Table 2. In column 6, the grey boxes correspond to periods when the hydrological patterns were similar in Tuscany and in west-central Europe (Magny, 2001, 2004). Note that the empty corer at levels 1050-1100 cm prevents establishment of a clear comparison between the two regions.

The sedimentary basin fills of Lago dell' Accesa

E. Chapron & C. Matter

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High-resolution seismic profiling (3.5 kHz) in Lago dell'Accesa (western Toscani, Italy) allowed optimizing the locations of two piston cores (7 to 8 m long) and several short gravity cores. The seismic stratigraphy of this small but deep lake of karstic origin revealed characteristic seismic facies (Figure 1) associated with: (i) the littoral platform (from 0 to 25 m depth); (ii) the deep basin (from 25 to 34.5 m depth) and (iii) sediment slides remolding lateral and deep basin sediments along the steep NW and SE slopes.

Due to gas migration into the deep basin sediments, the acoustic signal was absorbed 5 m below the lake floor. However two key horizons (KH1 & KH2) producing high amplitude reflections (Figure 1) can clearly be correlated to specific sedimentary facies in cores AC05-C and B. These horizons are characterized by lower gamma density values and KH2 contains up to 12 % of organic matter while surrounding sediments generally contains around 8%.

KH2 is laterally associated with the development of a former littoral facies buried below KH1 down to 34 m depth. This specific geometry results from a phase of low-lake level during formation of KH2. Based on the present-day repartition of the littoral facies, we suggest a lake regression of ca. 9 m during the sedimentation of KH2.

Similarly, KH1 is laterally associated with the development of a thin former littoral facies deposited down to 32 m depth. KH 1 is thus also interpreted as resulting from a phase of low-lake level but during this more recent phase, c. 7 m of lake lowering was associated with the development of significant littoral sediment sliding (Figure 1) and remolded large parts of the deep basin. At the coring site AC05-B for example this key horizon is covering a clear turibite deposit that can be followed on several short cores across the basin.

Based on available radiocarbon dating in the piston cores, the low-lake level phase associated with KH1 occurred around 860 cal yrs BP, while the phase associated with KH2 lasted during most of the Bronze Age period, between c. 3700 and 2800 cal yrs BP. Two sedimentary facies associated with lower gamma densities where also recognized in the lower part of core AC05-B and suggest phases of lake regression between c. 4600 to 4300 yrs cal BP and 8600 to 7900 yrs cal BP.

The development of sediment slides in this lake suggests reduced sediment stability resulting from the occurrence of (i) gas (sulfur) in the sediments, (ii) steep slopes and (iii) lake level regressions. Sulfur in sediments from Lago dell'Accesa is probably related to the hydrothermal setting of the study area.

This study shows that selection of long coring site for paleoclimate reconstructions in such type of small but deep lake of karstic origin should be based on a high-resolution seismic reflection survey.

