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Vegetational history of the "Gran Bosco di Salbertrand" (Val di Susa, NW Italy) by means of pollen analysis

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ABSTRACT

BRAGGIO, G. †, L. CORNARA, S. PLACEREANI, M. A. GUIDO & C. MONTANARI (2000). Vegetational history of the "Gran Bosco di Salbertrand" (Val di Susa, NW Italy) by means of pollen analysis. *Candollea* 55: 187-199. In English, English and French abstracts.

The pollen diagram for a peat bog near Col Blegier (2350 m a.s.l.) can be divided into 3 pollen zones: the oldest part (SAL 1) is characterised by a maximum of pine pollen (*Pinus mugo/sylvestris* type, with a little *P. cembra-t.*), suggesting local occurrence of sub-Alpine scrub. An intermediate zone (SAL 2) shows an abrupt drop in the pollen concentration, interpreted as a reduction of pine scrub near the site. Pollen zone SAL 3 coincided with the beginning of peat deposition, with an increase of heliophilous species and many taxa typical of Alpine grasslands, as well as anthropogenic indicators. The middle of zone SAL 3 has a radiocarbon date of 1360 ± 60 B.P., calibrated to A.D. 640-685. The most interesting aspect may be the proof of the presence of a mountain pine scrub, which in the late Atlantic reached the ridge and surrounded what then was a small lake on a pass. Interpretation of the diagram was aided by the pollen analysis of moss polsters taken from the edge of the peat bog.

RÉSUMÉ

BRAGGIO, G. †, L. CORNARA, S. PLACEREANI, M. A. GUIDO & C. MONTANARI (2000). Analyses polliniques pour l'histoire de la végétation du "Gran Bosco de Salbertrand" (Vallée de Susa, Turin). *Candollea* 55: 187-199. En anglais, résumés anglais et français.

Les auteurs ont effectué l'analyse pollinique du sédiment, qui atteint 480 cm, de la tourbière du Col Blegier (2350 m) située dans le Parc du "Gran Bosco de Salbertrand". On a obtenu, au niveau de 150 cm, une datation au radiocarbone de 1360 ± 60 ans BP qui répond à la date calibrée de 640-685 AD. On a observé aussi le dépôt pollinique récent par l'étude des pollens contenus dans des coussinets de bryophytes prélevés au bord de la tourbière. La partie la plus ancienne du diagramme pollinique est caractérisée par la prédominance absolue du pollen de *Pinus*. Pendant une phase intermédiaire on observe la diminution de la concentration pollinique, qui dénote l'éclaircie ou l'éloignement de la pinède. Au passage Subboréal-Subatlantique apparaissent beaucoup de taxa herbacés (*Cyperaceae*, *Lycopodiaceae, Selaginella*) et on trouve aussi la nouvelle présence d'indicateurs anthropiques (*Castanea, Juglans, Plantago*, *Urticaceae*, *Cerealia*). L'aspect le plus intéressant est la présence d'une brousse à *Pinus montana* s.l. qui, pendant le passé (Atlantique), atteignait et entourait le bassin.

KEY-WORDS: Pollen analysis – Vegetation history – Tree-line – W Alps – Italy – Holocene.

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Introduction

The "Gran Bosco di Salbertrand" (Great Salbertrand Wood) is "an oasis of mesophilous forest vegetation among the typically xerophilous plant communities of the Val di Susa" (MORANDINI & al., 1969). Its specific features induced these authors to carry out an accurate study of the flora, vegetation, climate, pedology, and forestry of this remarkable phytocoenosis, in order to describe all these features and identify their origin. The current Director of the "Gran Bosco di Salbertrand" nature park, Mr. Elio Pulzoni, urged us to undertake palaeoecological studies in this area, with the aim of expanding knowledge particularly about the origin and the remote history of such an interesting biotope, which has warranted the creation of this special nature park. The protected area covers about 2000 hectares, of which 70% is woodland and 30% grassland (Fig. 1). Some 700 hectares consist of mixed conifer forest with silver fir *(Abies alba* Miller) and spruce (*Picea abies* (L.) Karsten), and this is the most significant and peculiar part of the whole complex (MORANDINI & al., 1969).

Description of the territory

In order to evaluate briefly the environmental features of the area, it is necessary to provide some concise informations on the most important plant communities, mainly on the basis of the paper referred to above (MORANDINI & al., 1969).

