View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Directory of Open Access Journals

Vol. LVI -1 ANNALI DI BOTANICA 1998

QUATERNARY HISTORY OF FAGUS IN THE ITALIAN PENINSULA

DONATELLA MAGRI
Dipartimento di Biologia Vegetale, Università "La Sapienza", P.le Aldo Moro, 5. 00185 - Roma, Italy

ABSTRACT - The Upper Pleistocene and Holocene history of the genus *Fagus* in Italy is reviewed. *Fagus* was present in central Italy during the last interglacial (Eemian), when it was virtually absent from the rest of Europe, markedly expanded in the following forest phases (St Germain I and St Germain II), and persisted during the last glacial period in central and southern Italy, from where it started a new spread already in the Lateglacial. However, in the northern Apennines and at the foothills of the Alps *Fagus* immigrated later and expanded only in the mid-Holocene, generally with an east to west trend.

KEY WORDS - *Fagus*, Italy, palynology, Upper Pleistocene, Holocene

INTRODUCTION

The European vegetation of the present interglacial is characterized by a widespread diffusion of *Fagus*, extending from the Cordillera Cantabrica to the Caucasus and from Sicily to southern Sweden. Apart from a few special environments, this genus would be almost universally present under natural conditions in central Europe, as it can occupy a wide range of habitats, with different soil types and a wide climatic amplitude (Ellenberg, 1988). However, the Holocene history of *Fagus* shows that such extensive geographical distribution is very recent, dating back to the last few millennia, and that the continuous presence of beech during at least the last glacial-interglacial cycle can be traced only for restricted areas.

These premises have stimulated several works discussing the timing and mode of the Postglacial spread of *Fagus* populations, both at a European scale (Huntley and Birks, 1983; Huntley, 1988; Lang, 1992, 1994) and at a regional scale, including the reviews by Birks (1989) on the British Isles, by Pott (1989) on central Europe, by Ralska-Jasiewiczowa (1983) on Poland, by de Beaulieu *et al*. (1994) on the French Alps and the Jura, by Schneider (1978) on the southern border of the Alps, and by Filipova-Marinova (1995) on Bulgaria.

While it is still a matter of discussion whether the primary factor controlling Holocene migrations of *Fagus* was climatic change (Huntley *et al*., 1989) or human influence (Reille and Beaulieu, 1990; Reille and Lowe, 1993), there is general agreement that the refuge areas of *Fagus* during the last glacial period had a southern

location, in the Italian and Balkan peninsulas (Huntley and Birks, 1983), as happened to most forest trees which today extend to northern Europe (Bennett *et al*., 1991). The hypothesis has also been advanced (Lang, 1992; 1994) that *Fagus* followed two main paths of invasion: an eastern route from the western Balkan peninsula to the eastern Alps, the Carpathians, northern Germany, Poland and southern Sweden, and a western route from Italy to the western Alps, France and southern England.

The aim of the present paper is to review the available information, possibly from radiocarbon dated sites (Fig. 1), on the past distribution of *Fagus* in peninsular Italy since the upper Pleistocene, and discuss the relationship with the history of the Alpine and central European beech forests.

UPPER PLEISTOCENE

There is one site in central Italy from where the vegetational history of the last 250,000 years can be reconstructed without significant interruptions: Valle di Castiglione (44 m) near Rome (Fig. 1; Follieri *et al*., 1988; 1989). That record shows that *Fagus* has been continuously present in the Italian peninsula since at least the middle Pleistocene, with very important diffusions during the Roma II and Roma III forest periods (200,000 - 170,000 years BP) corresponding to substages 7a and 7c of the oxygen isotope stratigraphy.

The vegetation of the last interglacial (Eemian; approx. 130,000-115,000 years BP) was characterized by thermophilous taxa, including evergreen oaks, *Olea* and other Mediterranean elements, by appreciable diffusion of *Zelkova* (Follieri *et al*., 1986a), and by reduced presence of *Fagus* and *Abies*, slightly increasing at the end of the interglacial. The sparce presence of *Fagus* in Italy during the last interglacial is confirmed also by the pollen data from Lago Lungo (371 m) near Rieti (Calderoni *et al*., 1994), and is particularly important considering the other European records, where, apart from one site in the North Black Sea region of Bulgaria (Bozilova and Djankova, 1976) and a few other sporadic findings, beech is completely absent. This virtual absence of *Fagus* on such a wide scale is so remarkable as to induce Tzedakis (1994) to hypothesize that a disease suppressed the European *Fagus* populations and that perhaps new and more robust populations developed by the time of the first glacial interstadials. Irrespective of the possible explanations for this absence, it is important to stress that central Italy is the only European area for which an uninterrupted presence of beech is documented since the middle Pleistocene (Follieri *et al*., 1988).