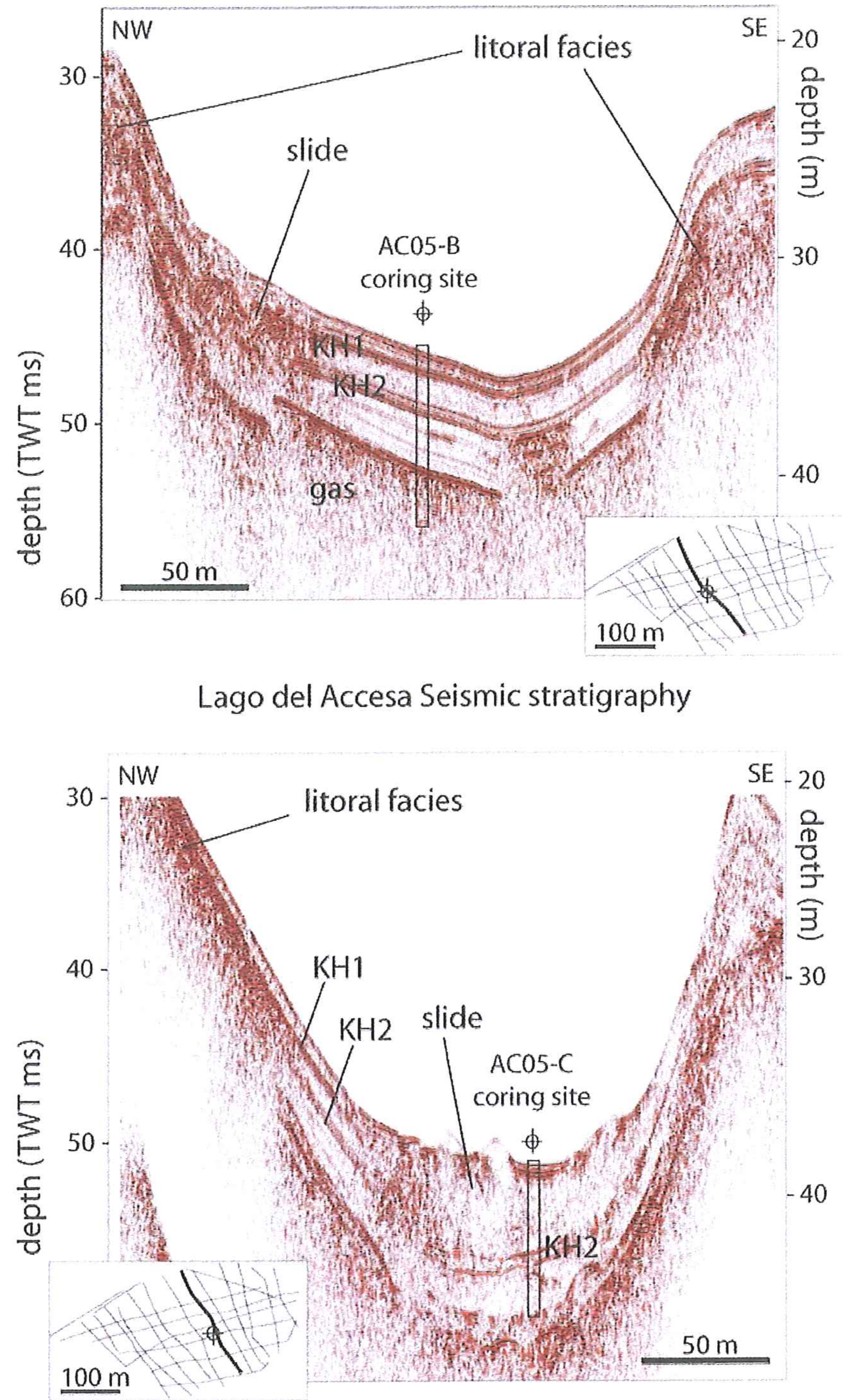

Figure 1: Illustration of basin fills geometries along two seismic profiles in Lago dell'Accessa where piston cores were selected into undisturbed sediments (AC05-B) and into slide deposits (AC05-C). Note that key horizons KH1 &2 can be correlated across most of the deep lake basin.

Modern pollen assemblages as climate indicators on the Italian Peninsula

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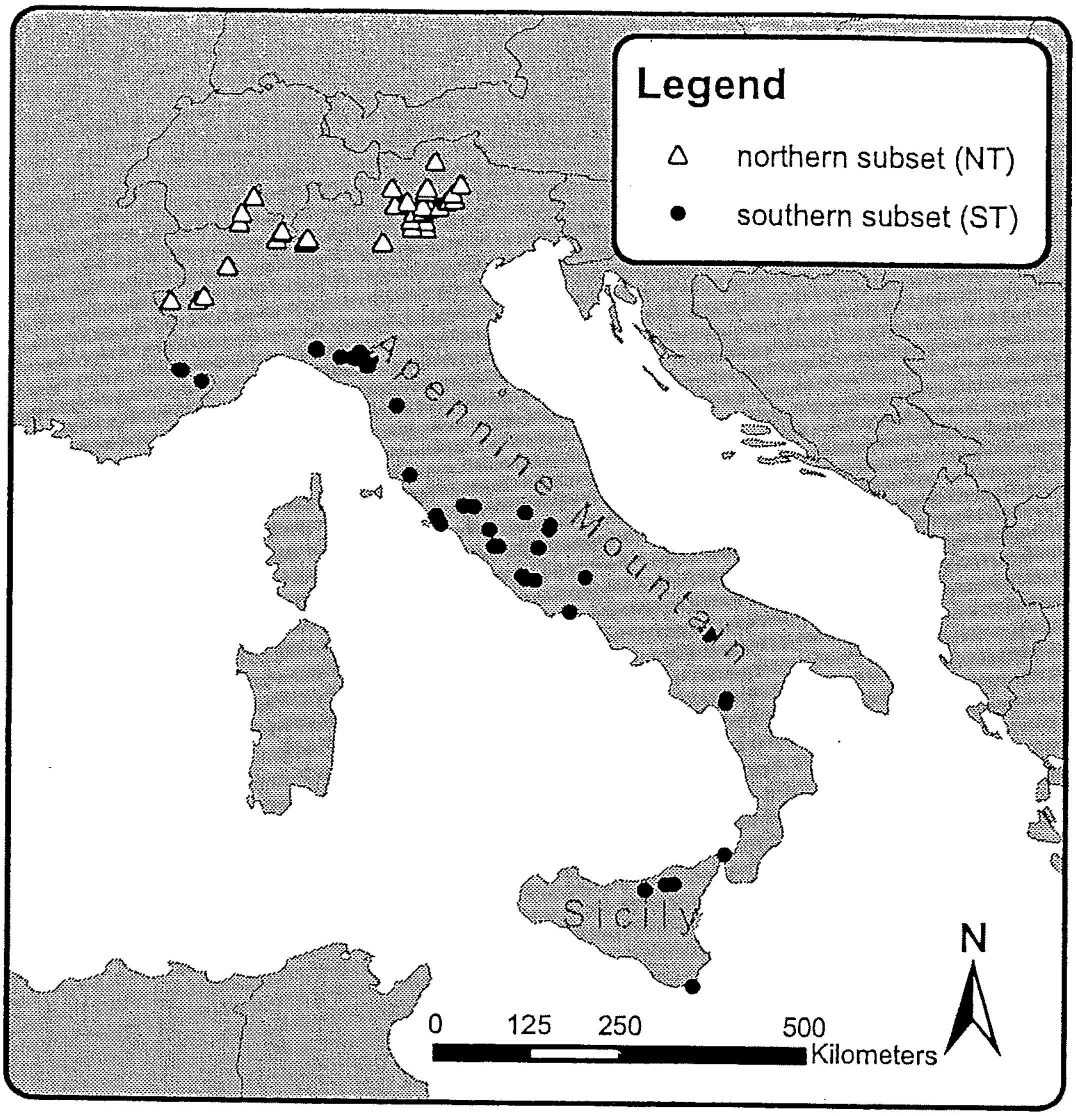
Our aim is to develop pollen-climate inference models for southern Europe and test their performance and inference power by cross-validation with modern climate data. Surface sediments collected from lakes along a climate gradient from the winter-cold/summer-wet Alps to winter-wet/summer-dry Sicily were analyzed for modern pollen assemblages.

