IMPLICATIONS OF A POLLEN DIAGRAM FROM THE ADRIATIC SEA

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SUMMARY

A pollen diagram from the shelf of the Adriatic is presented and compared with diagrams from the adjoining mainland and with pollen spectra from Mediterranean deep sea samples. This comparison may give information on local pollen production on the mainland as well as on the influence of secondary pollen in deep sea sediments.

Next to palynological dating, volcanic ash layers may provide more precise dates. It seems that for palynological investigations cores from shallow water are preferable to those from deeper water.

INTRODUCTION

A previous study of two cores from the Adriatic Sea bottom has shown that the sediments contain pollen (Bottema & van Straaten, 1966). Prof.Dr. L.M.J.U. van Straaten kindly submitted the core nr. 240, which formed part of one of his malacological studies (van Straaten, 1966), for palynological study. I am much indebted to him for the use of the core as well as for his advice and discussion.

The core was taken in the Adriatic Sea, ca. 30 km from the coast of Italy, at the latitude of Termoli (fig. 1) on the shelf at a depth of 105 m.

Certain zones of the core sediment contain volcanic ash, the composition of which (in combination with malacological data) allows correlation with ash deposits in other cores from this area. According to van Straaten (1966) the mud of core 240 was deposited during Subboreal and Subatlantic time.

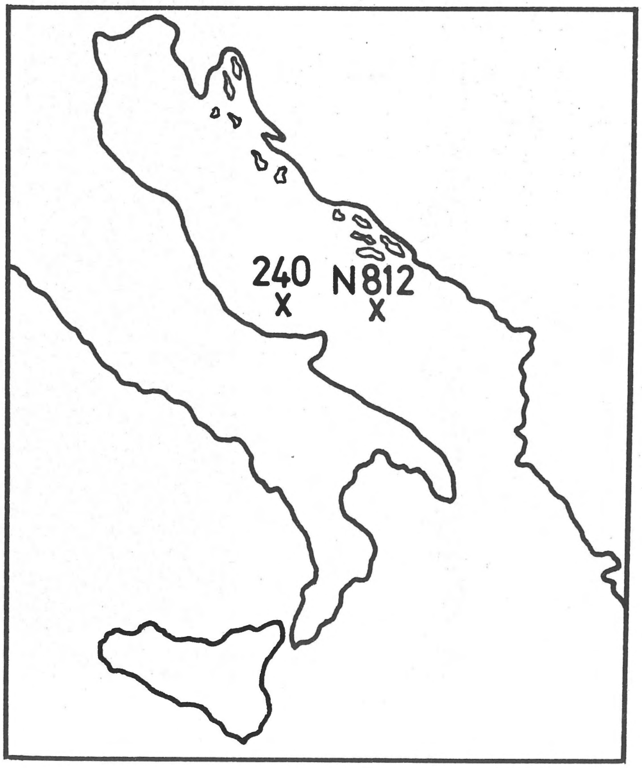

Fig. 1
Situation of core localities 240 and N812.

THE POLLEN DIAGRAM

The samples from which the pollen spectra are obtained have been treated with a heavy liquid to separate the pollen from the minerals. The pollen sum includes all pollen types; the spores of ferns are calculated on the basis of this sum.

The pollen diagram is subdivided in two zones, called Y and Z which are used for this diagram in particular and this subdivision cannot simply be applied to other diagrams.

Zone Y (spectra 1-7)

This zone is characterized by high values of *Quercus robur*-type pollen, while various other deciduous tree pollen types are present. Σ AP percentages are generally higher than in the next zone.