The forest phases following the Eemian interglacial, namely St Germain I (ca. 110,000-95,000 years ago) and St Germain II (ca. 90,000-75,000 years ago) are characterized by very pronounced expansions of *Fagus* in the Italian peninsula. This is recorded not only by the pollen data from Valle di Castiglione, Lago Lungo di Rieti, Lagaccione (355 m) near Lago di Bolsena (Magri, 1998) and Magliano Romano (Follieri, 1979a), but also by fossil leaves and fruits at Torre in Pietra (Follieri, 1979b), a site on the coastal plain northwest of Rome. Diffusion of beech during the St Germain I forest period is shown also by other long pollen records in Europe, for example at Les Echets (267 m), near Lyon in France (de Beaulieu and Reille, 1984), and at Ioannina (470 m), in NW Greece (Tzedakis, 1994), where *Fagus* reaches 30% and 20% respectively. However, differently from central Italy, at the French and Greek sites *Fagus* is not a major component of the vegetation, which is characterized by *Carpinus* and deciduous *Quercus* respectively. At the same time, at the mountain site

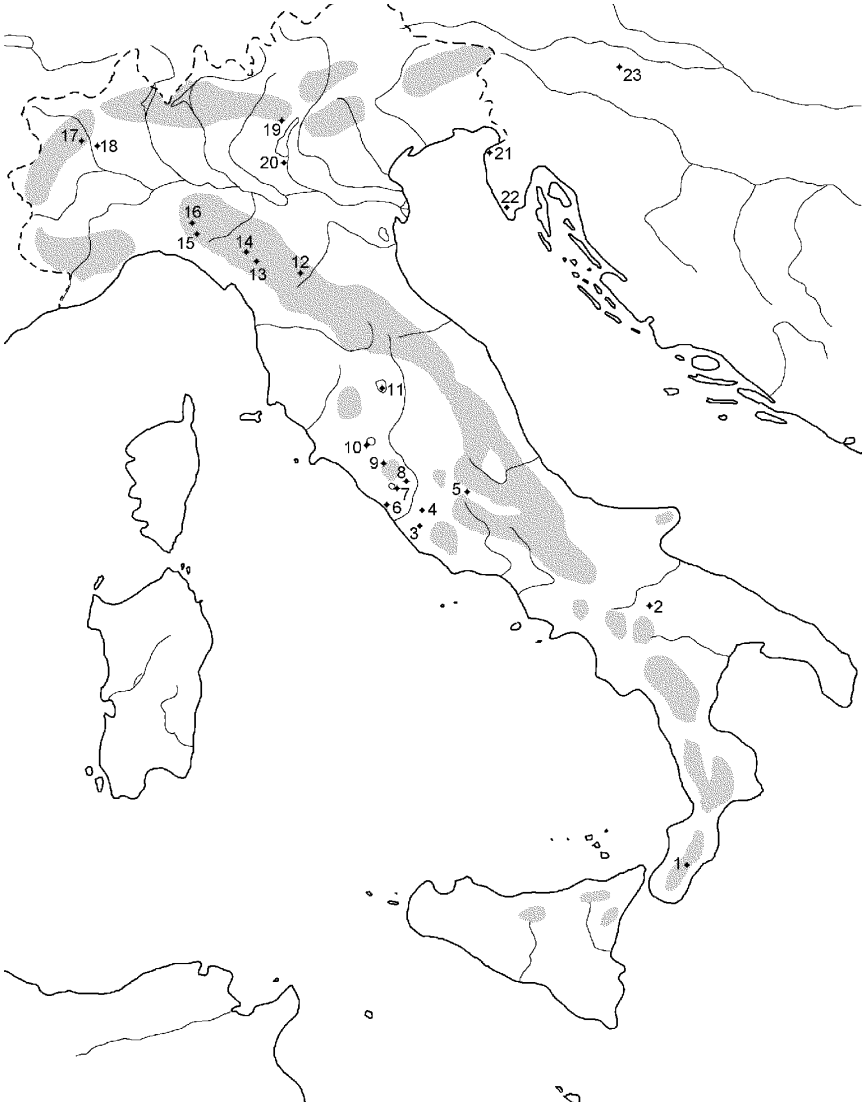

Fig. 1 - Location of the sites mentioned in text: 1. Cànolo Nuovo (Grüger, 1977; Schneider, 1985); 2. Lago Grande di Monticchio (Watts *et al*., 1996a, 1996b); 3. Lago Albano (Lowe *et al*., 1996); 4. Valle di Castiglione (Follieri *et al*., 1986, 1988, 1989); 5. Piana del Fucino (Magri and Follieri, 1991); 6. Torre in Pietra (Follieri, 1979b); 7. Stracciacappa (Follieri *et al*. 1998); 8. Magliano Romano (Follieri, 1979a); 9. Lago di Vico (Follieri *et al*. 1997); 10. Lagaccione (Magri, 1998); 11. Lago Trasimeno (Schneider, unpublished, in Lang, 1992); 12. Pratignano (Watson, 1996); 13. Lago Padule (Watson, 1996); 14. Prato Spilla A (Lowe and Watson, 1993); 15. Prato Mollo (Macphail, unpublished, in Watson, 1996); 16. Lago Nero (Macphail, unpublished, in Watson, 1996); 17. Lago d'Alice (Schneider, 1978); 18. Lago di Viverone (Schneider, 1978); 19. Lago di Ledro (Beug, 1964); 20. Castellaro (Bertoldi, 1968); 21. Secovlje (Ogorelec, 1981; Sercelj, 1996); 22. Sandalja (Culiberg and Sercelj, 1995); 23. Luknja (Culiberg, 1991). The shaded areas indicate the modern distribution of *Fagus* in Italy (redrawn from Biondi, 1989).

of Lac du Bouchet (1200 m) on the French Massif Central (Reille and de Beaulieu, 1990) *Fagus* is absent; this fact induced Reille and de Beaulieu (1990) to suggest that the habitat where *Fagus* would grow naturally, in the absence of human activity, would be the collinean stage.