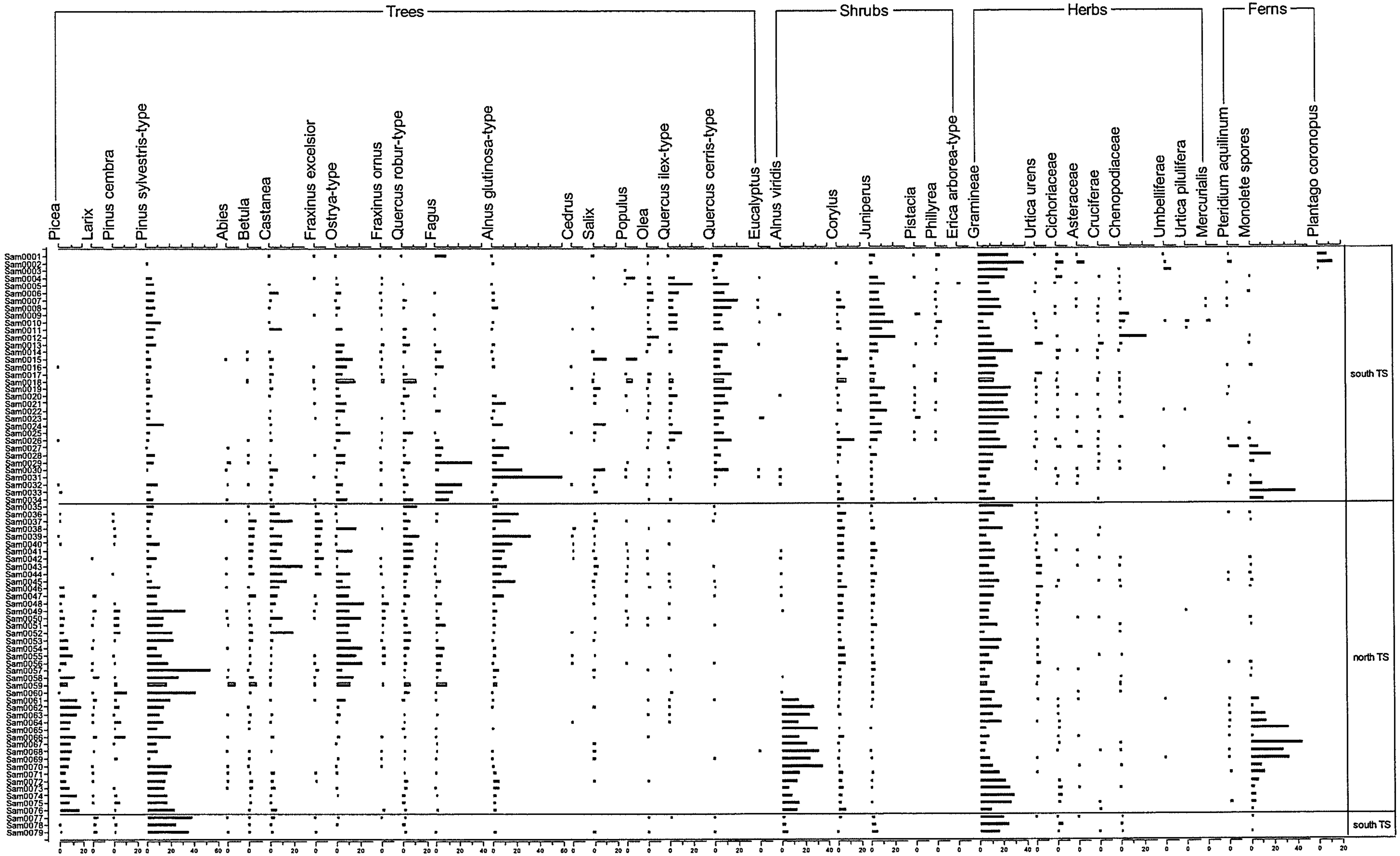
For each lake mean monthly temperatures, seasonal precipitation, and site specific climate uncertainties have been estimated. Pollen-climate relationships were studied using numerical analyses, and inference models were derived by partial-least squares (PLS) and weighted-average-PLS (WA-PLS) regressions for January and July temperatures (T), and for winter, spring and summer precipitation (P).

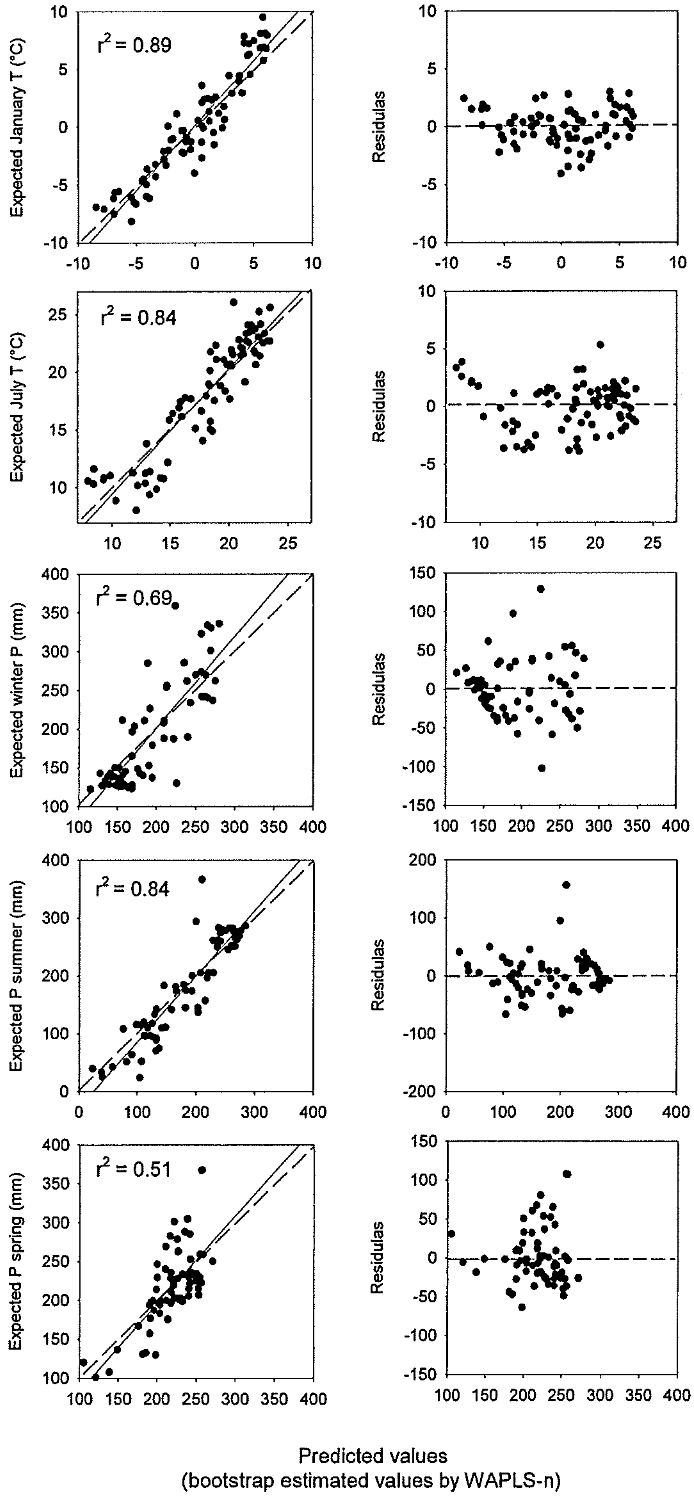
Low bootstrap cross-validated root-mean square-errors of prediction (RMSEP) for January T (1.7 °C), July T (2.1 °C), and summer P (38mm) as well as low RMSEPs expressed as a percentage of the gradient length (8-9%) indicate a good inference power. Models revealed excellent to good performance statistics for January T, July T, and summer P ($r^2 = 0.8$), and for winter and spring P ($r^2 = \sim 0.5$).

