FLORA TERTIARIA MEDITERRANEA

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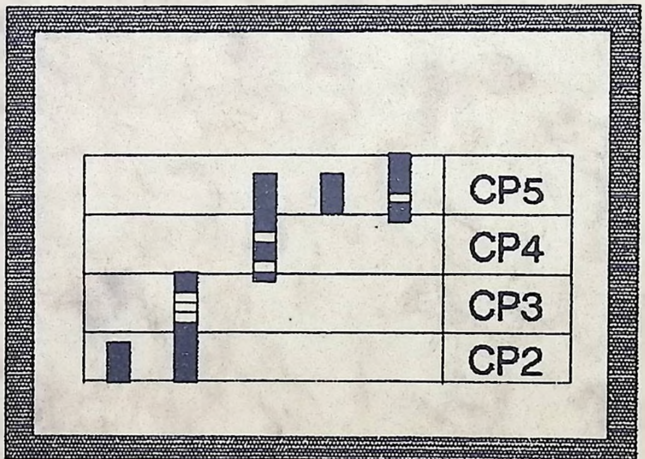

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FLORA TERTIARIA MEDITERRANEA V.3

Floras of Villafranchian age in Central Europe and the problem of the Plio-Pleistocene vegetation

by Hans-Joachim GREGOR[1] & Thomas GÜNTHER[2]

with a confirmation by Klaus-Jürgen MEYER[3]

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Floras of Villafranchian age in Central Europe and the problem of the Plio-Pleistocene vegetation in Italy

by H.-J. GREGOR[1] & Th. GÜNTHER[2]

with a confirmation by K.-J. MEYER[3]

Summary

Fruit- and seedfloras from different Italian fossil sites are under research, concerning the question of the stratigraphical ages. A computer supported survey allows the clear separation of floras, found in sievable and in splittable sediments. The problematic terms 'Villafranchiano, Calabriano, Santerniano, Limite Tiberiano etc.' are seen in connection to floras from the Pliocene-Pleistocene. The latter does not seem to be a break in vegetational history, but a true transition in the sense of MENKE with his Cainocene.

Zusammenfassung

Verschiedene fossile Frucht- und Samenfloren aus Italien haben ein problematisches Alter, was sich in den Begriffen 'Calabriano, Santerniano, Limite Tiberiano und Villafranchiano u.a.' widerspiegelt. Eine computergestützte Untersuchung einer Reihe von Floren ergibt einen allmählichen Übergang vom Pliozän zum Pleistozän (sensu MENKEs Känozän), aber keinen Bruch in der Vegetationsgeschichte - allerdings alles deutlich in Abhängigkeit vom Sediment (siebbar oder spaltbar)

Content

1. Introduction

In 1994 an AIQUA-meeting was held in Peveragno, to solve some problems of 'Villafranchian age'. We prepared a paper for this Symposium, concerning the new data from our computer work with fossil floras. The papers for this Symposium were examined by various Italian colleagues and our work was not accepted by several reasons. So we decided to publish it separately, to bring information to our colleagues from english speaking countries and to discuss the preliminary facts we have from many floras in Europe.

Below we pay attention to the following item:

The terms 'Upper Pliocene, Miocene etc.' are used for the fossil floras in the sense of 'similar to compositions of upper Pliocene floras etc.'. As we try to get a sequence through the ages (GÜNTHER & GREGOR 1990-1997), independent of other data for the geological ages of the different floras, we must have in mind the problem of floras in sievable or splittable sediments, poor and rich floras, water, swamp and dry floras, etc. After a first trial to get an idea of the relative age of Italian and other floras we try to correlate them, if possible.

For a long time Villafranca d'Asti was a type locality for a timespan between the Pliocene and the Pleistocene, especially for mammal specialists. Also the floras were called „belonging to the Villafranchiano", if they were continental in facies and partly correlated with the marine Calabriano or nowadays better with the Santerniano (Stratigraphical comments see in LÜTTIG 1958, 1959). The sequence now is critically revised in AIQUA-Convegno 1994: Revisione ....

For years one of the authors (GREGOR) studied Mediterranean floras from the Neogene of Turkey to Portugal and also Paratethys and Atlantic floras from Scandinavia to Switzerland and from England to Vienna Basin and Poland. A first overview of Neogene European floras was given in GÜNTHER & GREGOR (1989, 1990, 1992, 1993, 1997).

Very often the stratigraphic determinations of the floras were doubtful (geological or palynological problems) or the floras and the faunas showed contradictory conditions. This was the case at the Stirone River, the Santerno River (both Italy), the Tiglian flora in the Netherlands, the Rhenish floras in Germany and especially in the Villafranca area.

The latter area yielded a lot of outcrops with different fruit, seed, and leaf floras (Fornace RDB, Fornace di Baldichieri, Arboschio etc.) which were not comparable with the floras north of Torino or with the floras from Emilia-Romagna-area. But the problem always was the age - because the bio- or chronostratigraphic sequences alsways were made with faunas and there are changing border lines between the ages (Plio-Pleistocene 1.8 or 1.65 million years or 2.4 like in Germany, see also ALBERDI & BONADONNA 1987 and the problem of the chronostratigraphic age of the Villafranchiano). So the decision was to think about a floral „zonation" similar to that of the mammal units or others (see GREGOR 1990b: tab. 7, VELITZELOS & GREGOR 1987: fig. 4). As we always have isolated basins with single floral horizons we cannot work with floras in superposition and have to compare one flora with others by itself. A special computer program, running for some years now, allows to get some ideas not only about the Northern floras in the Neogene, but also about the Italian ones. Future work will allow us to find an evolutionary line in the floras from the Oligocene to the Pleistocene in the whole Europe. In contrast to the mammals, ostracodes, and foraminifera we do not have the type of clearly distinguishable index-fossils for zones like in ammonite-zones, but we have index-fossils for larger units or possibly „large scale zonation fossils", but the composition of the floras and their content of special plantgeographical elements like the paleotropical or the exotic (compare GÜNTHER & GREGOR 1990: 11-13 and GREGOR 1995) are useful for first evaluations.

2. The European Record

Some important fossil sites from Europe mentioned here are shown on the plates, to understand the differences in size of site and species number op fossil fruits or leaves, sediment, facies, and other factors (eg. pls. 1-5). Some fossils are also presented to show the type of sediment (eg. pl. 5).

The Plio-Pleistocene boundary is a great problem because there is a lack of international coincidence about the term „Pleistocene". There are several possibilities to define the boundary (1.8; 1.5; 2.4 mio. years) either by „climatic" reasons (*Arctica islandica* etc.), by FADs and LADs of various mammals or microfossils or by chronostratigraphic data (Olduvai etc.). No definition is satisfying and even the floras with megafossils show no „break" at the official border. The „Limite Tiberiano" of the Italian palynofloras (LONA & BERTOLDI 1973) cannot be stated today or occurs not only unique, but several times (MEYER 1978) and are criticized by various authors (MENKE 1975, KRUTZSCH 1988).

Now, how about the macrofloral record? The macrofloras with mostly autochthonous conditions give another picture of this transition, having a warm-humid climate (Cfa sensu KÖPPEN) throughout the Pliocene, ranging into the formerly so-called Calabriano (marine) or the equivalent Villafranchiano (terrestrial) with a similar climate, only somewhat more temperate. In the Lower Pliocene we have abundant floras with a high percentage of exotic or paleotropical elements (tabs. 7-9), descending in the Pliocene to an amount of approximately 10 or less percent. We have enough macrofloras in the Netherlands, Germany, Italy, Spain, and Greece (Reuver, Wörth, Mainflingen, Bobila Ordis, Viettone etc., see pls.1-3) with large floras with accordingly compositions. The formerly called „Pleistocene floras" like that of Schwanheim, Castle Eden or Stirone (Calabriano = today Santerniano) show a high amount of exotic elements, going to an amount of zero at the floras of Lieth (MENKE 1975, GREGOR & MENKE 1986), Uhlenberg, or Crespia (see tab. 7-9).