During the pleniglacial (75,000-13,000 years ago), the persistence of reduced populations of *Fagus* in the Italian peninsula is recorded by four pollen sequences in the Lazio region (Fig.1; Valle di Castiglione, Lagaccione near Lago di Bolsena, Lago di Vico and Stracciacappa near Lago di Bracciano; Follieri *et al*., 1998) and by the record from Lago Grande di Monticchio (656 m) in the Basilicata region (Watts *et al*., 1996a). Beech is generally present in low percentages, but during some weak expansion of arboreal vegetation it surpasses 10%, a value that, according to modern pollen data, may indicate the regional presence of beech-dominated woodland (Huntley and Birks, 1983). Only at Cànolo Nuovo (945 m) in Calabria (Grüger, 1977), in correspodence with and before a radiocarbon date around 37,000 years BP, were there values higher than 40%, which may indicate that beech-dominated forests were present locally. These are the highest values recorded in Europe during the last pleniglacial period: even at Ioannina, in northwest Greece (Tzedakis, 1994), where a continuous and significant presence of deciduous trees is recorded throughout the glacial period (Tzedakis, 1993), *Fagus* never exceeded 5%.

LATE- AND POSTGLACIAL

In southern and central Italy, the continuous presence of beech is found already during the Lateglacial (Fig. 2). At Cànolo Nuovo in Calabria (Grüger, 1977; Schneider, 1985) *Fagus* shows percentages of 3-6% close to the radiocarbon date 12,385±125, then it persisted for the whole Postglacial, although with values generally lower than 10%. At Lago Grande di Monticchio (652 m) in Basilicata (Watts *et al*., 1996b) the pollen of *Fagus* is continuously present since slightly before the AMS date 12,540±130, reaching values of over 5% during the Lateglacial. As at Cànolo Nuovo, the Postglacial values of beech seldom exceed 10%, even if a moderate increase is recorded in the late Holocene. Also at Lagaccione (355 m) near Lago di Bolsena (Magri, 1998) the continuous presence of beech dates back to the earliest Lateglacial, before the date 12,015±115 BP. *Fagus* persists with low percentage values until the date 8215±90, when a vigorous exponential growth occurred, leading to values of over 40% about 7500 years BP. After this spread the percentages oscillate around 10-20% until a marked drop 3700 years ago. At the Piana del Fucino (650 m), an intermountain plain in Abruzzo, *Fagus* is found with low percentages in the Lateglacial and increases markedly in the Postglacial, with values often surpassing 20% (Magri and Follieri, 1991).