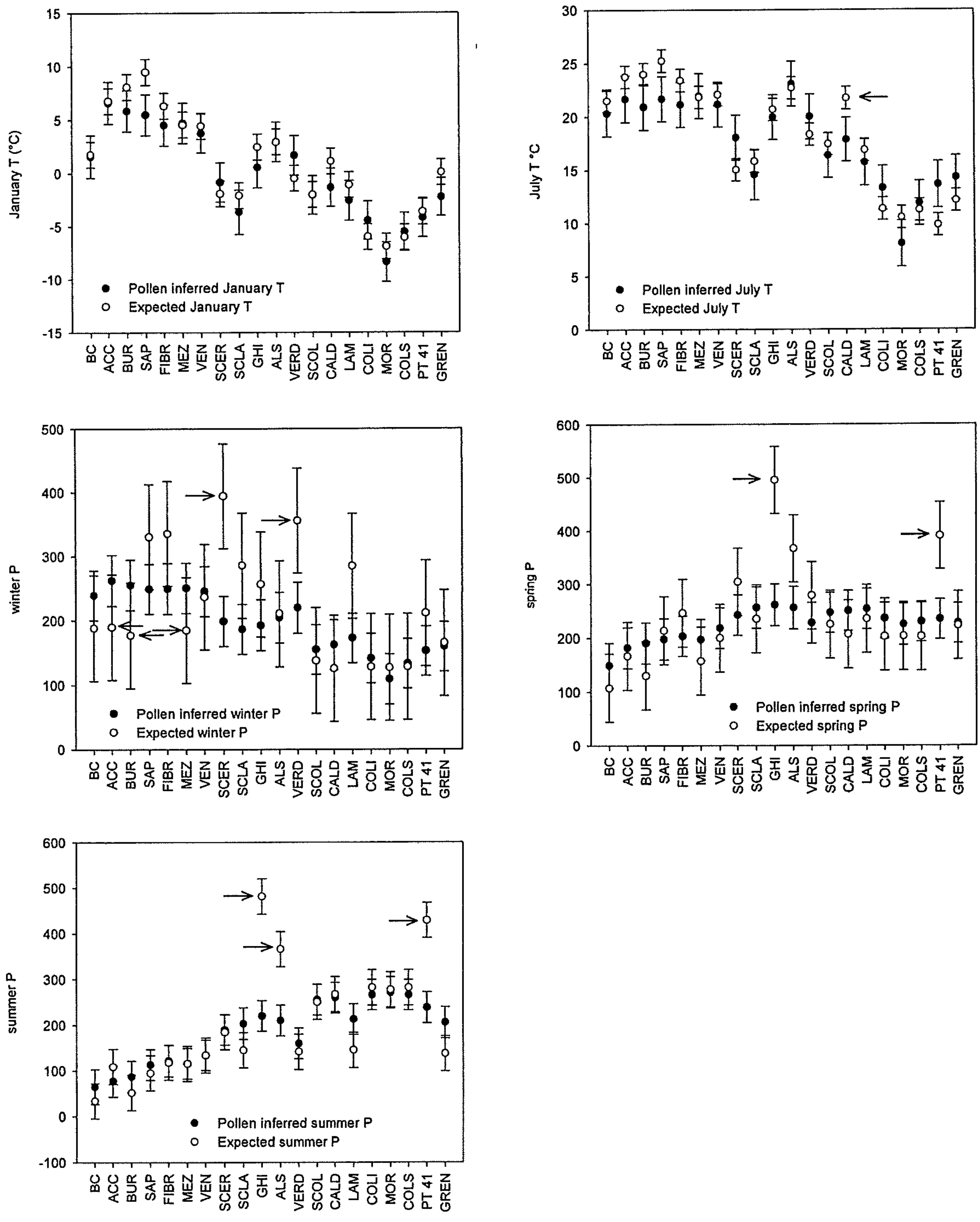
Despite a long history of human activities on the landscape, the study reveals the influence of climate conditions on modern pollen assemblages and indicates the potential of pollen data for long-term climate reconstructions. These models may therefore provide important information on past regional climate variability in Southern Europe.