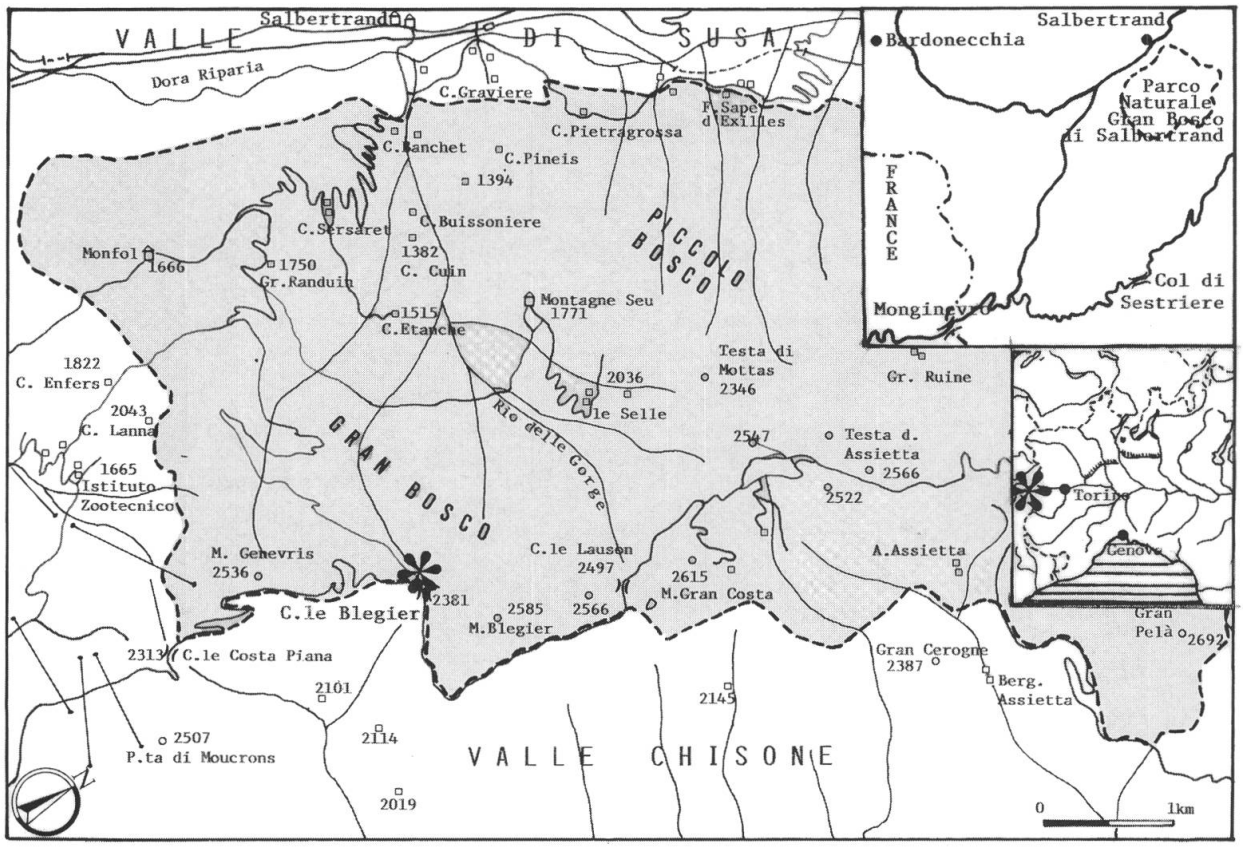

Fig. 1. – Map of the study area. The location of the drilling near Col Blegier is highlighted by an asterisk. The shaded area shows the Nature Park of "Gran Bosco di Salbertrand".

The park extends as far as the valley of Rio delle Gorge, a tributary on the right-hand side of the Dora Riparia River, which runs through the Susa Valley. This side-valley is occupied to a great extent by the "Gran Bosco" and by a smaller woodland known as the "Piccolo Bosco" (Small Wood). The altitude rises from about 1000 m a.s.l. at the bottom of the valley up to 2500 m on the main crest (Fig. 1). At the highest altitudes, Alpine grassland prevails, stretching downwards in digitations and consisting of secondary grassland and meadows. Above 2300-2400 m, acidophilous pastures (*Nardus stricta* L. communities) prevail, with patches of heathland (with *Vaccinium* spp., *Juniperus nana* Willd., *Salix* spp., *Rhododendron ferrugineum* L.). Pioneer plant communities with basiphilous species live on the debris of calcareous schists, which are the parent rocks of this area. Among these *Dryas octopetala* L. should be mentioned. The upper forest belt, characterised by larch (*Larix decidua* Miller) and stone pine (*Pinus cembra* L.), is developed between 2300 and 1900 m, where rhododendron (*Rhododendron ferrugineum* L.), bilberry (*Vaccinium myrtillus* L.) and other species of sub-Alpine heathland, typical of soils containing acid raw humus, are widespread in the underbrush. Below a transition belt (1900-1700 m), in which the species of the larch-stone pine community still prevail, there is a wide belt of mesophilous wood (1900-1400 m), where silver fir and spruce prevail. As already pointed out, this is the most interesting part of the area for it is not consistent with the regional climate, which is typically continental-dry (climate stations in the vicinity record an average rainfall of 700 mm per year, with an atypical trend for the Alpine region, i.e. equinoctial maximum values). The summers are therefore dry, but atmospheric moisture is provided by mists persisting in the "Gran Bosco" area. Snow is plentiful in winter and is long-lasting due to the altitude (from November to May at 1800 m). As a consequence of the peculiar mesoclimatic features, the flora of the fir and spruce wood comprises many mesophilous species typical of montane woodland rather than the sub-Alpine zone, including silver fir itself, which on the whole appears to be more competitive than spruce. It is accompanied by *Veronica urticifolia* Jacq., *Euphorbia dulcis* L., *Trochyscanthes nodiflora* (All.) Koch, *Paris quadrifolia* L., *Aegopodium podagraria* L., *Actaea spicata* L., etc. Meso-hygrophilous species, which are common in the larch-stone pine wood and in the transition areas, and those with a wide ecology, on the other hand, are absent or sporadic. Other aspects, referred mainly to the dynamics of these plant communities, are considered in the framework of the results of the pollen analysis.

Palaeobotanical study

A wide peat bog close to Col Blegier at an altitude of about 2500 m provided an opportunity to carry out palaeobotanical research, in particular pollen analysis, in order to investigate the history of the vegetation of the "Gran Bosco" and of the surrounding area (BRAGGIO & al., 1996). Information of this type on neighbouring areas (Chisone Valley, see Fig.1) has already been published by CHARRIER (1967, 1970). There are also a number of pollen diagrams referred to many other areas in the western Alps (e.g. AROBBA & IMPERIALE, 1981; CHARRIER, 1967, 1970; CHARRIER & PERETTI, 1977; KELLER, 1932; BERTOLANI MARCHETTI, 1955; BRAGGIO & al., 1993; Aosta Valley: BRUGIAPAGLIA, 1996, MENOZZI, 1997; Maritime Alps: DE BEAULIEU, 1977).

Methods

Palynological sampling was carried out with a hand-operated Hiller peat borer, to a depth of about 500 cm at the centre of the peat bog (August 1992). We were unable to reach deeper layers because of sharp-angled gravel, possibly relating to the rocky bottom of the basin. It is well-known that this type of corer causes contamination of the samples, and the results must therefore be considered with caution, at least as far as isolated grains and small quantities of pollen are concerned.