At other sites, as Valle di Castiglione (44 m; Follieri *et al*., 1986b) and Lago Albano (293 m; Lowe *et al*., 1996) near Rome, and Lago Trasimeno (258 m) in Umbria (Schneider unpublished, in Lang, 1992) *Fagus* puts in its first appreciable appearances at the beginning of the Holocene: around 10,800 BP at Valle di Castiglione and around 9500 BP at Lago Trasimeno. At the sites near Rome, during the Holocene only occasionally does *Fagus* exceed 10%, whereas at Lago Trasimeno there is a clear expansion around 8,000 BP, similar to that of Lagaccione.

In a recent review of the vegetational history of the northern Apennines, Watson (1996) argues that *Fagus* appeared earlier in the eastern than in the western part of

the region during the mid Holocene and became dominant in the northern Apennine forests post 3000 BP. In particular the beginning of a rise in the levels of *Fagus* pollen is dated at 5780±40 BP at Pratignano (1307 m, 50 km SW of Modena), at 5260±55 at Lago Padule (1187 m, ca. 40 km NE of La Spezia) and at 5035±50 at Prato Spilla A, 60 km south of Parma (1550 m, Lowe and Watson, 1993), whereas at sites of eastern Liguria (Lago delle Lame, Prato Mollo and Lago Nero) located at over 1000 m, the ages for the same event range from approximately 4600 BP to 3000 BP (Macphail, unpublished, in Watson, 1996).

The palaeovegetational data from the Po plain (Accorsi *et al*., 1996) show that *Fagus* was very sparse (<2.5%) during the Atlantic, and became significant only in the Subatlantic, after about 4700 BP.

Also the data from the southern border of the Alps seem to indicate an immigration of *Fagus* from the east (Schneider, 1978), even if a real expansion is recorded at almost all sites around 5000 BP. Beech was presumably present already around 7500 BP at Lago di Ledro (655 m; Beug, 1964) and at Castellaro (100 m; Bertoldi, 1968), but only around 6000 BP at Lago d'Alice (580 m; Schneider, 1978) and Lago di Viverone (220 m; Schneider, 1978).

These data are confirmed by the findings outside the Alpine chain, generally much older towards Slovenia than towards France. In Istria, at Secovlje (1 m, Ogorelec *et al*., 1981; Sercelj, 1996) pollen of *Fagus* is already present in a sample dated 9160±120, and charcoal fragments of beech from Sandalja, near Pula, are dated at 21,740±45 and 25,340±170 (Culiberg and Sercelj, 1995). In Slovenia, in the Luknja cave (150 m) near Novo Mesto, two fragments of *Fagus* have been found (Culiberg, 1991), dated 12,580±250. As opposed to this early eastern distribution, on the French Alps beech generally appeared around 6000 BP and its mass expansion occurred around 5000 BP, although on the Dauphiné foothills it appeared already about 6500 BP, possibly spreading from refuge areas near the Rhône valley (de Beaulieu *et al*., 1994).

Discussion

The data hitherto collected from the Italian peninsula are still scanty, and do not represent adequately all the geographic and vegetational situations of such a diversified country. It is however clear that the history of *Fagus* differred considerably in Italy from region to region and that a wide range of situations has taken place during the last tens of thousands of years.

The Italian peninsula appears to have been a privileged area for the survival of beech not only during the glacial periods, but also during previous interglacials, when *Fagus* was virtually absent from the rest of Europe. In this sense, looking at the vegetational history of periods when the impact of human activity on the landscape was negligible, *Fagus* can be viewed as a genus typical of the wettest countries of the Mediterranean region, and not of the mid-European forests, where it has a very recent and transient history.