Legend
northern subset (NT)
southern subset (ST)
Apennine Mountain
Sicily
N
0 125 250 500
Kilometers

Distribution of pollen taxa along the north-south gradient of the lakes.
Pollen percentages




r² = 0.89
Expected January T (°C)
r² = 0.84
Expected July T (°C)
r² = 0.69
Expected winter P (mm)
r² = 0.84
Expected P summer (mm)
r² = 0.51
Expected P spring (mm)
Residulas
Predicted values
(bootstrap estimated values by WAPLS-n)


January T (°C)
Pollen inferred January T
Expected January T
July T °C
Pollen inferred July T
Expected July T
winter P
Pollen inferred winter P
Expected winter P
spring P
Pollen inferred spring P
Expected spring P
summer P
Pollen inferred summer P
Expected summer P
BC ACC BUR SAP FIBR MEZ VEN SCER SCLA GHI ALS VERD SCOL CALD LAM COLI MOR COLS PT 41 GREN


4) To Bergamo
3) Lago Trasimeno
1) Lago dell'Accesa
2) M.te Amiata
Pistoia
Prato
Montecatini Terme
A 11
Lucca
Altopascio
Firenze
Pisa
Empoli
Incisa Val d'Arno
San Giovanni Valdarno
Sansepolcro
Livorno
A 12/E 80
Arezzo
Poggibonsi
Volterra
TOSCANA
Siena
Cecina
Castiglion Fiorentino
SS 3bis/E 45
Sinalunga
Pienza
Follonica
Grosseto
Piancastagnaio
A 1/E 35
Acquapendente
Orvieto
20 km

Late glacial and Holocene vegetation and climate development at Lago Trasimeno (Umbria, Central Italy)

RUTH DRESCHER-SCHNEIDER

The site

Lago Trasimeno (258 m a.s.l., 43°6' N, 12°11' E) is located on the western border of the Central Apennines in the Perugia province. The surrounding hills reach not more than 800 m a.s.l. (M. Castiglione).

Originally the basin was without outlet. The consequences were regular water level oscillations of several meters. Attempts to control the water level (first during Roman time) let to poor results. After the construction of a new channel (1895-1898) and the following danger of drying up of the lake(late 1950's, depth 2,93 m only) some tributaries of Lago di Chiusi are diverted to Lago Trasimeno.

Results

The pollen diagram provides a record of vegetation and climatic change spanning over 15000 years. The Late glacial section covers only 17 cm of the 4,6 m long core.

The **sediment** composes of fine detritus gyttja with rest of molluscs (Holocene), silty and sandy gyttja (early Holocene, YD, LGI) and very dry silt during Full glacial. According to the radiocarbon dates the rate of sediment deposition is irregular during the Holocene: ±1,25 mm/y between 8300 and 7000 cal BP and ±0,19 mm/y only between 5700 and 3000 cal BP.

The pollen spectra of the lowest 40 cm show a ± **treeless steppe vegetation** with very high percentages of Chenopodiaceae and *Artemisia.* The **Lateglacial Interstadial** (13cm) is dominated by open decidous oak forests. The **Younger Dryas** (5 cm) is characterised by a week decrease of the deciduous oaks and higher values of NAP (Cichorioideae). *Ruppia marittima* lets to think to a special salty environment during the Late glacial.

The **Holocene** vegetation is dominated by deciduous oak forests. Only the first *Q.ilex* dominance between ca. 8300 and 7300 cal BP is developed in Lago Trasimeno. At that time *Abies* is only very weekly present on the surrounding hills, whereas *Fagus* is a more important component of the deciduous forests.

The position of the core is too fare from the shore and the vegetation influence by man. Therefor the signs of **Human impact** in the pollen record is week. It starts at about 8000 cal BP and increases at ca. 2900 cal BP during late Bronze Age. *Castanea* and *Juglans* pollen is recorded most probably from ca 2800 cal BP.