Zone Z (spectra 8-16)

This zone differs from the preceding one by the appearance or increase of some Mediterranean tree pollen types and some weed types. From spectrum 8 onwards, distinct curves of *Phillyrea, Olea, Artemisia, Plantago lanceolata*-type, *Centaurea solstitialis*-type, and Cerealia-type are shown. Zone

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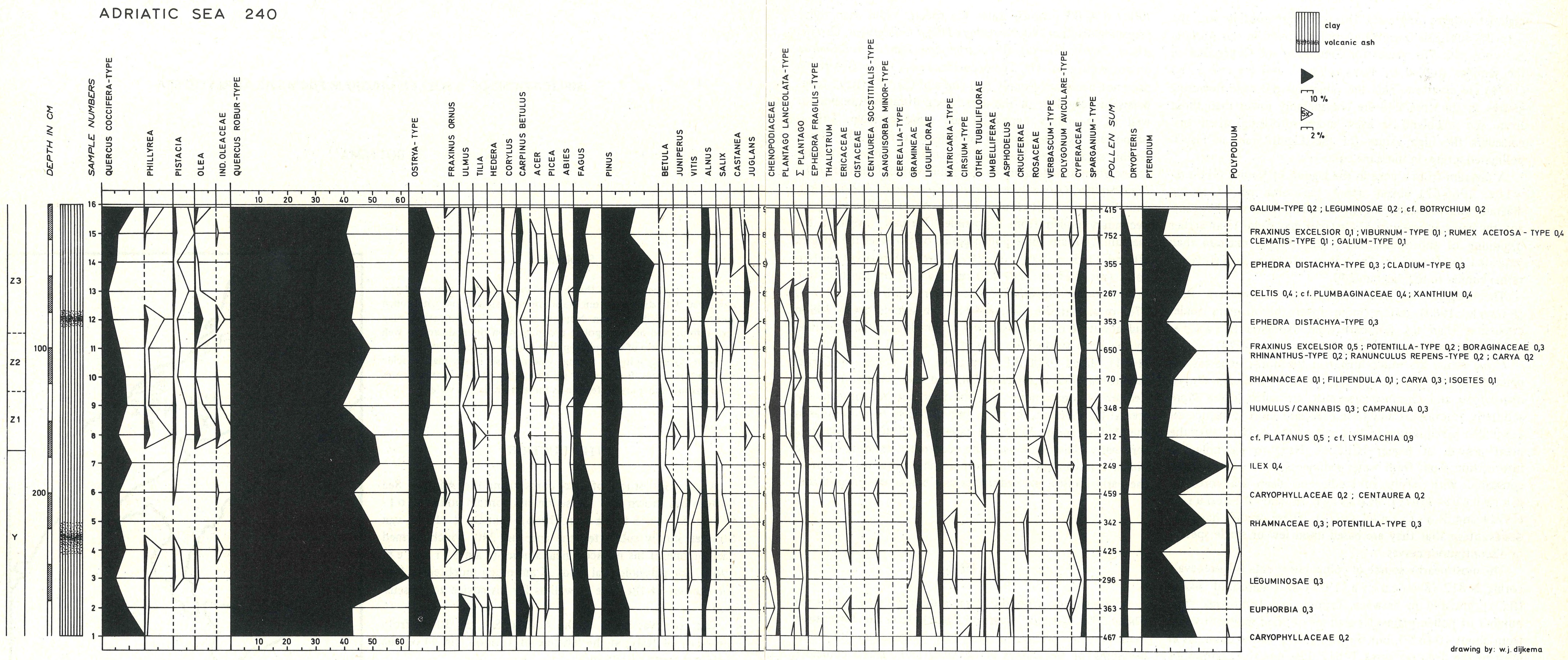

Z is divided in three subzones. Subzone Z 1 (spectra 8 and 9) shows relatively high percentages of Mediterranean types. These values decrease during subzone Z 2 (spectra 10 and 11). Subzone Z 3 (spectra 12-16) shows an increase of Mediterranean pollen types, while pollen of *Juglans* and *Castanea* is found.

VEGETATIONAL HISTORY

A translation of the diagram in terms of vegetation follows here. During zone Y, deciduous forests would have occurred on the mainland on lower and middle elevations. These forests would have been dominated by oak, while *Acer* must have been quite common. On middle elevations *Ostrya* and some *Ulmus, Tilia, Corylus* and *Carpinus betulus* occurred. Under natural circumstances, the role of the Mediterranean xerophytic vegetation must have been limited as in Greece (B o t t e m a, 1974). In the mountain belt forests *Fagus, Abies, Picea*, and *Pinus* occurred. During zone Z, Mediterranean vegetations expanded, probably due to human influence. The appearance of pollen of *Olea, Artemisia, Plantago lanceolata*-type, and Cerealia-type points to farming and herding. Cutting of deciduous forest enabled Mediterranean xerophytic vegetations to expand. In the mountains *Fagus* probably decreased, indicated by a drop in pollen values from 6% to 2%.