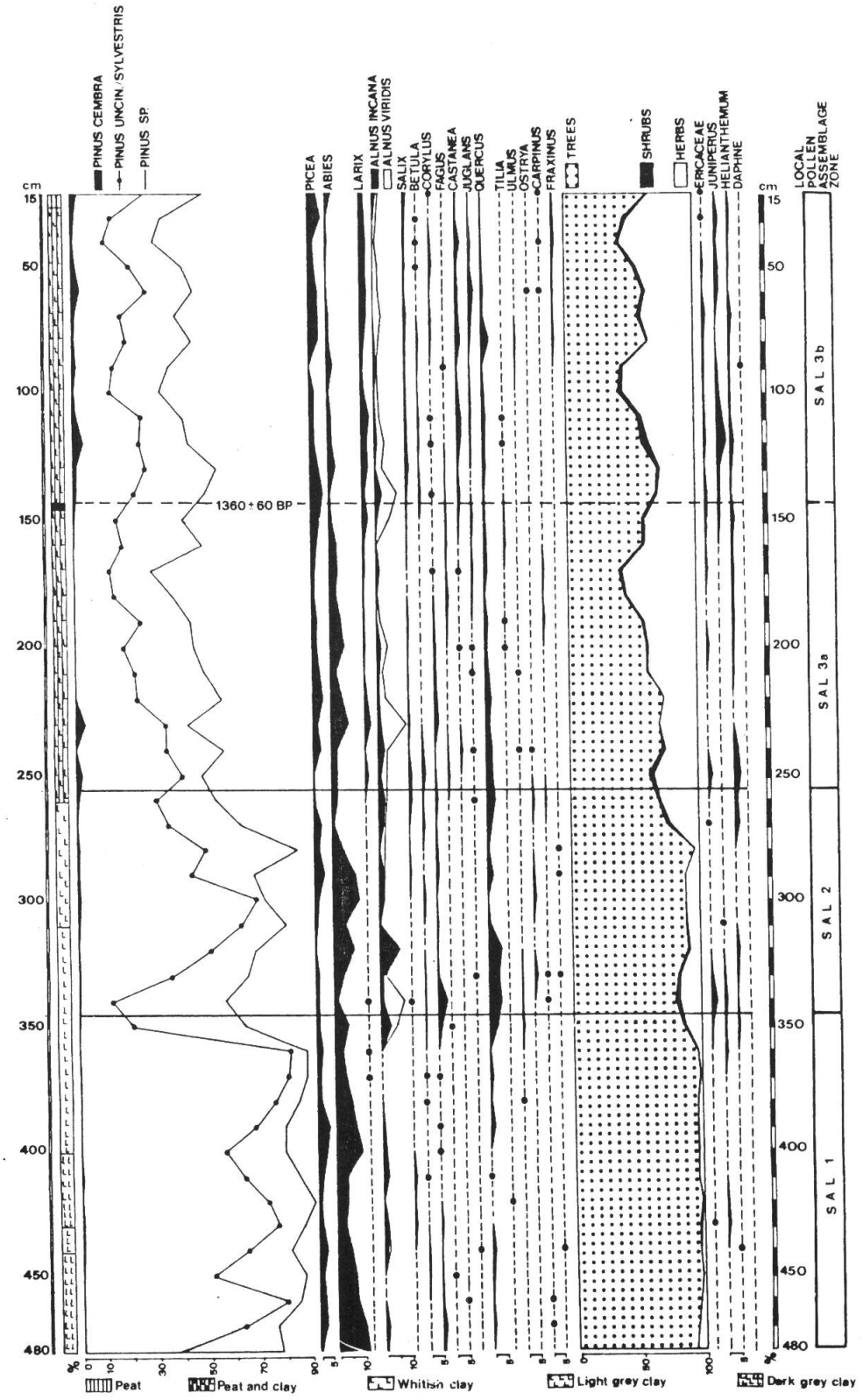

Fig. 2a. – Pollen diagram obtained from the sediments of the Col Blegier peat bog showing tree and shrub pollen. The percentages of upland plants are calculated on the basis of total land pollen (TLP).

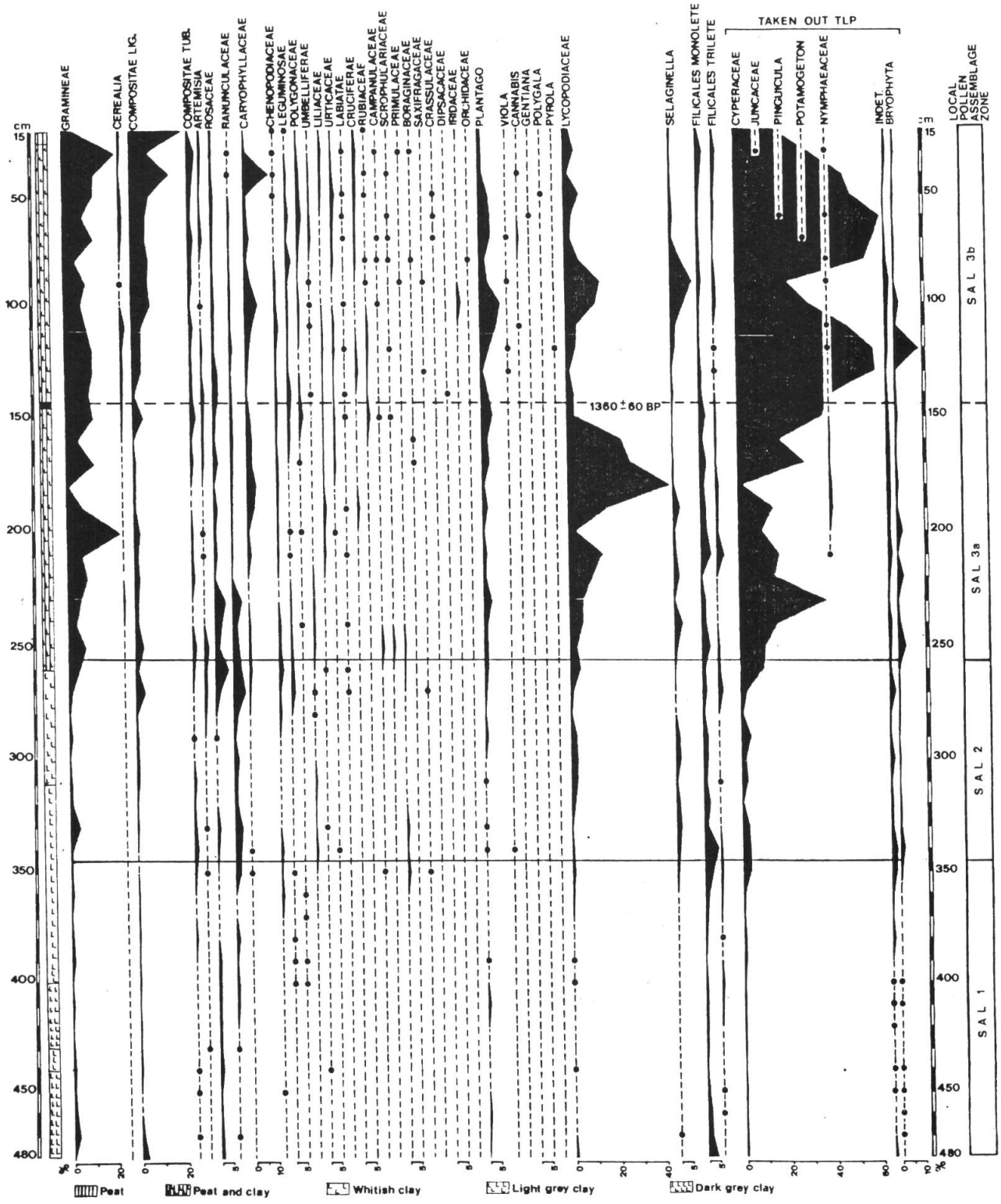

Fig. 2b. – Pollen diagram obtained from the sediments of the Col Blegier peat bog showing herb pollen. The percentages of upland plants are calculated on the basis of total land pollen (TLP).