References

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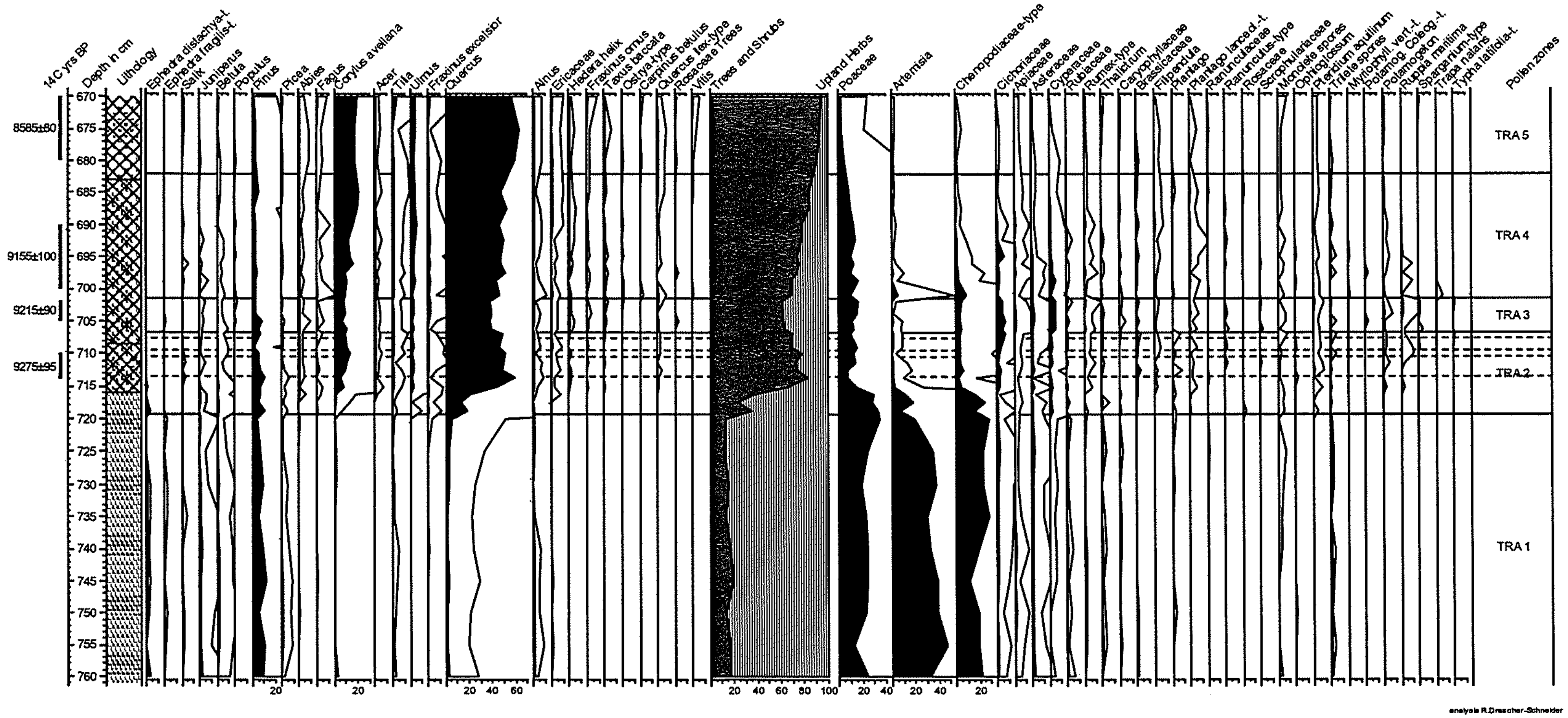
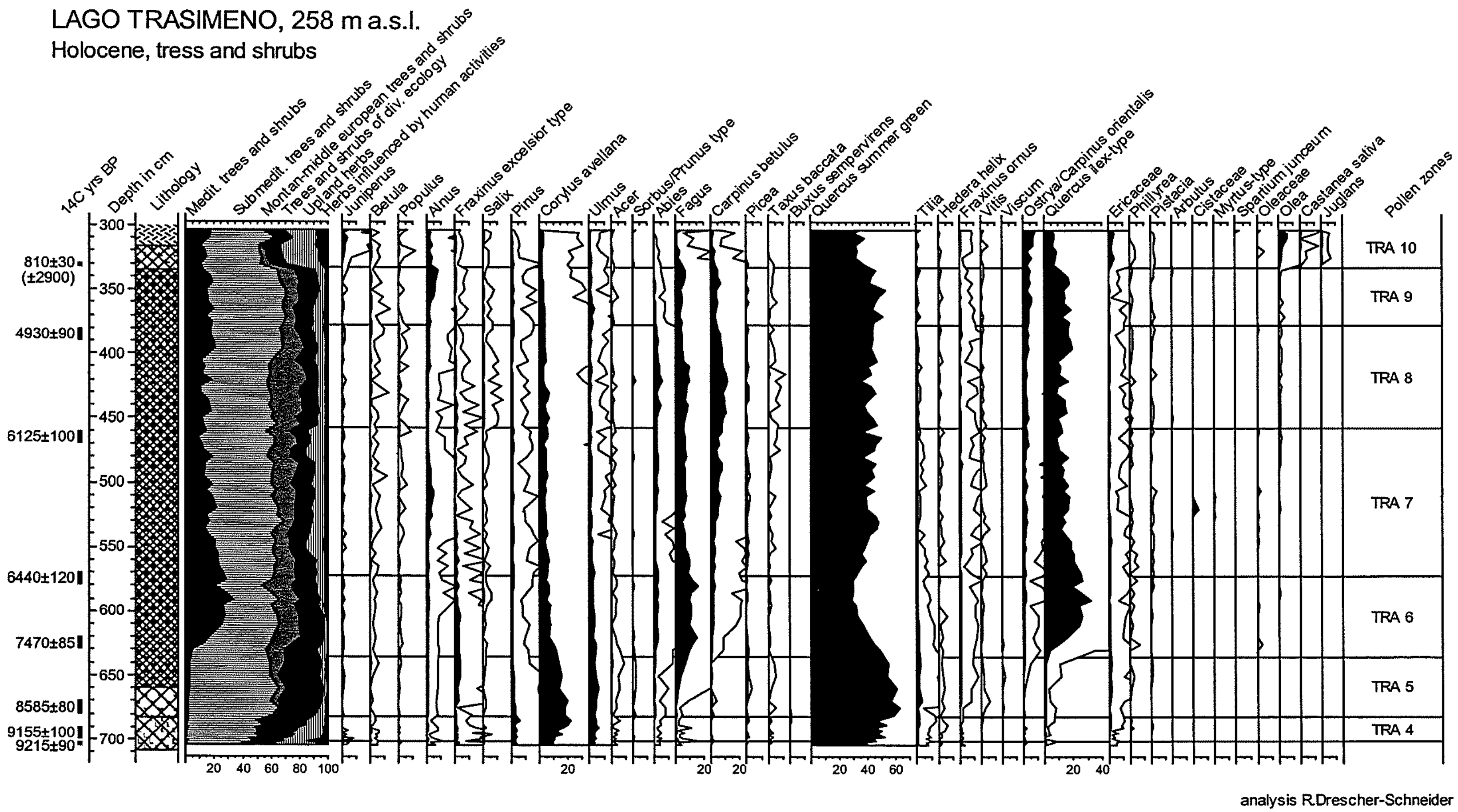
Orsomando E., Catorci A. (eds.)(1991). Carta della vegetazione del comprensorio Trasimeno. Dip. di Botanica de Ecologia, Univ. degli Studi di Camerino; Editrice Grafica L'Etruria s.r.l., Cortona (AP), 118 pp, 1 map.