Differently from central Europe, the Holocene spread of beech in central and southern Italy appears less pronounced than in previous forest periods (e.g. St Germain I and St Germain II), although an early and continuous diffusion of beech is recorded at all sites (Fig. 2). On the contrary in northern Italy, without excluding the possibility of local refuge areas, it seems clear that the *Fagus* populations did not spread at the beginning of the Holocene, but generally had marked increases around or after 5000

years ago.

The start of *Fagus* during the earliest Lateglacial both at Cànolo Nuovo, and at Lago Grande di Monticchio as well as at Lagaccione indicates that populations of beech may have survived during the last glacial period at different locations in the peninsula,

so that no clear large scale migrational trends can be recognized in southern and central

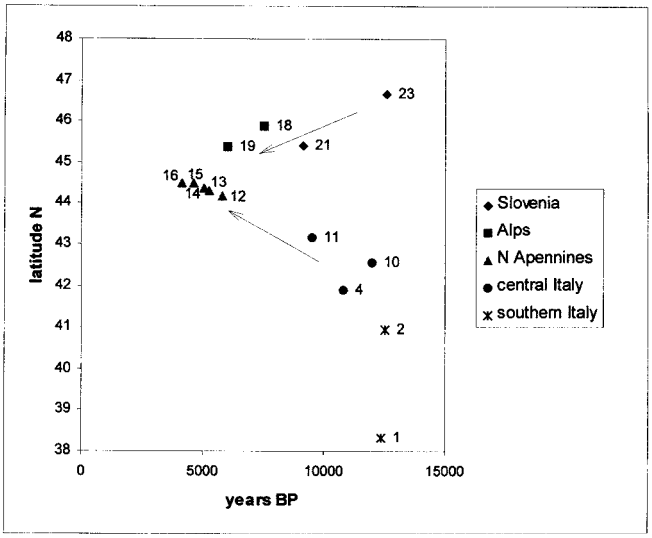

Fig. 2 - The age of the late- and postglacial start of the expansion of *Fagus* is plotted against the latitude. The numbers refer to the sites listed in Fig. 1. The arrows indicate possible migrational trends.

Italy. On the contrary the data from northern Italy suggest that migrations took place from the eastern toward the western part of the country. However, based also on the scarcity of beech in the Po plain, it seems reasonable to suppose that the origin of the Alpine and Apennine populations of *Fagus* was different (Fig. 2): although there are no data from Tuscany confirming this hypothesis, it seems most likely that the populations of the northern Apennines originated from the central Apennine, while Slovenia might have been the starting point for at least some of the Alpine populations.

It is worth noticing that *Fagus* spread earlier on the foothills of the Alps than on the northern Apennines. This contradicts the hypothesis that the populations that survived during the last glacial period in central and southern Italy may have expanded to central and northwest Europe: the late arrival of beech on the Ligurian Apennine would indicate that this was the northwestern limit of the Apennine populations, at a time when a large part of the vegetation of Europe was already beech-dominated.

ACKNOWLEDGEMENTS

Work carried out within the framework of the EU Environment project Ariduseuromed (ENV4-CT95-0062).

References

Accorsi C.A., Bandini Mazzanti M., Mercuri A.M., Rivalenti C. and Trevisan Grandi G., 1996 - *Holocene forest pollen vegetation of the Po plain - Northern Italy (Emilia Romagna data)*. Allionia, **34**: 233-276.

Beaulieu J.L. de and Reille M., 1984 - *A long Upper Pleistocene pollen record from Les Echets, near Lyon, France*. Boreas, **13**: 111-132.

Beaulieu J.L. de, Richard H., Ruffaldi P. and Clerc J., 1994 - *History of vegetation, climate and human action in the French Alps and the Jura over the last 15,000 years*. Dissertationes Botanicae, **234**: 253-275.

Bennett K.D., Tzedakis P.C. and Willis K.J., 1991 - *Quaternary refugia of north European trees*. Journal of Biogeography, **18**: 103-115.

Bertoldi R., 1968 - *Ricerche pollinologiche sullo sviluppo della vegetazione tardiglaciale e postglaciale nella regione del lago di Garda*. Studi Trentini di Scienze Naturali, sez. B, **45**(1): 87-162.

Beug H.-J., 1964 - *Untersuchungen zur spät- und post-glazialen Vegetationsgeschichte im Gardaseegebiet unter besonderer Berücksichtigung der mediterranen Arten*. Flora **154**: 401-444.