The pollen and spores were extracted and concentrated using the standard methods, that is to say HCl 10%, NaOH 10% in a boiling bath, cold HF 40%, several washings, centrifugations and acetolysis. The residue was preserved in a mixture of water and glycerol (1:1). Pollen counting was carried out at a magnification of 400-1000 x, while the pollen concentration was calculated as the number of pollen grains per gram of dry sediment (APF, cf. ACCORSI & RODOLFI, 1975). The pollen sum consisted of all the pollen and spores from the upland plants (TLP), and the percentages of hydro-hygrophilous taxa were calculated on a pollen sum including TLP + pollen from each wetland taxon. The recent pollen deposition was investigated by means of the pollen analysis of moss polsters taken from the four cardinal points, at the edge of the marshland.

Stratigraphy of the sediments

The profile examined (see Fig. 2a-2b) consisted of clay varying in colour from whitish to dark grey in the lower half (depth 480 to about 260 cm). Above this level, organic matter consisting of peat mixed with clay became more abundant. The layers above 230-240 cm did not react with HCl, and a clear reaction with HF was only found for the samples corresponding to 430-440 cm. The peat was compact and homogeneous, with no recognizable macroremains that would have been useful for interpreting the local palaeoenvironment. In any case, no specific macrofossil study was carried out.

Pollen diagram

The pollen diagram is based on 50 sub-samples, taken at intervals of 10 cm (Fig. 2a-2b). The pollen concentration was uneven, ranging from a few hundred up to 100,000 grains per gram of dry sample. Specifically, below 350 cm the APF was much higher, while above this level the concentration was low, exceeding 2500 only near the surface (Fig. 3). Surface spectra obtained from moss polsters showed APF's of 77,000-150,000 (Fig. 4 and Fig. 5), not much higher than in some of the oldest layers. On the whole, sedimentation seemed to be continuous for both mineral and organic matter, and only few stratigraphic changes useful for locating local pollen assemblage zones (PAZ) can be identified. One of the most evident was where the deposition of peat started, at a depth of about 260 cm. This event is closely linked to the basin's evolution. Another was found at about 350 cm, related to the sharp drop in the concentration of *Pinus* pollen. Above this level, a progressive increase of NAP could be observed. Some other less obvious modifications could perhaps be recognised close to the dated layer (150 cm).

SAL 1, pine-wood phase. In the oldest sedimentation phase, deposition was mainly mineral, possibly due to slow erosion of the slopes of the small basin. It is possible that these were covered with a thick scrubby pine-wood, which left little room for other species of trees and for herbaceous plants. *Abies* and *Picea* pollen came from the lower belts, although these more demanding taxa probably reached higher altitudes than at present. This is a widespread occurrence: among others, DE BEAULIEU (1977) delineates a very wide altitudinal belt (700-900/2100 m a.s.l.) for silver fir woods, during the Atlantic period on the Southern French Alps. Pollen evidence of other species (*Larix, Quercus, Alnus, Salix, Betula, Corylus*) was very scarce and would therefore seem to indicate the absence of pollen sources in the neighbourhood. Single grains of *Castanea* and *Juglans* in these assemblages suggest contamination from more recent layers during the sampling, or even sporadic transport from the bottom of the valley. Indeed, it now seems sure that sweet chestnut (PAGANELLI & MIOLA, 1994) and possibly even walnut lived spontaneously in these regions before they were cultivated. Only traces of shrubs were found (*Juniperus*, *Ericaceae*, *Helianthemum*) and little pollen of herbaceous plants (*Gramineae*, *Compositae*, *Rosaceae*, *Ranunculaceae*, *Cyperaceae*, *Filicales*). It is well known that anemophi-