It is evident, that we have to distinguish between the splittable and the sievable sediments with floras, because with the first ones we have ecological conditions not dependent of climate and as phytostratigraphy is climate-stratigraphy we cannot use these floras for stratigraphical purposes (GÜNTHER & GREGOR 1993: figs. 13, 14, 15). The interpretation of these bottomland-floras is different from that of floras from sievable sediments - we proved this idea well balanced in the German molasse (GREGOR 1982). Floras of sievable sediments belong to mesophytic forests dependent on climate and not the ground-water and in this way are indicators for climate and age (GREGOR 1990a: 239-242) in contrast to the conservative floras of the riparian belts.

In this respect we now know that the „borderline floras" (Plio-Pleistocene, with 10 or 5 percent of exotic or paleotropical elements) are floristically warm-temperate enough to be „Pliocene". The younger „Pleistocene floras" have approximately zero percent of exotic or paleotropical elements and are mostly of water-facies. So the floras from Tegelen, Bobila Ordis, Mizerna etc. are typical Pliocene floras - not Pleistocene as formerly believed (GÜNTHER & GREGOR 1992, 1993).But this is also a problem of defined borders - in Germany we have the 2.4 ma-line in contrast to the 1.65 ma-line of Italy - and the latter is just under critics. But we also do not find a „break" in the composition of the floras, only a transition between the Plio- and Pleistocene floras, which makes a definition of the stages very obscure. The palynofloras give another picture - some cooler and warmer phases which cannot be stated here (for example see GREGOR 1986).

3. The Italian Record

Italian fossil sites will be shown in other parts of the FTM V. (GREGOR 1997), but here we present for comparison the localities Lugagnano, S. Barbara, San Gimigniano, Villafranca and Stirone (pls. 3-5).

When we have a look on the following tables and graphs, we get some important information about the sequence and distribution of Italian fossil floras (GREGOR 1990b). We always must have in mind that the sediment is important in yielding a „sievable“ or a „splittable“ possibility for a flora - this is a facies question. On the other hand it can be that the sediment is not changing - but the flora - it depends on a time- and taphocoenosis-factor.

Tables 1-3 give us an impression about the Villafranchian floras and their similarity to other European floras. Villafranca 1-1, the youngest flora is significantly similar to the Thuringian Upper Pliocene floras, the older floras from Villafranca (1-2 and 1-3) are comparable with other Pliocene localities, but mostly somewhat older than the foregoing. So we have two different complexes in Villafranca, one Upper Pliocene and one Lower Pliocene/Upper Miocene.

We must explain this dating by the following experience: The „Upper Miocene“ composition must not be understood as really belonging to the Upper Miocene - it is a composition of a fossil flora, most similar to „Upper Miocene“ floras of other European regions, but we know today that we have a certain relict behavior in Italian floras (see GÜNTHER & GREGOR 1990: 106,fig. 18). The Pleistocene aspect is missing totally, that means the native elements today growing in the research area, are missing in the Pliocene. In any case, for the moment we have Pliocene compositions in Villafranca, different from the composition of, for example, Stura and Viettone nearby (see tab. 5, 6).

As Stura formerly was thought to be of Pleistocene age (ALLASON et al. 1981, CERCHIO et al. 1990) and was redefined by MARTINETTO (1990/91) by the macroflora as „Pliocene“, we see the problems of stratigraphical confusion. The term „Upper Miocene - Lower Pliocene“ for Stura 1-1 (see GÜNTHER & GREGOR 1993: tab. 3) is a question of floral composition, not of direct chronostratigraphic age (see also tab. 6). The same happens with the megaflora of Viettone 1-1 (see tab. 5), which is „middle Miocene“ in composition (in comparison to other European floras), but Lower Pliocene dated by marine sediments. We can see in this respect that fossil floras are better understood by the whole compositions of their taxa instead of dating them by somewhat problematic geological reasons.

As stated just before we have to expect a relict-niche in Italy in the Pliocene, similar to the Alsace region, which has „old floras“ in young sediments. The whole composition and the first comparison with Lower Miocene floras was done by MARTINETTO, PAVIA & BERTOLDI (1994). The question was, which age the floras of Arjuzanx and Sessenheim have in respect to the Viettone flora. The first is now Lower (to Middle) Miocene (GREGOR 1995), the second is Upper Miocene - Lower Pliocene (all data in GÜNTHER & GREGOR 1993: tab. 3).

A comparison with the Pliocene floras from Villafranca and Stirone with others from Europe Reuver, Schwanheim etc.) give the impression that Villafranca 1-1, 1-2, and 1-3 show an intermediate situation in the variability of Pliocene floras of Europe. In this case the „Villafranchiano“ with ist floras is identical with the „Calabriano“ of the Stirone River (see PLANDEROVA & GREGOR 1992, BENESOVA & GREGOR 1994) concerning the forelaying data sets of the megafloras and palynofloras.

Tables 7 and 8 show a first idea of a sequence of European and Italian floras depending on the paleotropical and exotic element - but this is a first attempt und will be studied in the future more precisely. In any case it can be clearly shown that the splittable sediments yield floras, where the „Pleistocene-Pliocene“ are somewhat mixed up and show no clear transition (tab. 7 and 8, left side), whereas the floras in sievable sediments give an impression of a straight line between the

Pliocene and Pleistocene floras (tab. 7 and 8, right side). The „trends" can be seen in tab. 9 and 10, depending on mix-value and a theoretical model.

Table 10 is an arrangement of different floras with important elements of exotic-subtropical and more temperate or native elements. So one can compare the different floras at one glance and get impression about the „Plio-Pleistocene" floras and their transitions. The problem for the moment is that we do not know anything about the different maritime or continental influenced climates or other conditions (some ideas see tab. 10) - but that will be the work of the next generation. As we know today we have a regional diversity in the fossil floras which is not comparable to the recent geographical distribution of vegetation and climate (see GÜNTHER & GREGOR 1990: figs.19-31).

One outstanding problem of our computer work is, that we only work with fruit and seed floras, but not with leaf floras for the moment. Often we have abundant leaves but no seeds - this problem also has to be solved in the future. On the other hand we have enough rough data for leaf-floras in Europe (WEBENAU 1995, KOVAR-EDER et al. 1994, VELITZELOS & KNOBLOCH 1985, KNOBLOCH & VELITZELOS, 1985), that we can be sure to get stratigraphical data also with leaves. A very good example of this problem is the locality Oriola near Faenza, where VIGLIOTTI et al. (1994) have made a magneto-stratigraphic survey which gave a Brunhes/Matuyama „picture". This age was doubted by TORRE (AIQUA-Symposium, oral communication) and can be stated paleobotanically as being older by megafloral remains as leaves of *Liquidambar* (?), *Acer laetum*, giant *Quercus*, *Zelkova ungeri*, *Populus* sp. and *Corylopsis* fruits and *Tsuga* cones. This flora does not seem to be purely Pleistocene, but perhaps belongs to a transitional composition, older than the magnetostratigraphic record (Early Pleistocene?). Especially this quarry gives a good impression about stratigraphic problems in Europe.

Table 11 is a preliminary list of different taxa (only genera) and various fossil localities and the reason of comparison is to show the similarities and differences in the composition. Some important hints can be shown clearly in this table:

Rich floras (No. 4, 6, 7, 18, 20, 23, 25, 27, 28) have a high content of arctotertiary elements, that means they are younger floras with Plio-Pleistocene composition.
Rich floras (No. 4, 14, 18, 20, 25, 28) have a high content of low warm-temperate elements, that means they are young floras with Upper Pliocene composition.
Rich floras (No. 4, 8, 11, 16, 18, 20) have a high content of high warm-temperate elements, that means they are somewhat older floras with Lower Pliocene composition.

Poor floras (No. 1, 12, 22, 24, 26) have a medium content of arctotertiary elements, that means they are young florase with p.p. Pleistocene composition.
Poor floras (No. 1, 2, 3, 5, 13, 17, 26) have a medium content of low warm-temperate elements, that means they are young florase with Upper Pliocene composition.
Poor floras (No. 10, 22) have a medium content of high warm-temperate elements, that means they are young florase with Upper Pliocene composition.