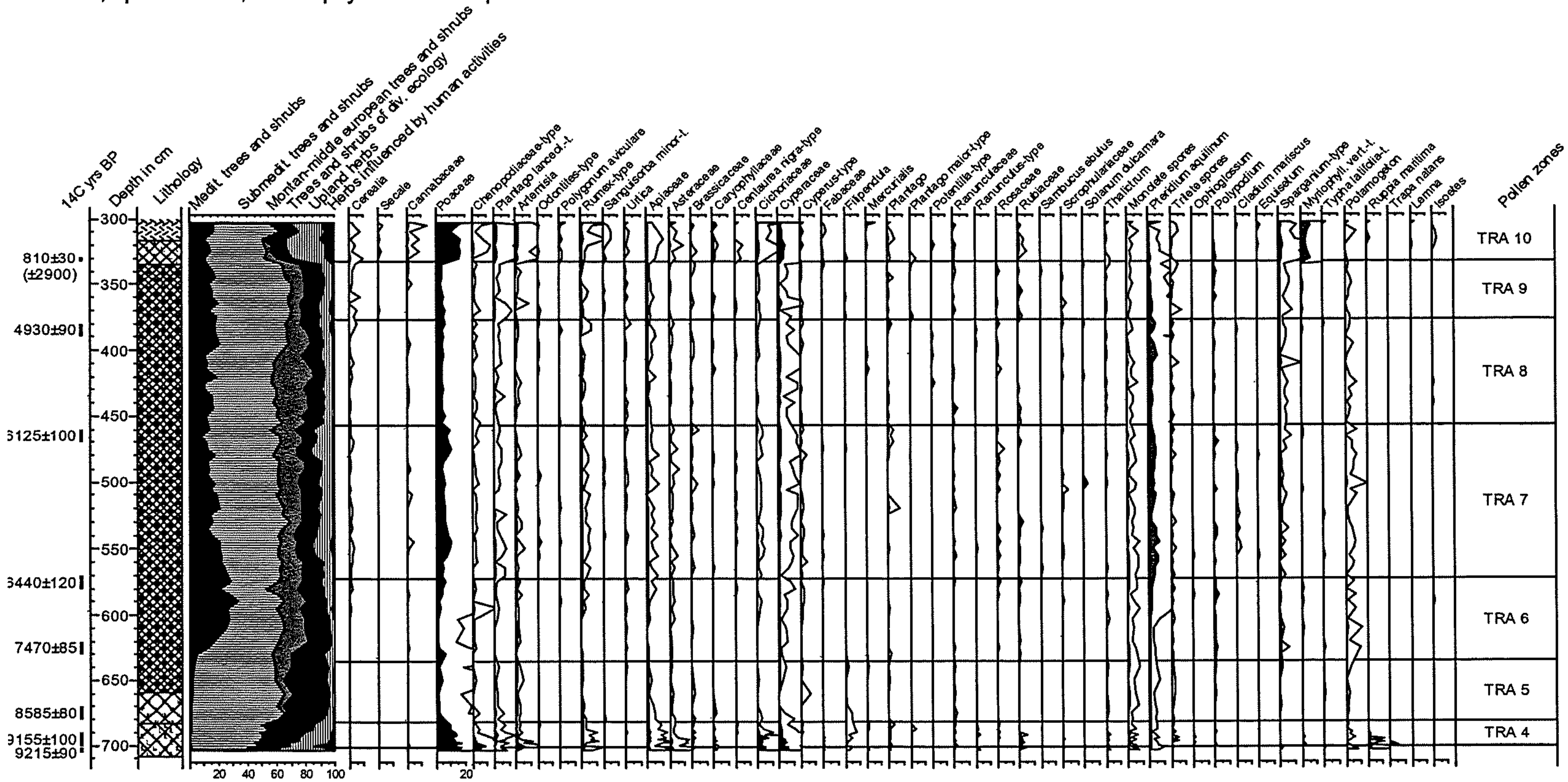
LAGO TRASIMENO, 258 m a.s.l.
Late Glacial




LAGO TRASIMENO, 258 m a.s.l.
Holocene, tress and shrubs
14C yrs BP
Depth in cm
Lithology
Medit. trees and shrubs
Submedit. trees and shrubs
Montan-middle european trees and shrubs
Trees and shrubs of div. ecology
Upland herbs
Herbs influenced by human activities
Juniperus
Betula
Populus
Alnus
Fraxinus excelsior type
Salix
Pinus
Corylus avellana
Ulmus
Acer
Sorbus/Prunus type
Abies
Fagus
Carpinus betulus
Picea
Taxus baccata
Buxus sempervirens
Quercus summer green
Tilia
Hedera helix
Fraxinus ornus
Vitis
Viscum
Ostrya/Carpinus orientalis
Quercus ilex-type
Ericaceae
Phillyrea
Pistacia
Arbutus
Cistaceae
Myrtus-type
Spartium junceum
Oleaceae
Olea
Castanea sativa
Juglans
Pollen zones
810±30
(±2900)
4930±90
6125±100
6440±120
7470±85
8585±80
9155±100
9215±90
300
350
400
450
500
550
600
650
700
20 40 60 80 100
20
20 20
20 40 60
20 40
TRA 10
TRA 9
TRA 8
TRA 7
TRA 6
TRA 5
TRA 4
analysis R.Drescher-Schneider

LAGO TRASIMENO, 258 m a.s.l.

Holocene, upland herbs, Pteridophyta and water plants



analysis R.Drescher-Schneider

Kalibrationstabelle

BP	AD/BC	CalAD/BC
100		1830
	1800	1810
200		1810
	1700	1660
300		1590
	1600	1560
400		1470
	1500	1440
500		1430
	1400	1410
600		1360
	1300	1340
700		1290
	1200	1280
800		1250
	1100	1210
900		1120
	1000	1090
1000		1020
	900	1000
1100		940
	800	920
1200		840
	700	760
1300		720
	600	670
1400		650
	500	630
1500		580
	400	540
1600		480
	300	410
1700		370
	200	290
1800		270
	100	180
1900		110
	0	70
2000		30
	100	-30
2100		110
	200	180
2200		270
	300	290
2300		380
	400	400
2400		410
	500	590