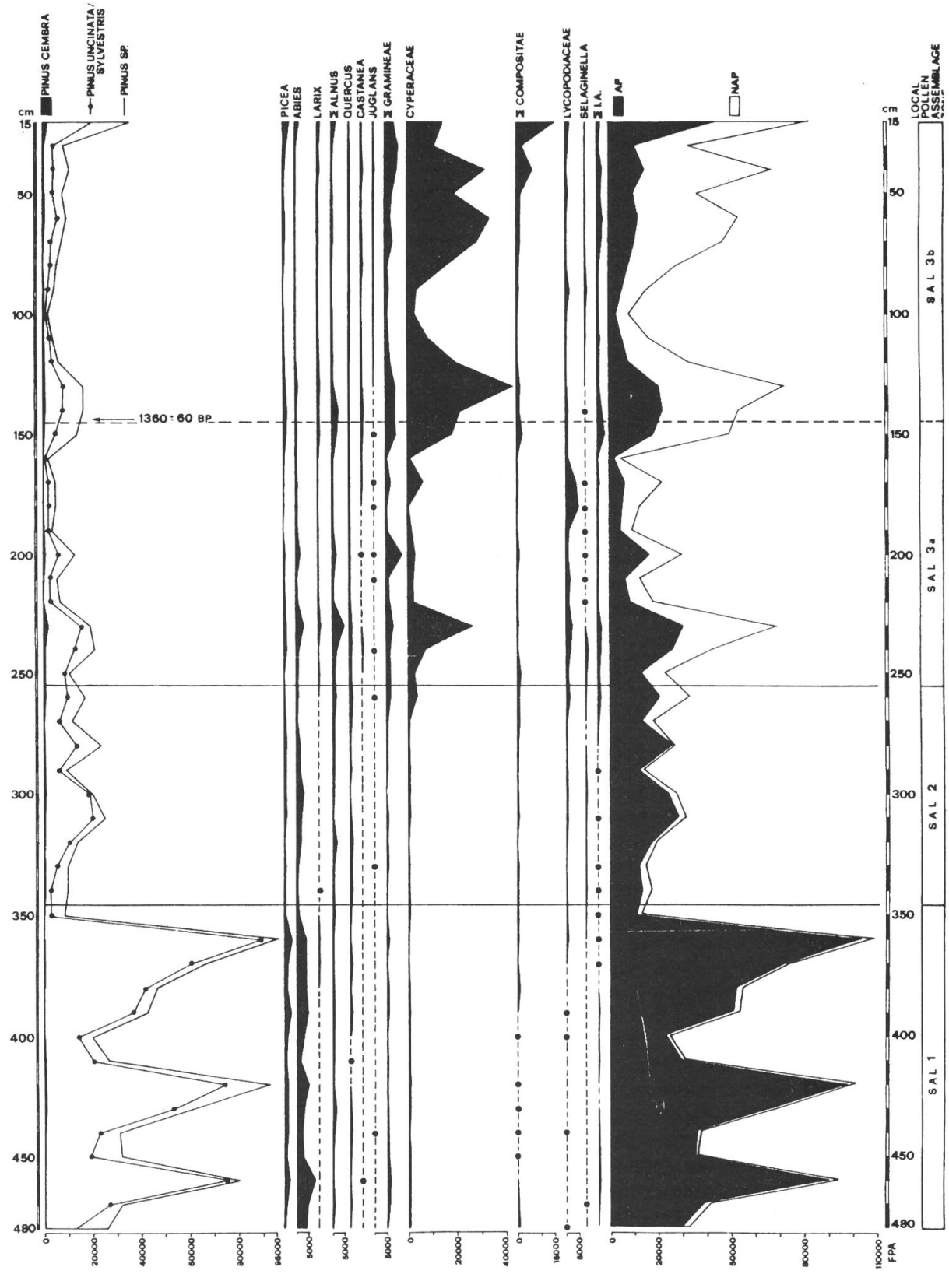

Fig. 3. – Pollen concentration diagram. APF = number of pollen grains per gram of dry sample.

lous trees are over-represented in sediments forming in basins above the tree-line, due to the low production of pollen by the Alpine grassland species. Nevertheless, in this case a very high concentration of pine pollen (Fig. 3), albeit discontinuous, and the simultaneous scarcity of pollen from heliophilous herbaceous plants would seem to suggest the presence of a pine wood in the vicinity. Unfortunately, the differentiation between *Pinus sylvestris* and *Pinus mugo s.l.* is always very doubtful. On the basis of the morphological features, which were evaluated with particular care in this case, it would seem that most of the grains could be identified as *Pinus mugo s.l.* If, on the contrary, most of the pine pollen referred to *Pinus sylvestris*, it would be possible to assume that there was once a pioneer wood of this species in the vicinity of the site, before the soil developed sufficiently to allow the growth of the current more demanding forest communities (e.g. larch and stone pine woods at higher, and silver fir and spruce woods at lower altitude). The identification of *Pinus cembra* was easier and highlighted the secondary role of this species throughout the period considered, particularly in depth. Marked fluctuations in the pollen concentration (Fig. 3) may be due to poor preservation in some layers, which is also the cause for some doubts concerning identification throughout the diagram. On the other hand, if it is supposed that phases of retreat of the pine scrub occurred (during minimal pine concentrations), it would have to be concluded that there were other, less demanding, species or at least indications of some factor adverse to pine (e. g. species of Alpine grassland or dwarf shrubs). On the contrary, such pollen evidence is almost absent.

SAL 2, clearing phase. This refers to an intermediate pollen zone, during which tree pollen again prevailed. This, however, is not consistent with the comparatively low pollen concentration. This fact, together with the more abundant finding of pollen from anemogamous trees (*Alnus, Quercus, Fagus*) and a certain increase in local heliophilous plants (*Ericaceae*, *Helianthemum*, *Gramineae*, *Rosaceae*, *Ranunculaceae*, *Cyperaceae*, *Plantago*, *Selaginella*, *Filicales*, *Lycopodiaceae*), suggest that the pine wood was cleared from the slopes of the basin, or moved away.

SAL 3, marsh meadow phase. The start of the peat deposition coincided with an increase of many Alpine grassland taxa that were already present earlier (*Gramineae*, *Compositae*, *Ranunculaceae*, *Rosaceae*, *Plantago,* and *Lycopodiaceae*). The tree curve continued the downward trend that started in the previous phase until it reached a mean value of about 50%. In the local history of the basin this was a phase featuring invading swamp herbs (*Cyperaceae*) and hydrophytes (*Nymphaeaceae*, *Potamogeton*). The dell was now tree-less and hosted Alpine grassland with many heliophilous herbaceous plants (*Gramineae*, *Compositae* lig. and tub. such as *Hieracium* and *Artemisia*, *Caryophyllaceae*, *Ranunculaceae*, *Plantago*, *Umbelliferae*, *Cruciferae*, *Leguminosae*, *Polygonaceae*, etc.). On the basis of this evidence and of some anthropogenous indicators, it is possible to split this phase into a first half (SAL 3a, up to 150 cm), with a less rich flora, and a second half (SAL 3b), with a greater variety of herbaceous plants and in larger quantities and with the constant presence of pollen from *Castanea*, *Juglans*, *Cerealia*, and *Urticaceae*. It is possible that the simultaneous spreading of *Fraxinus*, the leaves of which were once used as fodder, was due to the management of plant resources. Throughout this more recent phase dwarf shrubs were present on a more regular basis (*Ericaceae*, *Juniperus*, *Helianthemum*, *Salix*), which is further evidence of the in-filling of the basin. Among the tree species, a leading role was retained by pines, including *Pinus cembra*. No significant variation was noted for *Picea*, while *Abies* seemed to give way to *Larix*, almost absent in the earlier phases. If we assume that the speed of peat accumulation was constant, since no stratigraphic discontinuity was observed, and on the basis of the radiocarbon dating, it can be suggested that the vegetation history recorded by these sediments reaches recent times. Recent pollen spectra might confirm this interpretation (Fig. 4 and Fig. 5).