Floras like No. 9, 15, 21 have a intermixed content of all elements and have no significant stratigraphical composition.
Also intermediate Floras occur (e.g. No. 4), that means the oldest and highest warm-temperate elements significantly show the stratigraphical character (composition, not age).

In this sense Villafranca 1-3 has enough „warm" elements including others to be Pliocene, but Villafranca 1-1 and 1-2 must be younger, because they are „cooler" in composition. All these preliminary data give a first long-range impression about fossil floras and must be stated in the future.

Table 12 is a list of fossil floras, the same as in table 11, but with the percentages for a combination of elements a=arctotertiary, n=native, e=exotical and p=paleotropical. It can be clearly stated that some floras are similar, e.g. in the percentage of ae (Stirone 2-1, Megalopolis 1-1 with 0 %, Villafranca 1-2, S.Barbara 1-2, Mugello 1-1, Willershausen 1-1 about 30 %) or the percentage of pe (Mizerna 1-1, Bobila Ordis 1-1, Villafranca 1-1/1-2 about 15 %). Some of these data are similar to those of table 11. In both cases the way to come to clear decisions about age is complicated.

Table 13 is a bit dangerous, because one might misinterprete it. The table shows the stratigraphical column of the Neogene, together with various values from GÜNTHER & GREGOR (1993). The Italian floral record is correlated with the 'age sequence' by certain percentage of correspondence and shows a preliminary dating of various floras. The terms 'Miocene' etc. are to be seen in the sense of 'Miocene composition' of flora, because we could have relic problems of fossil floras in Italy. These data are preliminary but allow separation of

- the older complex (B): Villafranca 1-1, Villafranca 1-2, Stura 1-1, St. Barbara 1-2 and
- the younger complex (A): Villafranca 1-1, Stirone 3-3, Leffe 1-1.

Future research will help to clear up zonations of fossil floras in Italy.

4. Suggestions, claims and concepts

It should be allowed to propose some preliminary items, having had a look on the tables and graphs:

4.1. The term „Villafranchian" (Villafranchiano) is of no further use and should be eliminated, as just proposed by LÜTTIG (1970). The sequence in the type locality Villafranca surely is of Pliocene age (Upper Miocene to Upper Pliocene „composition" of flora), additionally of two different „stages". The confusion with the mammalian stages is obvious.

4.2. The „Limite Tiberiano" also is of no further use, as already proposed by MEYER (1978) and others. The *Taxodium*-phases are repeated and at Santerno River we have macrofossils of *Taxodium* in the Pleistocene ! (depending on definition, new data in progress by the author and colleague v. d. BURGH, see also chapter 4.10 and the confirmation by K.-J. MEYER).

4.3. The „Calabriano" in the sense of the creator is (like originally) Pliocene, especially at the Stirone River profile (Pliocene in composition of flora!). It is better, not to speak any more of the Stirone-Calabriano!

4.4. The occurrence of *Arctica islandica* and other „Nordic guests" does not concern the floras and there is no correlation of any cooling trend in the floras, time equivalent to the *Arctica* horizons (Santerno, Stirone etc.).

4.5. We have to distinguish between splittable and sievable sediments and the floras inside the sediments. Only with fruit and seed floras from the latter sediment we can make a stratigraphic sequence.

4.6. Floras from splittable sediments allow some ideas about the age, but not as precise as those from no. 5, because we have wetland and bottomland conditions. The occurrence of plants like *Glyptostrobus, Magnolia* or *Taxodium* is an indicator for the Pliocene, but only in connection with other points of interest.

4.7. We have no „break" of vegetation between the Pliocene and the Pleistocene but a „transition" which shows around 10 to 5 or even less percent of exotic or paleotropical elements in the floras.

4.8. We should correlate our macrofloras with one another and should not rely upon geological or other data until we got our own impression about the relative or absolute age of a fossil flora. Afterwards we can make a correlation. This hypothesis was proved in the German molasse and yielded sufficient success.

4.9. Some of the foregoing numbers allow us to reflect about a future „zonation" of fossil floras similar to that of the mammal units, the ostracod or foraminifera zones etc.

4.10. The term „Santerniano“ is doubtful in the same way as the Calabriano as the transition between the Plio-Pleistocene is a facies change and the sediments of the younger cycle contain *Taxodium*, which is - by definition - Pleistocene. The whole sequence seems to be of Pliocene age (excursion in the field by courtesy of Dr. ELMI, work in progress by GREGOR and coll.).

4.11. Data from the last years compare the microfloras from Pietrafitta, Villafranca, and Leffe with the one from Autan (France) which is of Pliocene age (KRUTZSCH 1988: 18-23) and not Pleistocene!

4.12. At the Stirone River we have a floral sequence from the cascate stream-downwards, formerly called Calabriano, which after the macrofloras and also the microfloras is obviously Uppermost Pliocene, perhaps a „transition“ to the Pleistocene (GREGOR 1986, PLANDEROVA & GREGOR 1992, BENESOVA & GREGOR 1994, MEYER in this report.).

4.13. The palynofloras give a picture of the original climate different from megafloras (see GREGOR, MARTINETTO & VELITZELOS 1993) because of pollen inputs depending on facies and other geological and geographical conditions. They cannot be used for stratigraphic purposes like it was until now (but see progress in Turkey by BENDA 1971). Only a combination with macrofloras allow us precise interpretations.

4.14. Outlook: This article must be stated to have preliminary character as the whole Mediterranean paleovegetation is under research by the authors. We claim for a teamwork with colleagues also if some topics have problematic character and could give problems to recent research.

4.15. The confirmation by K.-J. MEYER also shows a clear Neogene pollen succession in Villafranca and no „Pleistocene“ one. Additionally the floras of Villafranca are interpreted (see tab. 12) in the new stratigraphic divisions (see GÜNTHER & GREGOR 1993: fig. 1) in connection with some other important floras.

5. Confirmation by K.-J. MEYER

A test sampling for palynology was done by colleague GREGOR in oct. 1989 (excursion No. E 587/6) to get an impression about the profile in the lower part of the RDB pit (see Fig. 19 in AIQUA-Convegno 1994: Revisione ...: Some samples were sufficient for determinations from above to the base - the others were poor or sterile):

1. Sample 15 (ca. 16 m above 0): still tertiary elements, perhaps reworking, no dinoflagellate cysts.
2. Sample 8 and 9 (ca. 8-9 m above 0): typical tertiary elements, no dinoflagellate cysts, different facies elements!
3. Sample 4 (ca. 4 m above 0): Taxodiaceae, *Carya, Tsuga, Pterocarya, Sciadopitys, Sequoia* and many other characteristic elements, few dinoflagellate cysts.

The whole profile in this sense is „Pliocene“ or „Upper Neogene“ in floral composition and shows no Pleistocene influence (approximately zero percent of exotic elements) or Limite Tiberiano (*Taxodium* vanishes abruptly). Formerly it was thought to be of Villafranchian age - Pleistocene in the old sense. These data are well confirmed by the ‘Pliocene’ sequence of the Stirone river in the Calabriano after the ‘Cascate’ (BENESOVA & GREGOR 1994, PLANDEROVA & GREGOR 1992).