Biondi E., 1989 - *Il bosco nell'Appennino: conoscenze fitogeografiche e fitosociologiche*. In: E. Biondi (ed.) Il bosco nell'Appennino. Centro studi Valleremita, Fabriano, 237-269.

Birks H.J.B., 1989 - *Holocene isochrone maps and patterns of tree-spreading in the British Isles*. Journal of Biogeography, **16**: 503-540.

Bozilova E. and Djankova M., 1976 - *Vegetation Development during the Eemian in the North Black Sea Region*. Bulgarian Academy of Sciences, Phytology, **4**: 25-33.

Calderoni G., Carrara C., Ferreli L., Follieri M., Gliozzi E., Magri D., Narcisi B., Parotto M., Sadori L. and Serva L., 1994 - *Palaeoenvironmental, palaeoclimatic and chronological interpretations of a late-Quaternary sediment core from Piana di Rieti (central Apennines, Italy)*. Giornale di Geologia, **56**(2): 43-72.

Culiberg M., 1991 - *Late Glacial vegetation in Slovenia*. Academia Scientiarum at Artium Slovenica, Classis IV: Historia Naturalis, **29**, 52 pp.

Culiberg M. and Sercelj A., 1995 - Anthracotomical and palynological research in the palaeolithic site Sandalja II (Istria, Croatia). Razprave IV. Razereda Sasu, 36(3): 49-57.

Ellenberg H., 1988 - *Vegetation ecology of central Europe*. Cambridge University Press.

Filipova-Marinova M., 1995 - *The late Quaternary history of the genus* Fagus *L. in Bulgaria*. In: E. Bozilova and S. Tonkov (eds), Advances in Holocene Palaeoecology in Bulgaria, Pensoft Publ., Sofia, Moscow, pp. 84-95.

Follieri M., 1979a - *Late Pleistocene floristic evolution near Rome*. Pollen et Spores, **21**: 135-148.

Follieri M., 1979b - *Ricerche paleobotaniche sulla serie di Torre in Pietra (Roma)*. Quaternaria, **21**: 73-86.

Follieri M., Magri D. and Sadori L., 1986a - *Late Pleistocene* Zelkova *extinction in Central Italy*. New Phytologist, **103**: 269-273.

Follieri M., Magri D. and Sadori L., 1986b - Pollen analysis. In: Alessio, A., Allegri, L., Bella, F., Calderoni, G., Cortesi, C., Dai Pra, G., de Rita, D., Esu, D., Follieri, M., Improta, S., Magri, D., Narcisi, B., Petrone, V. and Sadori, L., 1986. *^{14}C dating, geochemical features, faunistic and pollen analyses of the uppermost 10 m core from Valle di Castiglione (Rome, Italy)*. Geologica Romana, **25**: 287-308.

Follieri M., Magri D. and Sadori L., 1988 - *250,000-year pollen record from Valle di Castiglione (Roma)*. Pollen et Spores, **30**: 329-356.

Follieri M., Magri D. and Sadori L., 1989 - *Pollen stratigraphical synthesis from Valle di Castiglione (Roma)*. Quaternary International, **3/4**: 81-84.

Follieri M., Giardini M., Magri D. and Sadori L., 1998 - *Palynostratigraphy of the last glacial period in the volcanic region of central Italy*. Quaternary International **47/48**: 3-20.

Grüger E., 1977 - *Pollenanalytische Untersuchung zur würmzeitlichen Vegetationsgeschichte von Kalabrien*

(Süditalien). Flora, **166**: 475-489.

HUNTLEY B., 1988 - *Europe*. In B. Huntley and T. Webb III (eds) Vegetation history. Kluwer Acad. Publ., Dordrecht, pp. 341-383.

HUNTLEY B., BIRKS H.J.B., 1983 - *An atlas of past and present pollen maps for Europe: 0-13000 years ago*. Cambridge University Press.

HUNTLEY B., BARTLEIN P.J. and PRENTICE C., 1989 - Climatic control of the distribution and abundance of beech (*Fagus* L.) in Europe and North America. Journal of Biogeography, **16**: 551-560.