During subzone Z 2, possibly some regeneration took place. In subzone Z 3, however, the same picture as in subzone Z 1 can be seen. In this last subzone Σ AP percentages decrease, whereas *Pinus* increases, probably a relative effect. Somewhere around the Adriatic *Castanea* and *Juglans* arrived, as their pollen shows up for the first time.

COMPARISON WITH OTHER PALYNOLOGICAL INFORMATION

The diagram has been compared with diagrams from the adjoining mainland (F r a n k, 1969; B r a n d e, 1973; B o t t e m a, 1974) and one from the lagoon of Venice (H o r o w i t z, 1966/67). The pollen sources, however, are difficult to trace. Pollen in the Adriatic is brought in by air, as well as by the rivers from both sides. Sea currents will also have influenced the pollen composition.

The diagrams of Mljet (B e u g, 1961), an island in front of the Yugoslavian coast, can not be compared very well, because they do not cover the last two thousand years. Besides, local pollen is rather dominant on Mljet. The study by B r a n d e (1973) on the Postglacial vegetation history of the Neretva valley in Dalmatia offers better possibities. Core 240 demonstrates the influence of local vegetation on the pollen precipitation. *Juniperus* values in the Neretva diagrams (B r a n d e, 1973) are much higher than in the diagram 240. It is generally accepted that Gramineous and Cyperaceous pollen can to a great extent be derived from local marshes etc. The pollen percentages of Gramineae in 110 surface samples from Northwestern Greece vary from about 5 to 50 (B o t t e m a, 1974). Subfossil samples from cores taken in the middle of lakes in Greece and the Near East also yield high percentages for grasses. This is in sharp contrast with the 2 to 3% subfossil Gramineous pollen found in the Adriatic Sea core 240. The values for Gramineae and Cyperaceae in the samples studied by Rossignol and Pastouret (1971) are also low. That the values for the wind-flowering grasses in the core 240 are considerably lower than those from the mainland is even more surprising when one considers the high values for the Liguliflorae, an insect-pollinated group, in the same core.

A diagram from a core in the lagoon of Venice (Horowitz, 1966/67) covers about the same period as the diagram under discussion. The continuous curve of *Juglans* and the early appearance of *Castanea* may point to an earlier beginning of the Subatlantic in the Venice diagram than indicated by Horowitz. The course of the pollen curves is rather similar to the diagram 240.

The diagram of lake Vico in central western Italy (Frank, 1969) differs more from the diagram under discussion than do diagrams from Dalmatia (Brande, 1973) and Northwestern Greece (Bottema, 1974).

Fagus values are much higher in the north, whereas the percentages of the *Ostrya*-type, which includes *Ostrya carpinifolia* and *Carpinus orientalis*, are much lower. More southerly vegetations may have exercised more influence on the pollen precipitation in this part of the Adriatic than the plant growth at higher latitudes. Next to palynological information from fresh water sediments, core 240 has been compared with results of studies on deep sea cores by Koreneva (1971), Rossignol and Pastouret (1971) and Rossignol (1972). These studies have the disadvantage that they are based upon few or single spectra or discontinuous curves.

The most nearby source of comparative data is Koreneva's coring N 812 (Koreneva, 1971) at a depth of 543 m (fig. 1), situated in between Termoli and Dubrovnik. The number of pollen grains per gramme of dried sediment varies from about 10 to 90, but the pollen sum is not given. As in most of the deep sea cores, N 812 does not give continuous curves. *Pinus* shows percentages up to 60% and *Quercus* from 15% to 30%. It is remarkable that *Fagus*, *Castanea*, and *Juglans* are found only in the lower part of the diagram, attributed to the Preboreal and Boreal. In pollen diagrams from the surrounding mainland *Castanea* and *Juglans* are first found during periods somewhere around the Subboreal and Subatlantic (Beug, 1961; Brande, 1973; Bottema, 1974). The *Ostrya-type* is lacking in diagram N 812, but this pollen type is perhaps included in either *Betula* or *Carpinus betulus*.

