BERICHTE DER AUSGRABUNG TALL ŠĒḪ ḤAMAD / DŪR-KATLIMMU (BATSH)

Band 1

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DIE REZENTE UMWELT VON TALL ŠĒḪ ḤAMAD UND DATEN ZUR UMWELTREKONSTRUKTION DER ASSYRISCHEN STADT DŪR-KATLIMMU

Herausgegeben von
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Palynological Investigations In The Syrian Ğazīra

Summary

This paper deals with the reconstruction of the environment in the Syrian Ğazīra for the upper half of the Holocene in connection with archaeology. It is tried to reconstruct the vegetation as part of the habitat met with by prehistoric man as well as to study the impact of human activity upon plant life, by means of palynological investigations. Up to now lowland-steppe palynology was hardly productive because of the nature of the sediments and the technical problems met with.

Sediment cores have been collected from the river valleys of the Ḫābūr and the Balīḫ and adjacent parts. Modern pollen precipitation in connection with the vegetation has been studied to provide reference for subfossil assemblages. The pollen evidence indicates that the climate in the Ğazīra did not change significantly during the last 6000 years. Changes in Bronze Age agriculture were not caused by increasing precipitation, but more likely by changing farming techniques as for instance advanced irrigation.

نعالج في هذا الموضوع تصورنا للبيئة في الجزيرة السورية خلال النصف الأخير من الحقبة الهيلوسينية ومدى ارتباطها بعلم الآثار .

ولقد حاولنا أن نتصور النباتات على أساس أنها جزء من المحيط الذي احتضن انسان ما قبل التاريخ . كما درسنا مدى تأثير النشاط البشري على حياة النبات ، ولقد اعتمدنا في ذلك على وسائل الأبحاث في علم غبار الطلع . وتبين لنا حتى الآن أن غبار الطلع في البوادي والأراضي السهلية بالكاد يكون منتجاً، وذلك بسبب طبيعة الرسوبيات والمشاكل التقنية الناشئة عن معالجتها .

جمعنا عينات رسوبية من وديان الخابور والبليخ والمناطق المجاورة لها كما درسنا كميات هطول الأمطار في الوقت الحاضر وارتباطها مع النبات ، وذلك لمعرفة أسباب انقراض تلك النباتات في العصور التاريخية . نستفيد من بقايا غبار الطلع أن المناخ في الجزيرة السورية لم يتغير تغيراً ملحوظاً خلال الآلاف الست الماضية . والتغيير الذي شهدته الزراعة في عصر البرونز لم يكن ناجماً عن ازدياد في نسب هطول الأمطار بل كان ناجماً على الأرجح عن تغيير في تقنية الزراعة مثل التقدم في فنون الري والسقاية .

1. Introduction

The Late Quaternary vegetation and climatic history of the Near East is based to a large extent upon palynological information. The aim of palynological investigations includes the reconstruction of the environment of prehistoric man as well as the interaction of man with the vegetation. The information obtained from the pollen record in terms of vegetation is also used to reconstruct the climate. As far as the last 15000 years are concerned conspicuous differences in the history of climate and especially of humidity are concluded for different parts of the Near East (for detailed information the reader is referred to Bottema, 1986; Bottema & Woldring, 1984; van Zeist & Bottema, 1977, 1982; van Zeist & Woldring, 1978, 1980).

From pollen data it can be concluded that an increase in humidity occurred first of all in northern Israel from about 15000 to 11000 B.P. The Syrian part of the Mediterranean coastal area developed a more humid climate c. 11000–9000 B.P. On the Anatolian plateau, where low temperatures strongly influenced tree growth, the modern situation was established later, c. 7000 B.P. For the Zagros Mountains modern climatic conditions were reached about 5500 B.P. when the so-called Zagros oak forest became established.

For the Syrian Ǧazīra hardly any information on Holocene vegetation and climate development was available. The distribution of early Neolithic habitation on the edges of wadis, outside the Balīḫ valley itself (verb. comm. P.M.M.G. Akkermans), may point to marshy conditions in the 9th millennium B.P. suggesting a moister climate at that time. Up to now no information on this period has been supplied by disciplines other than palynology. As the humidity development for the Near East turned out to be not uniform, reconstructions for the Syrian Ǧazīra could not simply be based upon inferred dates.

In this contribution the results of palynological investigations in the Syrian Ǧazīra will be discussed. Small-scale investigations were carried out in 1982 and 1984 by the second author during the excavations at Tall Ḥammām eṭ Ṭurkmān in the northern Balīḫ valley. In 1985 the palaeobotanical department of the Biologisch-Archaeologisch Instituut of the Rijksuniversiteit Groningen started more extensive palynological investigations at the request of Prof. Dr. H. Kühne (Institut für Vorderasiatische Altertumskunde, Freie Universität Berlin). Professor Kühne and his team carried out a program of archaeological investigations at several locations along the Ḫābūr. These investigations included the study of the agricultural economy during the Bronze Age. The environmental conditions present during that time were of interest for the excavators in relation to irrigation and/or dry farming techniques. The aim of the palynological investigations was to reconstruct the vegetation and climatic history of the Late Holocene of the Syrian Ǧazīra in general with special reference to the Bronze Age of the Ḫābūr area. The purpose of the fieldwork was to obtain sediment cores covering at least the last 5 or 6 millennia and to collect surface samples for the study of modern pollen precipitation in the area. The team in the field included S. Bottema, W. H. E. Gremmen and H. Woldring (Biologisch-Archaeologisch Instituut) and was assisted by Ch. Jagiella (Freie Universität Berlin). During the fieldwork important help and information was received from the excavators, among whom we especially wish to mention P. Pfälzner.