6. Tables and Abbreviations

The following abbreviations are used in the tables:

G = group (similarity category)
SF = similarity factor
strat = stratigraphy (composition, not age)

PL = Pleistocene
P = Pliocene
M = Miocene
l = lower
m = middle
u = upper
PPL = Transition Pliocene/Pleistocene

sed = sediment
siev = sievable
split = splittable
lith = lithologic data

c = clay
m = marl
l = limestone
b = browncoal
s = sand
u = unknown

spec = number of species

W = percentage of water facies
S = percentage of swamp facies
M = percentage of dry facies (mesophytic)

e = percentage of exotical elements
n = percentage of native elements (e + n = 100%)
p = percentage of paleotropical elements
a = percentage of arctotertiary elements (p + a = 100%)

an = percentage of elements which are arctotertiary and native
ae = percentage of elements which are arctotertiary and exotical
pn = percentage of elements which are paleotropical and native
pe = percentage of elements which are paleotropical and exotical

T = percentage of tree elements
R = percentage of recent elements

mix = percentage of stratigraphical mixture value, equivalent to e, p
AA = percentage of ASA-GRAY American-Asian disjunction of elements
TST = percentage of tropical-subtropical element
H = percentage of holarctic element
C = percentage of cosmopolitan element
D = percentage of dispersed element

Table 1: Comparable floras for Villafranca 1-1 (upper horizon) (sensu GÜNTHER & GREGOR 1989-1993, especially 1992: 7-14)

Table 1, part 1: General data						
G	fossil site	SF	strat	sed	lith	spec
1	Villafranca 1-1	100	u P	siev	c/m	50
3	Nordhausen 1-1	13	u P	siev	c/m	60
3	Kaltensundheim 1-1	11	u P	siev	c/m	58
3	Rippersroda 1-2	11	u P	siev	c/m	76
3	Rippersroda 1-1	10	u P	siev	u	70
3	Berga 1-1	9	l-uP	siev	c/m	157
3	Kranichfeld 1-1	8	l P	siev	c/m	28
3	Tegelen 1-2	8	l P	siev	c/m	201
3	Bobila Ordis 1-1	7	PPL	siev	c/m	9
3	Degernbach 1-1	7	m M	siev	c	8

Table 1, part 2: Percentage of plant characteristics within the flora													
fossil site	W	S	M	e	p	T	R	mix	AA	TST	H	C	D
Villafranca 1-1	18	46	36	40	28	28	90	27	7	28	13	42	9
Nordhausen 1-1	32	38	30	20	8	18	97	10	3	7	28	55	7
Kaltensundheim 1-1	16	34	50	16	11	31	98	10	0	10	27	60	3
Rippersroda 1-2	30	41	29	25	11	23	99	12	9	10	18	59	5
Rippersroda 1-1	32	35	33	25	15	23	97	14	10	10	19	56	5
Berga 1-1	10	28	62	33	14	47	98	15	10	10	29	39	12
Kranichfeld 1-1	9	44	47	35	14	42	98	16	12	12	23	44	9
Tegelen 1-2	17	29	53	18	9	23	100	9	6	8	32	50	3
Bobila Ordis 1-1	31	15	54	31	23	54	100	16	0	8	38	46	8
Degernbach 1-1	30	60	10	70	40	40	80	43	10	40	20	10	20

Table 2: Comparable floras for Villafranca 1-2 (lower horizon) (sensu GÜNTHER & GREGOR 1989-1993, especially 1992: 7-14; for explanations see table 1)

Table 2, part 1: General data						
G	fossil site	SF	strat	sed	lith	spec
1	Villafranca 1-2	100	u M	siev	c/m	4
2	St. Barbara 1-2	30	u M	split	c/m	16
3	Castellina 1-1	29	m M	split	c/m	3
3	Stirone 3-6	29	l PL *)	split	c/m	3
3	Unterwohlbach 1-1	29	m M *)	split	c/m	3
3	Ruszow 1-1	29	u M	split	u	3
3	Guarene 1-1	25	u M	split	l	4
3	Frimmersdorf 1-1	22	u M	split	c/m	5
3	Wengen 1-1	21	l M	siev	c/m	15
3	Kaltenhausen 1-1	21	l P	siev	b	15
3	Hambach 2-3	21	u M	siev	c/m	15

*) For nearly all fossil sites we used the stratigraphic data revised in GÜNTHER & GREGOR (1993). Only Stirone 3-6 and Unterwohlbach 1-1 yield older data, because the revised age determination is not possible depending on a very short floral list (3 species). The age of Stirone 3-6 could be Pliocene; the one from Unterwohlbach 1-1 Middle Miocene (see references in GÜNTHER & GREGOR 1992: 225-232).

Table 2, part 2: Percentage of plant characteristics within the flora													
fossil site	W	S	M	e	p	T	R	mix	AA	TST	H	C	D
Villafranca 1-2	17	67	17	50	17	67	100	17	17	0	17	33	33
St. Barbara 1-2	3	13	83	63	33	97	100	26	33	7	37	0	23
Castellina 1-1	25	25	50	75	0	75	75	26	25	0	25	25	25
Stirone 3-6	0	0	100	50	25	100	100	19	0	0	75	0	25
Unterwohlbach 1-1	0	0	100	33	17	100	83	17	33	0	50	0	17
Ruszow 1-1	17	17	67	33	0	83	100	9	17	0	67	0	17
Guarene 1-1	0	8	92	38	15	100	92	18	15	8	62	0	15
Frimmersdorf 1-1	20	20	60	40	0	80	100	11	20	0	60	0	20
Wengen 1-1	14	32	55	36	27	68	100	18	23	5	27	36	9
Kaltenhausen 1-1	14	24	62	38	29	71	95	20	29	5	33	24	10
Hambach 2-3	22	33	44	61	28	72	100	26	33	11	17	22	17

Table 3: Comparable floras for Villafranca 1-3 (RDB 1 horizon) (sensu GÜNTHER & GREGOR 1989-1993, especially 1992: 7-14; for explanation see table 1)

Table 3, part 1: General data						
G	fossil site	SF	strat	sed	lith	spec
1	Villafranca 1-3	100	u M/l P	siev	c/m	16
2	Stura 1-2a	31	l P	siev	b	36
3	Stura 1-2b	28	l P	siev	b	48
3	Dornassenheim 1-1	23	u M	siev	b	19
3	Ungstein 1-1	22	l P	siev	s	20
2	Eschweiler 5-6	21	u M	siev	s	23
3	Villafranca 1-2	20	u M	siev	c/m	4
3	St. Barbara 1-2	19	u M	split	c/m	16
3	Dorheim 1-1	19	u M	siev	b	26
3	Hambach 1-4	19	l P	siev	s	59
3	Hambach 2-3	19	u M	siev	c/m	15
3	Huba 1-1	19	l P	siev	u	36

Table 3, part 2: Percentage of plant characteristics within the flora													
fossil site	W	S	M	e	p	T	R	mix	AA	TST	H	C	D
Villafranca 1-3	13	43	43	47	23	43	97	22	13	13	13	43	17
Stura 1-2a	13	33	55	38	23	48	95	22	9	18	25	43	6
Stura 1-2b	11	38	50	36	21	40	96	20	8	15	23	49	6
Dornassenheim 1-1	25	25	50	70	40	70	95	33	35	15	20	10	20
Ungstein 1-1	3	6	91	57	34	97	100	28	34	17	37	6	6
Eschweiler 5-6	4	21	75	71	50	93	93	36	43	14	18	14	11
Villafranca 1-2	17	67	17	50	17	67	100	17	17	0	17	33	33
St. Barbara 1-2	3	13	83	63	33	97	100	26	33	7	37	0	23
Dorheim 1-1	15	23	62	69	42	77	92	33	42	12	23	4	19
Hambach 1-4	13	28	60	25	13	50	97	13	10	8	44	32	6
Hambach 2-3	22	33	44	61	28	72	100	26	33	11	17	22	17
Huba 1-1	7	19	74	38	12	74	100	14	29	5	33	24	10

Table 4: Villafranchian strata in comparison with the data of other Italian locality Stirone and some important European ones (for explanations see table 1).

fossil site	W	S	M	e	p	T	R	mix	AA	TST	H	C	D
Villafranca 1-1	18	46	36	40	28	28	90	26	7	28	13	42	9
Villafranca 1-2	17	67	17	50	17	67	100	17	17	0	17	33	33
Villafranca 1-3	13	43	43	47	23	43	97	22	13	13	13	43	17
Reuver 1-1	16	22	62	33	16	54	98	14	17	7	35	33	7
Frankfurt 1-1	5	10	84	39	14	81	99	14	25	4	48	13	10
Tegelen 1-1	0	2	98	32	17	98	100	14	25	7	53	14	2
Schwanheim 1-1	37	16	47	21	7	35	100	8	16	2	49	32	2
Stirone 2-1 Piacenzian	33	0	67	0	33	67	100	16	0	33	67	0	0
Stirone 3-5 Calabrian	3	13	83	23	13	80	97	12	17	10	50	23	0