With reference to the chronology of the vegetation history outlined here, we only have one single radiocarbon dating, plus some diagrams from various places in the western Alps. The ^{14}C dating refers to the peaty sediment at a depth of 145-150 cm and indicates an age of 1360 ± 60

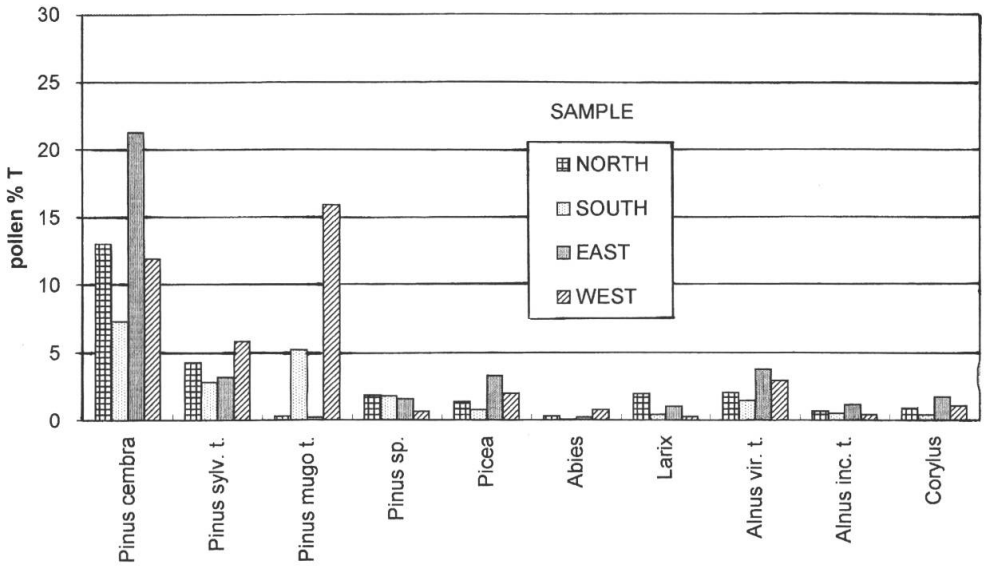

Fig. 4. – Recent pollen deposition from trees (AP) at the Col Blegier. Only taxa exceeding 2% (except *Abies*) are shown.

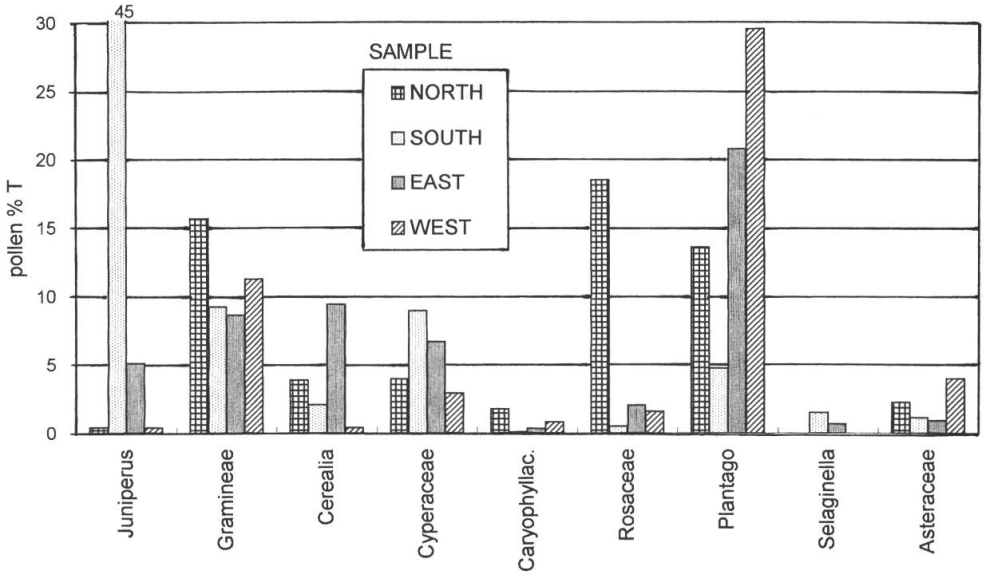

Fig. 5. – Recent pollen deposition from shrubs and herbaceous plants (NAP) at the Col Blegier. Only taxa exceeding 2% are shown.

B.P., corresponding to a calibrated date of A.D. 640-685. (CRG 1279, Centre de Recherches Géodynamiques, Thonon-les-Bains, France). These are therefore fairly young sediments, deposited during the late Holocene. If we assume that the sedimentation of peat took place steadily, an attempt can be made to refer to the classical Blytt-Sernander chronology; though it can cause some confusion because this chronology has been used as bio- and as chronozones, we think it can be still useful to make easier the comparison with other sites (cfr. BURGA, 1994; SCHNEIDER, 1985). Taking into consideration both biostratigraphy and the ^{14}C dating, the transition between the Subboreal and Subatlantic periods could be identified at around 260 cm (transition between SAL 2 and SAL 3 local pollen zones). Since the mineral sediment accumulates at a much

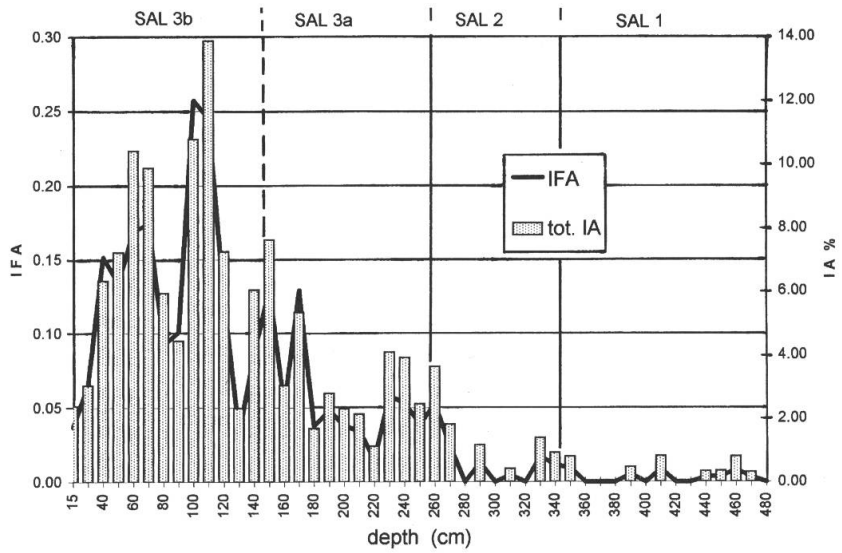

Fig. 6. – The pollen of cultivated plants and weeds (IA) was used as proxy information to evaluate human environmental impact. The IFA index is the ratio between anthropogenic indicators (IA) and the total tree pollen (AP).

slower rate than peat, it is indeed possible to suggest that the transition from the late Atlantic to the Subboreal period occurred at around 350 cm (transition from SAL 1 to SAL 2). Therefore, the sedimentation possibly started in the late Atlantic period.