BP	BC	CalBC
2500		650
	600	780
2600		800
	700	810
2700		830
	800	870
2800		940
	900	980
2900		1070
	1000	1160
3000		1220
	1100	1320
3100		1360
	1200	1410
3200		1470
	1300	1520
3300		1560
	1400	1610
3400		1710
	1500	1720
3500		1810
	1600	1840
3600		1940
	1700	2000
3700		2080
	1800	2120
3800		2210
	1900	2270
3900		2400
	2000	2460
4000		2510
	2100	2540
4100		2720
	2200	2750
4200		2790
	2300	2880
4300		2900
	2400	2960
4400		2980
	2500	3150
4500		3210
	2600	3240
4600		3360
	2700	3430
4700		3440
	2800	3510
4800		3590
	2900	3650

BP	BC	CalBC
4900		3680
	3000	3740
5000		3780
	3100	3870
5100		3890
	3200	3970
5200		3990
	3300	4040
5300		4130
	3400	4190
5400		4280
	3500	4300
5500		4350
	3600	4400
5600		4410
	3700	4480
5700		4520
	3800	4610
5800		4660
	3900	4740
5900		4790
	4000	4850
6000		4880
	4100	4940
6100		5000
	4200	5120
6200		5150
	4300	5190
6300		5250
	4400	5280
6400		5330
	4500	5380
6500		5410
	4600	5440
6600		5510
	4700	5550
6700		5560
	4800	5600
6800		5640
	4900	5690
6900		5720
	5000	5770
7000		5860
	5100	5900
7100		5930
	5200	5980
7200		6010
	5300	6060

BP	BC	CalBC	BP	BC	CalBC	BP	BC	CalBC
7300		6110	9700		8980	12100		12170
	5400	6130		7800	9020		10200	12230
7400		6200	9800		9040	12200		12290
	5500	6280		7900	9050		10300	12360
7500		6310	9900		9090	12300		12420
	5600	6390		8000	9210		10400	12490
7600		6430	10000		9330	12400		12560
	5700	6440		8100	9470		10500	12630
7700		6500	10100		9620	12500		12700
	5800	6530		8200	9870		10600	12770
7800		6580	10200		10000	12600		12850
	5900	6620		8300	10100		10700	12930
7900		6690	10300		10200	12700		13000
	6000	6850		8400	10270		10800	13080
8000		6890	10400		10340	12800		13170
	6100	6930		8500	10410		10900	13250
8100		7040	10500		10470	12900		13330
	6200	7140		8600	10520		11000	13410
8200		7160	10600		10580	13000		13490
	6300	7210		8700	10630		11100	13570
8300		7360	10700		10680	13100		13640
	6400	7400		8800	10730		11200	13720
8400		7460	10800		10780	13200		13790
	6500	7480		8900	10830		11300	13870
8500		7520	10900		10880	13300		13940
	6600	7550		9000	10920		11400	14010
8600		7560	11000		10970	13400		14080
	6700	7630		9100	11010		11500	14150
8700		7730	11100		11060	13500		14210
	6800	7800		9200	11110		11600	14280
8800		7830	11200		11160	13600		14350
	6900	7940		9300	11210		11700	14410
8900		7970	11300		11260	13700		14470
	7000	8000		9400	11310		11800	14540
9000		8030	11400		11360	13800		14600
	7100	8060		9500	11410		11900	14660
9100		8080	11500		11470	13900		14720
	7200	8200		9600	11520		12000	14780
9200		8210	11600		11580	14000		14840
	7300	8270		9700	11630		12100	14900
9300		8330	11700		11690	14100		14960
	7400	8380		9800	11750		12200	15020
9400		8420	11800		11810	14200		15080
	7500	8630		9900	11860		12300	15140
9500		8660	11900		11920	14300		15190
	7600	8720		10000	11980		12400	15250
9600		8790	12000		12040	14400		15310
	7700	8860		10100	12100		12500	15360

BP	BC	CalBC
14500		**15420**
	12600	**15480**
14600		**15530**
	12700	**15590**
14700		**15640**
	12800	**15700**
14800		**15750**
	12900	**15810**
14900		**15860**
	13000	**15910**
15000		**15970**
	13100	**16020**
15100		**16070**
	13200	**16120**
15200		**16170**
	13300	**16220**
15300		**16270**
	13400	**16320**
15400		**16370**
	13500	**16410**
15500		**16460**
	13600	**16510**
15600		**16550**
	13700	**16600**
15700		**16650**
	13800	**16690**
15800		**16740**
	13900	**16780**
15900		**16830**
	14000	**16880**
16000		**16930**
	14100	**16980**
16100		**17030**
	14200	**17080**
16200		**17130**
	14300	**17180**
16300		**17240**
	14400	**17300**
16400		**17350**
	14500	**17410**
16500		**17470**
	14600	**17540**
16600		**17600**
	14700	**17670**
16700		**17730**
	14800	**17800**
16800		**17870**
	14900	**17940**

BP	BC	CalBC
16900		**18010**
	15000	**18080**
17000		**18160**
	15100	**18230**
17100		**18300**
	15200	**18380**
17200		**18450**
	15300	**18520**
17300		**18600**
	15400	**18670**
17400		**18740**
	15500	**18810**
17500		**18880**
	15600	**18940**
17600		**19010**
	15700	**19080**
17700		**19150**
	15800	**19210**
17800		**19280**
	15900	**19340**
17900		**19410**
	16000	**19470**
18000		**19540**
	16100	**19600**
18100		**19660**
	16200	**19730**
18200		**19790**
	16300	**19850**
18300		**19920**
	16400	**19980**

Kalibriert mit Radiocarbon Calibration Program 1993, Rev. 3.0 des Quaternary Isotope Lab der University of Washington (M. Stuiver und P.J. Reimer, Radiocarbon 35, 1993, 215-230).

Die Basis bildet die 20Jahre-Intervall-Kurve aufgrund der Dendrokurve bis 9440 cal BC und eine erschlossene athmosphärische Kurve aufgrund von Korallendaten bis 20000 cal BC.

Die Daten wurden von 100-10950 BP mit $\sigma \pm 20$ errechnet, dann gemittelt und auf 10 Jahre gerundet; ab 11000 BP wurden die Schnittpunkte auf der Kurve auf 10 Jahre gerundet.