Table 5: Viettone 1-1 in comparison to other European floras (for explanations see table 1)

Table 5, part 1: General data						
G	fossil site	SF	strat	sed	lith	spec
1	Viettone 1-1	100	m M	siev	c/m	23
2	Düren 1-1	41	u M	siev	s	36
2	Arjuzanx 1-2	33	l M	siev	s	67
2	Arjuzanx 1-1	30	l M	siev	c/m	24
3	Hambach 2-5	29	u M	siev	s	26
3	Eschweiler 4-1	29	u M	siev	b	25
3	Köflach 1-2	29	l M	various	various	25
3	Hambach 2-9	28	u M	siev	s	20
3	Seußen 1-1	28	u M	siev	u	13
3	Kreuzau 2-1	27	m M	siev	c/m	44

Table 5, part 2: Percentage of plant characteristics within the flora													
fossil site	W	S	M	e	p	T	R	mix	AA	TST	H	C	D
Viettone 1-1	0	16	84	81	55	97	90	43	48	23	13	0	16
Düren 1-1	3	11	86	81	57	97	86	44	46	22	16	0	16
Arjuzanx 1-2	4	16	80	67	49	92	94	37	33	23	25	7	11
Arjuzanx 1-1	4	17	79	73	60	92	96	42	38	27	17	8	10
Hambach 2-5	0	22	78	74	59	85	78	47	37	30	11	15	7
Eschweiler 4-1	0	20	80	80	64	96	96	41	48	12	16	16	8
Köflach 1-2	0	18	82	82	55	94	94	42	42	21	12	12	12
Hambach 2-9	0	29	71	81	67	86	86	47	43	24	10	14	10
Seußen 1-1	0	0	100	92	77	100	85	52	69	23	8	0	0
Kreuzau 2-1	2	24	74	87	65	90	92	47	37	27	8	6	21

Table 6: Stura 1-2b in comparison to other European floras (for explanation see table 1)

Table 6, part 1: General data						
G	fossil site	SF	strat	sed	lith	spec
1	Stura 1-2b	100	l P	siev	b	48
2	Stura 1-2a	86	l P	siev	b	36
2	Sufflenheim 2-2	30	l P	siev	u	33
3	Auenheim 1-1	29	l P	siev	b	36
3	Rippersroda 1-2	29	u P	siev	c/m	76
3	Villafranca 1-3	28	u M/l P	siev	c/m	16
3	Hambach 1-4	28	l P	siev	s	59
3	Liessel 1-1	28	l P	siev	s	74
3	Sessenheim 1-2	27	l P	siev	u	19
3	Sessenheim 1-3	27	l P	siev	s	124
3	Reuver 1-1	27	l P	siev	c/m	65

Table 6, part 2: Percentage of plant characteristics within the flora													
fossil site	W	S	M	e	p	T	R	mix	AA	TST	H	C	D
Stura 1-2b	11	38	50	36	21	40	96	20	8	15	23	49	6
Stura 1-2a	13	33	55	38	23	48	95	22	9	18	25	43	6
Sufflenheim 2-2	16	19	66	34	19	62	97	17	19	9	36	31	5
Auenheim 1-1	13	15	72	41	19	69	96	19	26	11	37	20	6
Rippersroda 1-2	30	41	29	25	11	23	99	12	9	10	18	59	5
Villafranca 1-3	13	43	43	47	23	43	97	22	13	13	13	43	17
Hambach 1-4	13	28	60	25	13	50	97	13	10	8	44	32	6
Liessel 1-1	11	20	69	48	31	75	92	26	25	15	33	20	8
Sessenheim 1-2	18	18	64	29	14	64	96	15	21	11	39	25	4
Sessenheim 1-3	12	14	74	43	31	71	96	24	23	16	32	23	6
Reuver 1-1	16	22	62	33	16	54	98	15	17	7	35	33	7

Table 7: The paleotropical element in Plio-Pleistocene fossil floras in descending percentages, left row splittable sediments, right row sievable sediments.
Pleistocene floras are marked with *.

floras in splittable sediments	p in %	floras in sievable sediments
	60-70	Lugagnano 1-1 Corneliano 1-1
	50-55	Viettone 1-1 Roero 1-1 Isola d'Asti 1-1 Stirone 1-1
	40-47	San Gimigniano 1-1 St. Barbara 1-1 Ptolemais 1-5
St. Barbara 1-2	33-36	Ptolemais 1-2 * Igoumenitsa 1-1 Stirone 2-1
Stirone 3-6	21-29	Stura 1-1 Wörth 1-1 Pietrafitta 1-1 Villafranca 1-1 Stura 1-2a Bobila Ordis 1-1 Villafranca 1-3 Mainflingen 1-2 Stura 1-2b
	10-17	Tegelen 1-1 Villafranca 1-2 Reuver 1-1 Cessenon 1-1 Mühlheim 1-1 Mizerna 1-1 * Stirone 3-5 Mühlheim 1-2 * Megalopolis 1-1 Huba 1-1 Mainflingen 1-1 Valdarno 1-4
Leffe 1-1 Valdarno 1-1	5-9	Castle Eden 1-1 Tegelen 1-2 * Stirone 3-1 Schwanheim 1-1 * Stirone 3-4 * Stirone 3-3 Valdarno 1-3
Reuver 1-2 Willershausen 1-1 Arboscio 1-1 * Riano Romano 1-1 Crespia 1-1	0	* Uhlenberg 1-1 Tornago 1-1 Mugello 1-1 * Stirone 3-2 Valdarno 1-2

Table 8: The exotical element in in Plio-Pleistocene fossil floras in descending percentages, left row splittable sediments, right row sievable sediments.
Pleistocene floras are marked with *.

floras in splittable sediments	e in %	floras in sievable sediments
St. Barbara 1-2	60-81	Viettone 1-1 Lugagnano 1-1 Roero 1-1 St. Barbara 1-1 Corneliano 1-1 Tornago 1-1
Leffe 1-1 * Stirone 3-6 Arboscio 1-1	50-59	San Gimigniano 1-1 Villafranca 1-2 Isola d'Asti 1-1 * Stirone 3-3
Valdarno 1-1	40-47	Villafranca 1-3 Cessenon 1-1 Ptolemais 1-2 Valdarno 1-2 Wörth 1-1 Stura 1-1 Pietrafitta 1-1 Valdarno 1-3 Villafranca 1-1 Ptolemais 1-5 Valdarno 1-4
Willershausen 1-1	30-39	Mainflingen 1-2 Huba 1-1 Stura 1-2a Stura 1-2b Mühlheim 1-1 Reuver 1-1 Mugello 1-1 Mühlheim 1-2 Mainflingen 1-1 Tegelen 1-1 Bobila Ordis 1-1
	21-29	* Stirone 3-4 Mizerna 1-1 Stirone 1-1 * Stirone 3-1 * Stirone 3-5 Schwanheim 1-1
* Riano Romano 1-1	14-18	Tegelen 1-2 * Stirone 3-2 * Uhlenberg 1-1 Castle Eden 1-1
	4	* Megalopolis 1-1
Reuver 1-2 Crespia 1-1	0	* Igoumenitsa 1-1 Stirone 2-1

Table 9: The stratigraphical mix-value (see GÜNTHER & GREGOR 1990: 75) in Plio-Pleistocene fossil floras in descending percentages, left row splittable sediments, right row sievable sediments.
Pleistocene floras are marked with *.