Rossignol and Pastouret (1971) investigated the dark sapropelic part of a deep sea core about 20 km east from Crete at a depth of 2460 m. *Pinus* and *Quercus* are the dominant pollen types; furthermore *Tilia, Liquidambar, Ostrya*-type, *Alnus, Betula, Corylus, Carpinus, Zelkova,* cf. *Pterocarya*, cf. *Engelhardtia*, and *Cedrus* are found. They assume that this pollen was produced by vegetations from nearby Crete. The lower part of the dark layer is dated 7900± 170 B.P., which dates the spectra older than those present in diagram 240. Nowadays *Tilia, Liquidambar, Ostrya, Alnus, Betula, Corylus, Pterocarya, Engelhardtia,* and *Cedrus* do not occur on Crete. The occurrence of a few pollen grains does not necessarily imply that some of the "Tertiary" types persisted very late in the area. Long distance transport as well as secondary deposition are quite possible. This is supported by unpublished information from the Agios Gallini area, at sea level on the coast of Crete, dated by radiocarbon as belonging to the same period. Pollen of *Tilia, Liquidambar, Ostrya*-type, *Betula, Pterocarya, Engelhardtia,* and *Cedrus* is not found in the Agios Gallini samples. Secondary pollen from a possible "Tertiary" origin in the diagram 240, are some pollen grains of *Carya* in the spectra 10 and 11. Rossignol (1972) gives information on two cores (nrs. 125 en 128) 110 km and 260 km south of the Peloponnesos respectively. The water depth at site 125 is 2782 m and at site 128, 4640 m, the sample depth 208 m and about 86 m. These samples in fact look rather identical to the ones studied by Rossignol and Pastouret (1971), dated 7900 B.P. Especially the pollen of *Carya, Pterocarya, Tsuga, Engelhardtia,* and also *Liquidambar* and *Zelkova* is conspicuous, the first four not occurring in the area at the moment, the other two restricted to small areas in the Mediterranean. Rossignol dates part of the sediment to a very early Pleistocene age. The occurrence of some of these pollen types in the Holocene core near Crete may point to the early Pleistocene sediments as a source of redeposition.

DATING

A comparison with the Neretva diagrams (low values for *Ulmus, Tilia, Corylus, Abies* and *Fagus*) places the lowermost spectrum somewhere in the third millennium B.C. The beginning of the curves of *Castanea* and *Juglans* coincides with Roman activities in the area around the Adriatic. Brande (1973) gives a date of 165 ± 200 A.D. for the beginning of the *Castanea* and *Juglans* curves on the Dalmatian coast.

Another approach to date the diagram is to analyze the volcanic ash material contained in the core. Preliminary investigations led van Straaten (1966, 1967) to the tentative conclusion that ash fall 2, corresponding to the zone at 78 cm depth, respresents the "Pompeii-eruption" (79 A.D.) of the Somma-Vesuvius. The ashes found in van Straaten's malacological sample 210-240 cm (av. depth 225 cm) were according to him, probably deposited, in the general period of 1800-1400 B.C. This is the same period in which the great eruption of Santorini took place (cf. also Boekschoten, 1971). For the Santorini-eruption radiocarbon ages of 3370± 100 and 3527 ± 44 B.P. are mentioned by Opdyke et al. (1972). However, it is not yet certain whether this material has come from this volcano or from another one in the Mediterranean area. If van Straaten's conclusions are correct they would give a rather precise dating of the pollen diagram. Interpolation of these two ages would yield an age of about 900 B.C. for the beginning of Zone Z (spectra 7/8). The boundary of the Subboreal and the Subatlantic, established in the malacological diagram by van Straaten (1966), agrees well with the division in pollen zone Y en Z.

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