LANG G., 1992 - *Some aspects of European late- and post-glacial flora history*. Acta Bot. Fennica, **144**: 1-17.

LANG G., 1994 - *Quartäre Vegetationsgeschichte Europas*. Gustav Fischer Verlag, Jena.

LOWE J.J., ACCORSI C.A., BANDINI MAZZANTI M., BISHOP A., VAN DER KAARS S., FORLANI L., MERCURI A.M., RIVALENTI C., TORRI P. and WATSON C., 1996 - *Pollen stratigraphy of sediment sequences from lakes Albano and Nemi (near Rome) and from the central Adriatic, spanning the interval from oxygen isotope Stage 2 to the present day*. Mem. Ist. Ital. Idrobiol., **55**: 71-98.

LOWE J.J. and WATSON C., 1993 - *Lateglacial and early Holocene pollen stratigraphy of the northern Apennines, Italy*. Quaternary Science Reviews, **12**: 727-738.

MAGRI D. and FOLLIERI M., 1991 - *Primi risultati delle analisi polliniche dei sedimenti lacustri olocenici nella Piana del Fucino*. Atti del convegno "Il Fucino e le aree limitrofe nell'antichità", Avezzano 1989, pp. 45-53. Roma.

MAGRI D., 1998 - *Late-Quaternary vegetation history at Lagaccione, near Lago di Bolsena (central Italy)*. Palaeogeography, Palaeoclimatology, Palaeoecology, (submitted).

OGORELEC B., MISIC M., SERCELJ A., CIMERMAN F., FAGANELI J., STEGNAR P., 1981 - *Sediment secoveljske soline*. Geologija - razprave in porocila, **24**(2): 179-216.

POTT R., 1989 - *Die Formierung von Buchenwaldgesellschaften im Umfeld der Mittelgebirge Nordwestdeutschlands unter dem Einfluss des Menschen*. Ber. Geobot. Inst. Univ. Hannover, **1**: 30-44.

RALSKA-JASIEWICZOWA M, 1983 - *Isopollen maps for Poland: 0-11000 years BP*. New Phytologist, **94**: 133-175.

REILLE M. and BEAULIEU J.L.DE, 1990 - *Pollen analysis of a long upper Pleistocene continental sequence in a Velay maar (Massif Central, France)*. Palaeogeography, Palaeoclimatology, Palaeoecology, **80**: 35-48.

REILLE M. and LOWE J.J., 1993 - *A re-evaluation of the vegetation history of the eastern Pyrenees (France) from the end of the last glacial to the present*. Quaternary Science Reviews, **12**: 47-77.

SCHNEIDER R.E., 1978 - *Pollenanalytische Untersuchungen zur Kenntnis der spät- und postglazialen Vegetationsgeschichte am Südrand der Alpen zwischen Turin und Varese (Italien)*. Bot. Jahrb. Syst., **100**: 26-109.

SCHNEIDER R.E., 1985 - *Analyse palynologique dans l'Aspromonte en Calabre (Italie méridionale)*. Cahiers ligures de préhistoire et de protohistoire, n.s., **2**: 279-288.

SERCELJ A., 1996 - The origins and development of forests in Slovenia. Academia Scientiarum et Artium Slovenica, Classis IV: Historia Naturalis, **35**, 142 pp.

TZEDAKIS P.C., 1993 - *Long-term tree populations in northwest Greece through multiple Quaternary climatic cycles*. Nature, **364**: 437-440.

TZEDAKIS P.C., 1994 - *Vegetation change through glacial-interglacial cycles: a long pollen sequence perspective*. Philos. Trans. Royal Soc. Lond. B, **345**: 403-432.

WATSON C.S., 1996 - *The vegetational history of the northern Apennines, Italy: information from three new sequences and a review of Regional vegetational change*. Journal of Biogeography, **23**: 805-841.

WATTS W.A., ALLEN J.R.M. and HUNTLEY B., 1996a - *Vegetation history and palaeoclimate of the last glacial period at Lago Grande di Monticchio, southern Italy*. Quaternary Science Reviews, **15**: 133-153.

WATTS W.A., ALLEN J.R.M., HUNTLEY B. and FRITZ S.C., 1996b - *Vegetation history and climate of the last 15,000 years at Laghi di Monticchio, southern Italy*. Quaternary Science Reviews, **15**: 113-132.