floras in splittable sediments	mix in %	floras in sievable sediments
	41-44	Roero 1-1 Viettone 1-1 Corneliano 1-1 Lugagnano 1-1
	30-38	Isola d'Asti 1-1 Ptolemais 1-5 San Gimigniano 1-1 Ptolemais 1-2
St. Barbara 1-2	20-29	St. Barbara 1-1 Villafranca 1-1 Stirone 1-1 Wörth 1-1 Stura 1-2a Villafranca 1-3 Stura 1-2b
* Stirone 3-6 Leffe 1-1 Valdarno 1-1 Arboscio 1-1	11-19	Mainflingen 1-2 Stura 1-1 Pietrafitta 1-1 Cessenon 1-1 Villafranca 1-2 * Stirone 3-3 Stirone 2-1 Valdarno 1-3 Tornago 1-1 Bobila Ordis 1-1 Reuver 1-1 Tegelen 1-1 Huba 1-1 * Stirone 3-5 Mühlheim 1-1 Valdarno 1-4 Mizerna 1-1 Mühlheim 1-2 Mainflingen 1-1 Valdarno 1-2 * Stirone 3-4
Willershausen 1-1 * Riano Romano 1-1 Reuver 1-2 Crespia 1-1	1-9	* Igoumenitsa 1-1 Mugello 1-1 Tegelen 1-2 Schwanheim 1-1 Castle Eden 1-1 * Stirone 3-1 * Megalopolis 1-1 * Stirone 3-2 * Uhlenberg 1-1

Table 10: Theoretical model of Plio-Pleistocene floras with paleotropical elements in dependance to sievable (right row) and splittable (left row) sediments. One can see (tab. 7) a difference between the floras and a shift of floral complexes (e.g. marine influenced by sediment) and also a shift in the border between the two time spans Pliocene and Pleistocene. This may be due to geologic reasons but also to systematic floristic ones because the floras in sievable sediments (elements) show a mesophytic habitat (dependent on climate), the ones in splittable sediments show dependance on bottomland or wetland-forest (dependent on ground water, not climate). The boundary floras in sievable sediment seems to lie higher than in the Pleistocene floras which lie lower. The problem depends on a certain "hunchbacking" situation of the floras in splittable sediment in contrast to the floras in sievable sediment.

p in %	floras in splittable sediment	correlation	floras in sievable sediment	p in %
70				70
60			more marine influenced	60
50			more continental influenced	50
40				40
30				30
20	more marine influeced			20
10	more continental influenced	PPL — PPL		10
0				0

Table 11: Fossil elements of different characters in comparison with various localities. The similar floras give an idea of various complexes or possible phytozones (perhaps acme-, or assemblage zones, compare in HEDBERG 1976: 50, 59)

Taxa	Fossil sites (for explanation see below)																											
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Herbs	+	–	+	–	–	+	+	–	–	–	–	–	–	–	–	–	–	+	+	+	–	+	–	–	–	–	+	+
Pinus	–	–	–	+	+	–	+	+	–	–	+	–	+	+	+	+	–	+	–	–	–	–	+	–	+	+	+	+
Picea/Abies	–	–	–	–	+	–	+	–	–	–	–	+	–	–	–	–	–	+	–	+	–	+	+	–	–	+	+	+
Juniperus	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cupressus	–	–	–	+	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fagus	–	–	–	+	–	+	+	–	–	–	–	–	–	+	+	+	–	+	–	+	+	+	+	–	+	–	+	–
Alnus	–	+	+	+	–	+	+	–	–	–	–	–	–	–	+	–	–	+	–	+	+	+	–	–	+	+	+	–
Quercus	+	–	–	+	–	–	+	–	–	–	–	–	–	+	–	+	–	+	–	–	+	–	+	+	+	+	+	+
Swida	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	+	–	+	–	+	–	–	–	+	–	–	–	+
Carpinus	–	–	–	+	–	–	+	–	+	–	–	+	–	–	+	–	–	–	–	+	–	–	+	+	+	+	+	+
Acer	–	–	–	+	–	+	+	–	–	–	–	+	–	–	–	–	–	+	–	+	+	–	+	–	+	+	+	+
Daphne	–	–	+	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pterocarya	–	–	–	+	–	+	–	–	–	–	–	+	–	–	–	–	–	+	–	+	–	–	–	–	+	+	+	+
Prunus	–	–	–	+	–	+	–	–	–	–	–	–	–	–	–	–	–	+	+	+	+	+	+	–	+	–	+	+
Ostrya	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	+	–	–	–
Pyracantha	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	+	+	–	–	–
Paliurus	o	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tsuga	–	–	–	o	–	–	o	–	–	–	–	–	–	–	o	o	–	o	–	o	–	–	–	–	–	o	–	o
Cathaya	–	–	–	o	o	–	–	–	–	–	–	–	o	o	–	–	–	–	–	–	–	–	–	–	–	–	–	o
Cephalotaxus	–	–	–	o	–	–	o	–	–	–	–	–	–	o	–	–	o	o	–	–	–	–	–	–	–	–	–	o
Glypto-strobus	–	–	–	o	–	o	–	–	–	–	–	–	–	o	o	–	–	o	–	–	–	–	–	–	o	–	–	–
Taxodium	o	o	o	o	–	–	–	–	o	–	o	–	–	o	–	–	–	o	–	–	o	–	–	–	o	–	–	–
Liriodendron	–	–	o	–	o	o	–	–	–	–	–	–	–	–	–	–	–	o	–	o	–	–	o	–	o	–	–	–
Liquidambar	–	–	–	o	–	–	–	–	–	–	–	–	o	o	–	o	–	o	–	–	o	–	–	–	o	–	o	–
Juglans	–	–	–	o	o	–	o	–	–	–	–	–	o	o	–	–	o	o	–	–	–	–	–	–	o	–	–	o
Carya	–	–	–	o	o	o	o	–	–	–	–	–	–	o	o	–	–	o	–	–	–	–	–	–	o	–	o	o
Tricho-santhes	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	o	–	o	o	–	–	–	–	–	–	–
Eucommia	–	–	–	o	–	–	o	–	–	–	–	–	–	–	–	–	–	o	–	o	–	–	–	–	–	o	o	o
Corylopsis/ Parrotia	–	o	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	o	–	o	o	–	o	–	o	–	–	–
Nyssa	–	o	o	o	–	–	–	–	–	–	–	–	–	–	–	o	–	o	–	o	–	–	–	–	o	–	o	–
Zelkova	o	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	o	o	–	–	o	–
Leitneria	–	–	–	x	–	–	–	x	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	–	–	–
Menispermum/ Sinomenium	–	–	x	x	–	–	–	x	–	–	x	–	–	–	–	–	–	x	–	x	x	–	–	–	–	–	–	x
Meliosma	–	–	x	–	–	x	–	–	–	–	–	–	–	–	–	x	–	x	–	x	–	x	–	–	–	–	x	–
Eurya	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Visnea	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Zanthoxylum	–	–	–	–	–	–	–	–	x	–	–	–	–	–	x	x	–	–	–	x	–	–	–	–	–	–	–	–
Toddalia	–	–	x	–	–	x	–	–	–	x	–	–	–	–	–	x	–	x	–	–	–	–	–	–	x	–	–	–
Symplocos	–	–	–	x	–	–	–	x	–	–	x	–	–	–	–	x	–	x	–	–	–	–	–	–	x	–	–	–
Magnolia	–	–	x	x	x	x	–	x	–	–	x	–	–	–	–	x	–	x	–	x	–	x	–	–	x	–	x	x
Rehdero-dendron	–	–	–	x	–	–	–	x	–	–	x	–	–	–	–	x	–	x	–	–	–	–	–	–	–	–	–	–
Trigono-balanopsis	–	–	–	x	–	–	–	–	–	–	–	–	–	x	–	x	–	–	–	–	–	–	–	–	–	–	–	–
Sapium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–
Styrax	–	–	–	–	–	x	–	–	–	–	x	–	–	–	–	–	–	x	–	x	–	–	–	–	x	–	–	–

Explanations to table 11:

+ = elements of low warm-temperate climate (Cfa sensu KÖPPEN)
o = elements of middle warm-temperate climate (Cfa sensu KÖPPEN)
x = elements of high warm-temperate climate (Cfa sensu KÖPPEN)