On the basis of some anthropogenic pollen indicators, it is possible to investigate the changes caused to the vegetation cover by grazing, farming, and generally speaking by the exploitation of natural resources. It is true that the value of these indicators is relative and can vary depending on the historical period; nevertheless this kind of evaluation is interesting, and when it is applied to different situations in time and space it seems to provide consistent information. In this case, the pollen of *Castanea*, *Juglans*, *Cerealia*, *Chenopodiaceae*, *Polygonaceae*, *Urticaceae*, *Cannabis,* and *Plantago* have been grouped according to anthropogenic indicators (IA). The graph of Fig. 6 shows the trend of the IA and IFA indexes, the latter being the ratio between IA and total AP (IFA= anthropic frequentation index; ACCORSI & al., 1992). A strong and somewhat stepwise increase of the anthropogenic indicators was found at the time of the transition to PAZ SAL 3 and in particular to SAL 3b.

Recent pollen deposition

Present-day pollen deposition in the area of Col Blegier was investigated by analysis of 4 moss polsters taken from around the marsh area at the four cardinal points (m N, m S, m E, m W) (Fig. 4 and Fig. 5). As already mentioned above, the pollen concentration was high, with APF values ranging from 77,000 to 160,000.

In all the samples NAP dominated the spectra, with shrubs (m S: *Juniperus* = 46%) or herbaceous plants (m E and m W: *Plantago* = 21% and 29% respectively) prevailing locally. The most plentiful herbaceous taxa included *Gramineae*, *Cyperaceae*, *Rosaceae*, and *Plantago*. The AP total pollen never reached 50% and came exclusively from the more or less close surroundings (extra-local and regional contribution) and in particular from pines (*Pinus cembra*, *Pinus sylvestris*-t. and *Pinus mugo*-t.). This latter pollen type includes both *Pinus mugo* and *Pinus uncinata.* The finding is especially interesting because these two species do not occur today around the site (PULZONI, pers. comm.), but there is a *Pinus uncinata* wood in the "Val Troncea" nature park in the Chisone Valley, a few kilometres SW, opposite the Col Blegier. Among the four sur-

face samples, precisely m S and m W were those with highest *Pinus mugo*-t. values (10-15%), which suggests transportation from a medium distance. MONTACCHINI & CARAMIELLO (1968) also reported *Pinus mugo s.s.* communities growing on limestone in the upper Susa Valley. Other trees that can now be found in the "Gran Bosco" left constant but slight pollen evidence (*Picea, Abies, Larix, Alnus*), as did species from the lower vegetation belts (*Fagus, Quercus, Corylus, Tilia*, etc.). The fairly high pollen values (4-9%) for grasses of the *Cerealia* type (*Gramineae* > 40 mm) can be ascribed, with some uncertainty, to transport over long distances, since this taxon is characterised mainly by very low pollen representation. A contribution from spontaneous grasses with large pollen grains (e.g. *Bromus, Hordeum, Avena, Agropyron*) might be involved. It can be concluded that the recent pollen spectra are consistent with the local and surrounding vegetation. The local occurrence of Alpine and marshy grassland is clearly noticeable, as well as the main features of the surrounding woodland. If we compare the pine values of the recent spectra with the ones on the basal pollen assemblage zone SAL 1 we can conclude that the highest slopes of the valley up to the ridge were once covered with pine shrub.

Discussion

The palaeobotanical data from the Col Blegier peat bog are an important source of information on the local environment and on the "Gran Bosco" during the last few thousand years. The most interesting aspect, possibly, is the almost certain proof of the existence of a thick mountain pine scrub, which once (late Atlantic period) reached the ridge and surrounded what then was a small lake on a pass. However, at an estimated age of 2800-2600 years BP, woodland declines while the heliophilous species of Alpine grassland increase. An advance of the *Pinus montana* pioneer forest in much more recent times (probably V-I century b.C.) has been observed by CHARRIER (1967) at Colle del Sestriere (2035 m a.s.l., less than 10 km southward). It is not easy to explain this time difference, all the more that radiocarbon dating is scarce in both papers. Refering to anthropogenic indicators (Fig. 6), only starting from a depth of 260 cm a clear increasing can be observed at Col Blegier; therefore, it is unlikely that the retreat of the pine scrub was due to human activity (see also further on).

Another interesting point is the role that the stone pine (*Pinus cembra*) played in the late-holocene. As previously pointed out, this species is now a significant tree in the "Gran Bosco" and this is well testified even by high pollen percentages in surface spectra (Fig. 4). The stone pine pollen starts to increase only in SAL 3 zone, in accordance with larch (*Larix decidua*); very probably, this is mainly due to the retreat of the mountain pine scrub which had the twofold consequence of leaving room to the subalpine forest (stone pine-larch forest) and of allowing a more easy incoming of their pollen on the peat bog. Silver fir (*Abies*), on the contrary, seems to have been more plentiful once, or possibly it reached higher altitudes than it now does, matching other information from the western Alps (DE BEAULIEU, 1977). Taking into consideration only climatic effects, it seems that this picture is in good accordance with a transition from a wet-oceanic period (Atlantic) to a more dry-continental one (Subboreal-Subatlantic). It must not be forgotten that the occurrence of a mesophilous forest with silver fir, is quite unusual, in this area, as previously pointed out. Although there is no data available as yet to help us understand what caused the crisis of the ridge-scrub, the pre-historical (late Neolithic?) period and the sudden drop in pollen concentration could indicate that it was cleared by the first shepherds in order to create pastures around the small lake and to obtain firewood. With this problem in mind, we examined the layers around 350 cm in search of charcoal indicative of clearing by fire for farming purposes, a common practice all over the world, but found nothing. On the other hand, earlier studies (CHARRIER, 1967; CHARRIER & PERETTI, 1977; ARMANDO & al., 1975) have described clear glacial and palaeobotanical evidence, at a similar altitude and not far from this area, of climate changes in more or less recent times. In particular, "an appreciable lowering of the snow-limit, which had induced a shift downhill of the upper limit of forest vegetation" , took place at the beginning of the Subboreal period (c. 4000 B.P.) (CHARRIER & PERETTI, 1977). In a simi-

lar situation in the western Alps, CARAMIELLO & al. (1994) also thought it unlikely that a retreat of the timberline was due to human activity, even in more recent times.