01 = Villafranca 1-1
02 = Villafranca 1-2
03 = Villafranca 1-3
04 = St. Barbara 1-2
05 = Leffe 1-1
06 = Stura 1-2b
07 = Stirone 2-1
08 = San Gimignano 1-1
09 = Arboscio 1-1
10 = Isola d'Asti 1-1
11 = Lugagnano 1-1
12 = Riano Romano 1-1
13 = Tornago 1-1
14 = Valdarno 1-1
15 = Mugello 1-1
16 = Viettone 1-1
17 = Roero 1-1
18 = Sessenheim 1-4
19 = Megalopolis 1-1
20 = Mizerna 1-1
21 = Ptolemais 1-3
22 = Rippersroda 1-2
23 = Willershausen 1-1
24 = Bobila Ordis 1-1
25 = Hambach 1-3
26 = Schwanheim 1-1
27 = Reuver 1-1
28 = Tegelen 1-1

Table 12: Percentages of plantgeographical elements (an, ae, pn, pe) in several fossil floras in comparison with table 11.

fossil site	an	ae	pn	pe
Villafranca 1-1	57	15	3	25
Villafranca 1-2	50	33	0	17
Villafranca 1-3	53	23	0	23
St. Barbara 1-2	37	30	0	33
Leffe 1-1	42	50	0	8
Stura 1-2b	63	16	1	20
Stirone 2-1	67	0	33	0
San Gimigniano 1-1	41	12	0	47
Arboscio 1-1	50	50	0	0
Isola d'Asti 1-1	25	25	25	25
Lugagnano 1-1	20	10	0	70
Riano Romano 1-1	83	17	0	0
Tornago 1-1	40	60	0	0
Valdarno 1-1	57	38	0	5
Mugello 1-1	67	33	0	0
Viettone 1-1	19	26	0	55
Roero 1-1	0	50	25	25
Sessenheim 1-4	56	15	2	27
Megalopolis 1-1	88	0	8	4
Mizerna 1-1	75	11	0	14
Ptolemais 1-3	59	12	0	29
Rippersroda 1-2	74	15	1	10
Willershausen 1-1	70	30	0	0
Bobila Ordis 1-1	62	15	8	15
Hambach 1-3	52	21	3	24
Schwanheim 1-1	75	18	4	4
Reuver 1-1	65	19	1	15
Tegelen 1-1	68	15	0	17

Table 13: Distribution of some important Pliocene floras from Italy in the stratigraphical sequence of GÜNTHER & GREGOR (1993, fig. 1). Variabilities can clearly be seen.

"classical" ages	carpoflora phases	"age" sequence	Italian fossil sites	
			Stirone 3-3	complex A
Lower Pleistocene		50		jounger floras ~ Upper Pliocene composition
Upper Pliocene	CP7	45	Leffe 1-1 Villafranca 1-1	
		40		
Lower Pliocene	CP6	35	Valdarno 1-1	complex B
			Stura 1-1	older floras ~ Lower Pliocene composition
		30	Villafranca 1-2 St. Barbara 1-2	
Upper Miocene	CP5	25		
	CP4	20		
Middle Miocene		15		
	CP3			
		10		
Lower Miocene	CP2			
		5		
Upper Oligocene	CP1			

7. Literature

AIQUA - Convegno sul tema: „Il significato del Villafranchiano nella stratigrafia del Plio-Pleistocene“ Peveragno (CN) - Villafranca (AT), 20-24 giugno 1994

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8. Plates:

All photographs, if not otherwise mentioned, from author GREGOR with his Excursion-numbers from different years.
This combination of fossil sites and some types of fossil plants only should give a first impression about the variable sediments and their contents of plant fossils and the possibilities of interpretation in respect of paleoclimate, paleoecology and age etc.

Plate 1

Fig.1: Northern Field in Ptolemais-Coalfield, Northern Greece.
E 520/11

Fig.2: Open pit Hambach near Niederzier, Cologne, Germany
E 772

Fig.3: Browncoalfield Arjuzanx in SW-France.
E 214

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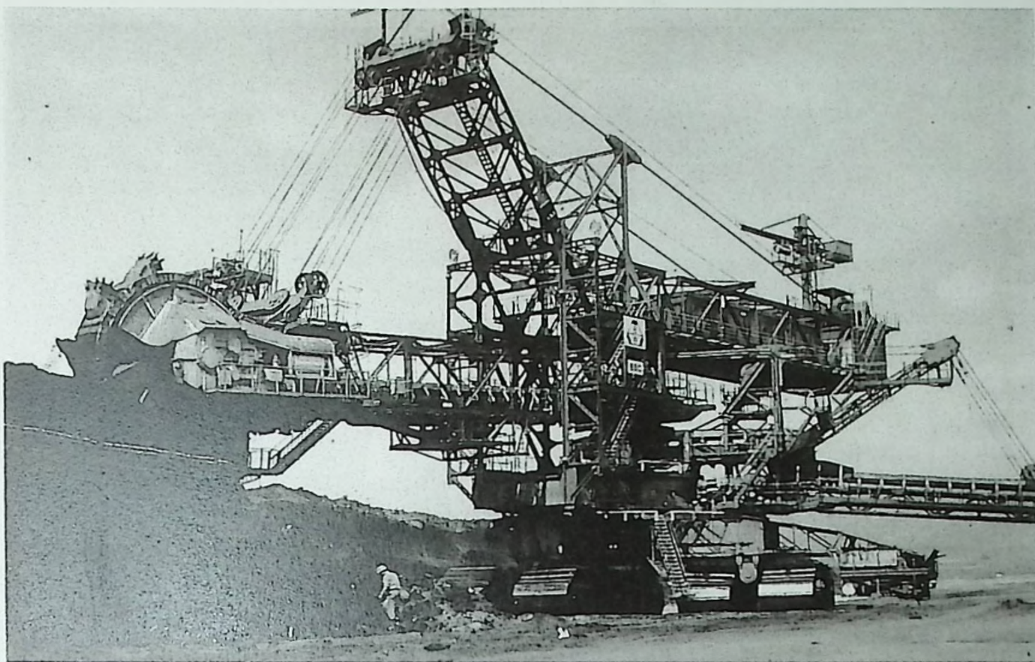

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Plate 2

Fig.1: Outcrop Lieth near Hamburg in Northern Germany.
E 429/17

Fig.2: Clay pit Bobila Ordis near Banyoles in Northeastern Spain.
E 637/3

Fig.3: Gravel pit Unterwohlbach near Hohenkammer, north of Munich, Bavaria, Germany.
E 701/1

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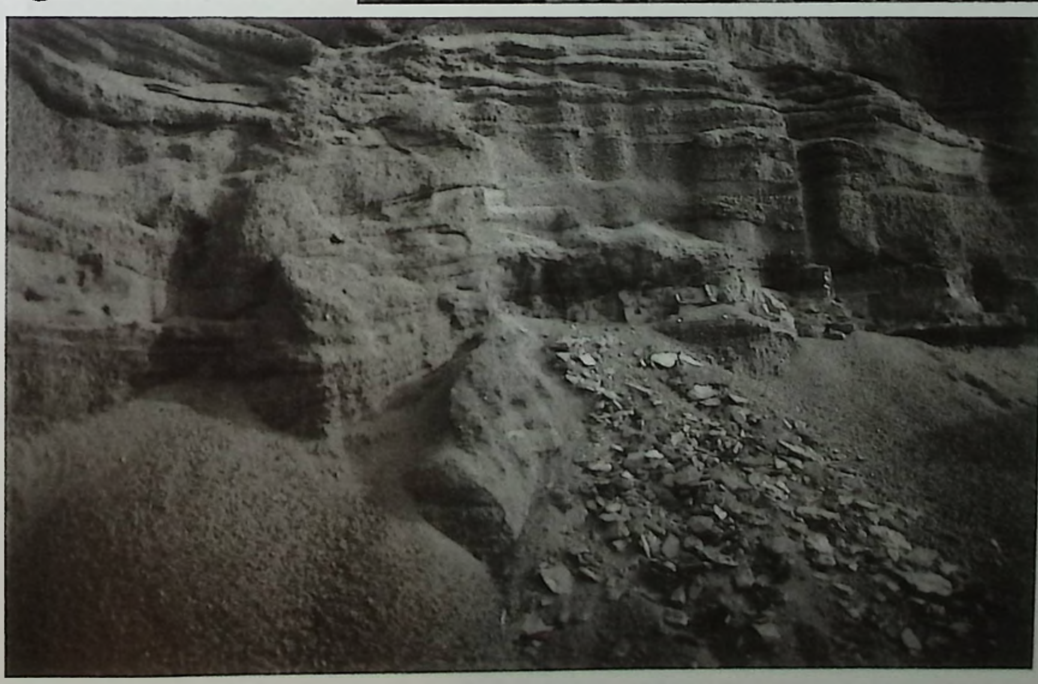