A few indications of interest for the recent history of the "Gran Bosco" can be found in a description by DES AMBROIS (1901) of the Montfol (a limestone ridge at about 1660 m in the "Gran Bosco" area). He mentioned a large forest known as "la Pineta" (the Pinewood), consisting of pines that were "naturally branched and with irregular shapes mixed with junipers and dead trees so that it was an immense black, dark forest which could hardly be penetrated, inhabited by wolves". Even if we take this rather picturesque description with a grain of salt (the author also spoke of a larch forest in similar terms, describing it as constantly (!) thick and dark), the life-form described seems to be typical of *Pinus montana s.l.*, and the occurrence of junipers obviously indicates a fairly clear environment. It seems, therefore, that remnants of mountain pine scrub (*Pinus uncinata* or even *Pinus mugo s.s.*, because of the presence of limestone) occurred not far from the Col Blegier as late as the end of the last century.

ACKNOWLEDGEMENTS

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REFERENCES

ACCORSI, C. A. & G. RODOLFI (1975). Primi risultati sullo studio di un suolo calcimorfo delle Alpi Apuane in relazione ad analisi palinologiche e microbiologiche. *Boll. Soc. Ital. Sci. Suolo* 9: 35-51.

ACCORSI, C. A., M. BANDINI MAZZANTI & L. FORLANI (1992). Segni palinologici, antraco-xilologici e carpologici dell'azione antropica sul paesaggio vegetale olocenico in Emilia Romagna. *Mem. Soc. Geol. Ital.* 42: 95-108.

ARMANDO, E., G. CHARRIER, L. PERETTI & G. PIOVANO (1975). Ricerche sull'evoluzione del clima e dell'ambiente durante il Quaternario nel settore delle Alpi occidentali italiane. V. La formazione di torbiera presso la fronte attuale del Ghiacciaio del Rutor (Valle d'Aosta): suo significato per la ricostruzione degli ambienti naturali del Piemonte nell'Olocene medio e superiore. *Boll. Comit. Glac. Ital.* 23: 7-25.

AROBBA, D. & G. IMPERIALE (1981). Indagini geosedimetologiche e palinologiche del deposito torbo-lacustre de l'Arpiat (Ceresole Reale, Piemonte). *Rev. Valdôtaine Hist. Nat.* 35: 27-49.

BERTOLANI MARCHETTI, D. (1955). Ricerche sulla vegetazione della Valsesia. III: Saggio di ricerche pollinologiche. La torbiera di Alpe Laghetto sul Monte Capio. *Nuovo Giorn. Bot. Ital.* ser. 2, 61: 423-427.

BRAGGIO, G., L. CORNARA, S. CAVALIERE & S. PLACEREANI (1993). Analisi polliniche nella torbiera del Ghighel (Val Formazza - Alpi Occidentali) e ricostruzione della paleovegetazione. *Candollea* 48: 476-484.

BRAGGIO G., L. CORNARA, S. PLACEREANI, M. A. GUIDO & C. MONTANARI (1996). Storia olocenica della vegetazione del Gran Bosco di Salbertrand (Val di Susa, Torino). *Giorn. Bot. Ital.* 130: 130.

BRUGIAPAGLIA, E. (1996). *Dynamique de la végétation tardiglaciaire et Holocène dans les Alpes Italiennes nord-occidentales*. Thèse en Sciences. Université d'Aix-Marseille III. 148 pp.

BURGA, C. (1994). Végétation et Paléoclimatologie Holocéne moyen d'une ancienne tourbière située au front du Glacier du Rutor, 2510 m (Vallée d'Aoste, Italie). *Rev. Valdôtaine Hist. Nat.* 48, Suppl.: 143-149.

CARAMIELLO, R., C. SINISCALCO, A. POTENZA, L. MERCALLI, L. ALLEGRI, L. MANFRI & A. PROPOSITO (1994). Pollen analysis and radiocarbon dating of a peatbog (Pian di Nel, 2256 m) in Orco Valley, Western Alps, Italy. *Il Quaternario* 7: 91-102.

CHARRIER, G. (1967). La torbiera del Colle di Sestriere (Torino): suo significato per la storia del clima e della vegetazione del versante italiano delle Alpi Cozie nell'Olocene superiore. *Allionia* 13: 221-250.

CHARRIER, G. (1970). Ricerche sull'evoluzione del clima e dell'ambiente durante il Quaternario nel settore delle Alpi occidentali italiane. I. I legni fossili di Larice del Colle di Sestriere (Torino) datati con il metodo del C14. *Allionia* 16: 155.

CHARRIER, G. & L. PERETTI (1977). Ricerche sull'evoluzione del clima e dell'ambiente durante il Quaternario nel settore delle Alpi occidentali italiane.VI Nuovi contributi allo studio del Neoglaciale nell'alta valle della Dora Riparia: la serie di San Sicario (Cesana). *Allionia* 22: 129-156.

DE BEAULIEU, J.-L. (1977). *Contribution pollenanalytique à l'histoire tardiglaciaire et holocène de la végétation des Alpes méridionales françaises*. Thèse en Sciences. Université d'Aix-Marseille III. 358 pp.

DES AMBROIS, L. F. (1901). *Notes et souvenirs inédits du chevalier Louis Des Ambrois De Nevache*. Zanichelli. Bologna.

KELLER, P. (1932). Storia postglaciale dei boschi dell'Italia settentrionale. *Arch. Bot.* 8: 1-19.

MENOZZI, B. (1997). *Storia della vegetazione tardigliaciale ed olocenica in Valle d'Aosta, sulla base di spettri pollinici*. Tesi in Scienze. Università di Genova. 96 pp.

MONTACCHINI, F. & R. CARAMIELLO (1968). Il Pinus mugo Turra e il Pinus uncinata Miller in Piemonte. Note critiche e distribuzione. *Giorn. Bot. Ital.* 102: 529-535.

MORANDINI, R., A. GIORDANO, G. P. MONDINO, R. SALANDIN (1969). Il Gran Bosco di Salbertrand. *Pubblicazioni dell'Istituto Sperimentale per la Selvicoltura* 17: 1-131.

PAGANELLI, A. & A. MIOLA (1991). Chestnut (Castanea sativa Mill.) as an indigenous species in Northern Italy. *Il Quaternario* 4: 99-106.

SCHNEIDER, R. (1985). Palynologic research in the Southern and Southeastern Alps between Torino and Trieste. *Diss. Bot.* 87: 83-103.

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