Plate 3

Fig.1: Sand pit Meinflingen near Frankfurt/M. in Germany.
Foto MELLER 1984

Fig.2: Underwater gravel pit Wörth near Karlsruhe, SW-Germany.
E 581

Fig.3: River bed outcrop „Laurano" at the „Fiume Stirone" near Fidenza, Upper Italy.
E 770/4

3

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Plate 4

Fig.1: Clay pit Lugagnano near Castell'Arquato,Parma-Piacenza, Upper Italy.
E 510/14

Fig.2: Browncoal-mine S.Barbara near Castelnuovo dei Sabbioni, south of Firenze, Italy.
E 202

Fig.3: Road cut south of S.Gimignano, south of Firenze, Italy.
E 492/10

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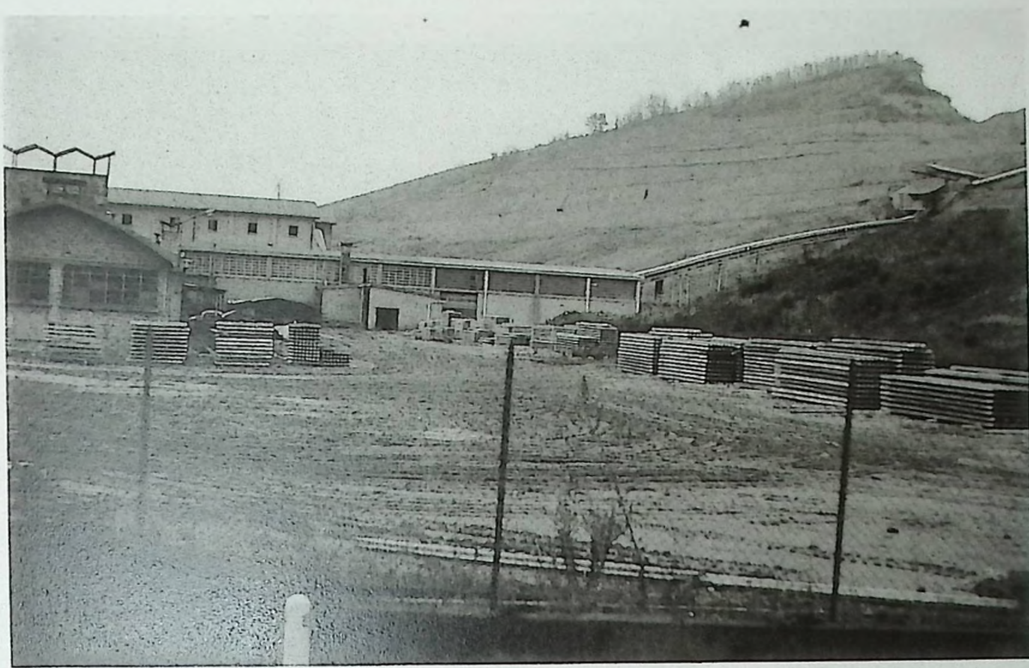

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Plate 5

Fig.1: S.Barbara mine with upper clays and plant debris horizons full of fruits and seeds. E 510/5 (see pl.4, fig.2)

Fig.2: Fornace RDB near Villafranca d'Asti E of Torino in Upper Italy. E 536/2

Fig.3: Silty layer with reddish oxidized leaf remains from Stirone River (see pl.3,fig.3).

Fig.4: Fossil fuits and seeds from Arjuzanx mine (see pl.1, fig.3).

Fig.5: Small nutlets from water plants from Lieth (horizon TC 1u, see pl.2, fig.1).

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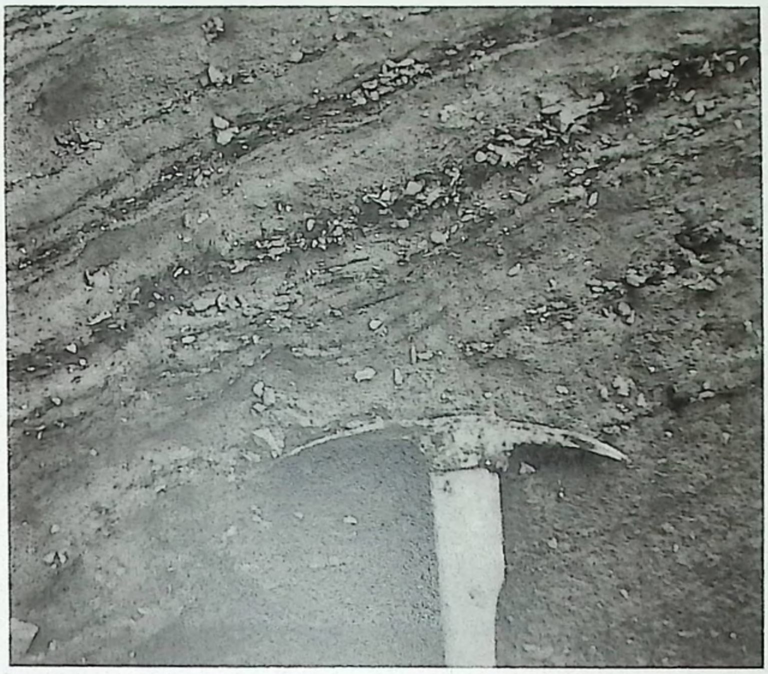

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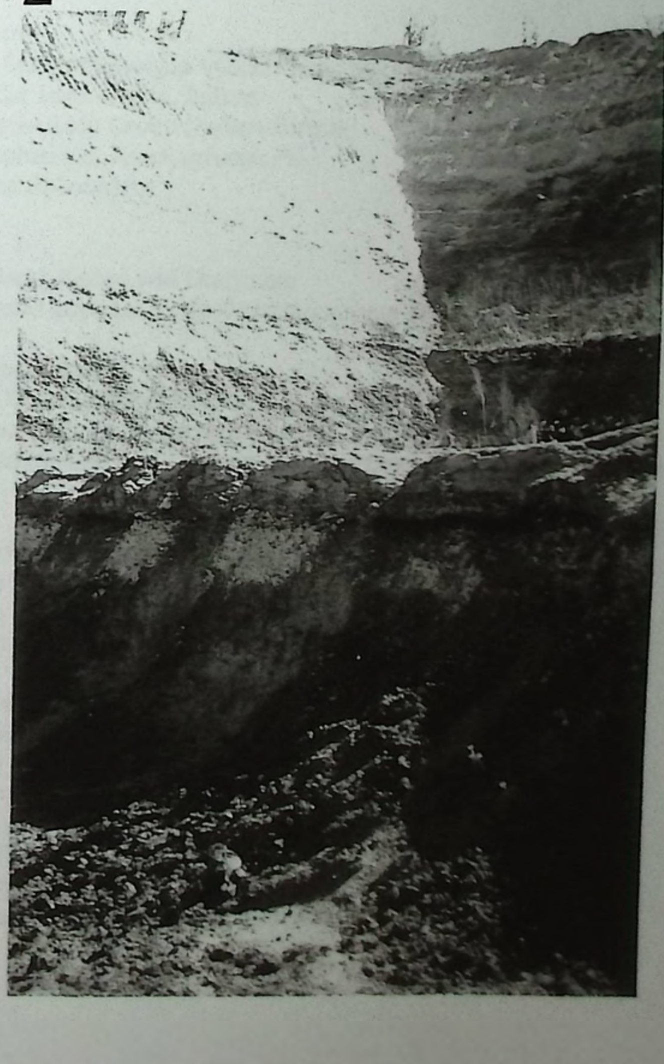

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