The authors are very grateful for the discussions with Prof. Dr. W. van Zeist who also critically read the manuscript. Mr. H. Woldring contributed by identifying rare pollen types. Mrs. G. Entjes-Nieborg typed the manuscript and Mrs. S. M. van Gelder-Ottway corrected the English.

2. Geography, Climate And Vegetation

2.1 Geography

The area studied is rather flat with the exception of the Ǧabal ʿAbd al-ʿAzīz, a mountain ridge up to about 900 m high. A large part of the soil in the area is rich in gypsum and therefore not suitable for agriculture.

In the southern part a desert-steppe area with extensive saline depressions extends as far as into Iraq. These saline depressions are mostly clayey. They are the basins into which the east-Syrian area drains. This explains the high salinity of the soils (Wirth, 1971). One of these depressions contains the lake of Buara.

2.2 Climate

Winters in northeastern Syria are cool to mild and summers are hot and dry. The average annual temperature is between 18 and 19°C with summer maxima above 40°C. The climate has a rather continental character (Wirth, 1971).

The rain falls in autumn and winter and the average annual amount of precipitation ranges from more than 300 mm in the area of Ḥatunīya in the north to about 100 mm in the Buara area in the south. North of the line Ǧabal ʿAbd al-ʿAzīz-Ǧabal Sinǧār dry farming is possible. South of this line this becomes more and more risky due to annual fluctuations in the rainfall. The number of seasons in which the required amount of rain falls decreases towards the south. Besides that, it has to rain in the right period, between December and February. The area of Buara is unsuitable for dry farming (Ergenzinger *et al.*, Z. Bibliog. Nr. 27).

2.3 Vegetation

The vegetation of northeastern Syria is classified as the Artemisietea herbae-albae mesopotamica (Zohary, 1973). The steppe is treeless and the vegetation is often dominated by *Artemisia herba-alba*. The saline depression of Buara is covered by vegetations of the Halocnemetea strobilacei in which Chenopodiaceae, such as *Halocnemum strobilaceum, Seidlitzia rosmarinus, Suaeda baccata* and *S. vermiculata*, play an important role in addition to grasses (*Aeluropus* spp.) (Zohary, 1973; Thalen, 1979).

Nowadays the natural vegetation is strongly affected by overgrazing and the cutting of shrubs for firewood. Animal husbandry involving anything more than a light to moderate grazing has a disastrous effect on a natural steppe vegetation (Thalen, 1979).

Along the Balīḫ and the Ḫābūr, riverine forest must have been the natural vegetation dominated by *Populus euphratica, Salix* spp., *Tamarix* spp. and dense reed beds (Zohary, 1973). Remnants of this vegetation were met with.

3. Sampling And Sample Preparation

Coring was carried out with a Dachnowsky sampler with a capacity of 25 cm and an inner diameter of 3.6 cm. In case the sediment was difficult to penetrate chain hoists were used. The Ḫābūr sediment near Tall Šēḫ Ḥamad was sampled from a freshly eroded riverbank.

For the surface samples moss cushions were collected, as they are the most suitable pollen traps present. When moss was absent some soil was collected, preferably at places where organic material had accumulated. For the locations Bdēri, Šēḫ Ḥamad, ʿAin Ḥawzīya, Rašīdīya and Buara II the topmost sample of the core was used as surface sample. It was assumed that the top of the cores represents the modern pollen rain.

All samples were prepared with the heavy liquid separation method using a bromoform alcohol mixture of s.g. 2.0. After acetolysis according to ERDTMANN (FAEGRI & IVERSEN, 1975) the residue was stained with safranine and embedded in silicone oil.

4. SURFACE SAMPLES

4.1 INTRODUCTION

A pollen record is not the same as a vegetation record. Whereas in a vegetation record plants are identified to the species level, a pollen record is mostly presented in taxa at the genus or the family level. The higher the taxonomic level, the less specific is the information provided by the pollen type. Besides, the relation of the pollen type to the taxon depends on the quantity of pollen produced by the taxon, the way the pollen is dispersed and on the extent to which the pollen is preserved. Information on relations between vegetation and pollen precipitation is of great value for the interpretation of subfossil pollen spectra in terms of vegetation.

Information on the modern pollen rain in Lebanon and Syria is presented by BOTTEMA and BARKOUDAH (1979). In the present study 13 surface samples taken in eastern Syria during the 1985 campaign will be discussed.

4.2 DESCRIPTION OF THE SAMPLING LOCALITIES (FIG. 61)

A short description is given of the sampling localities and the local vegetation. One should bear in mind that the area has been visited at the end of the summer season.

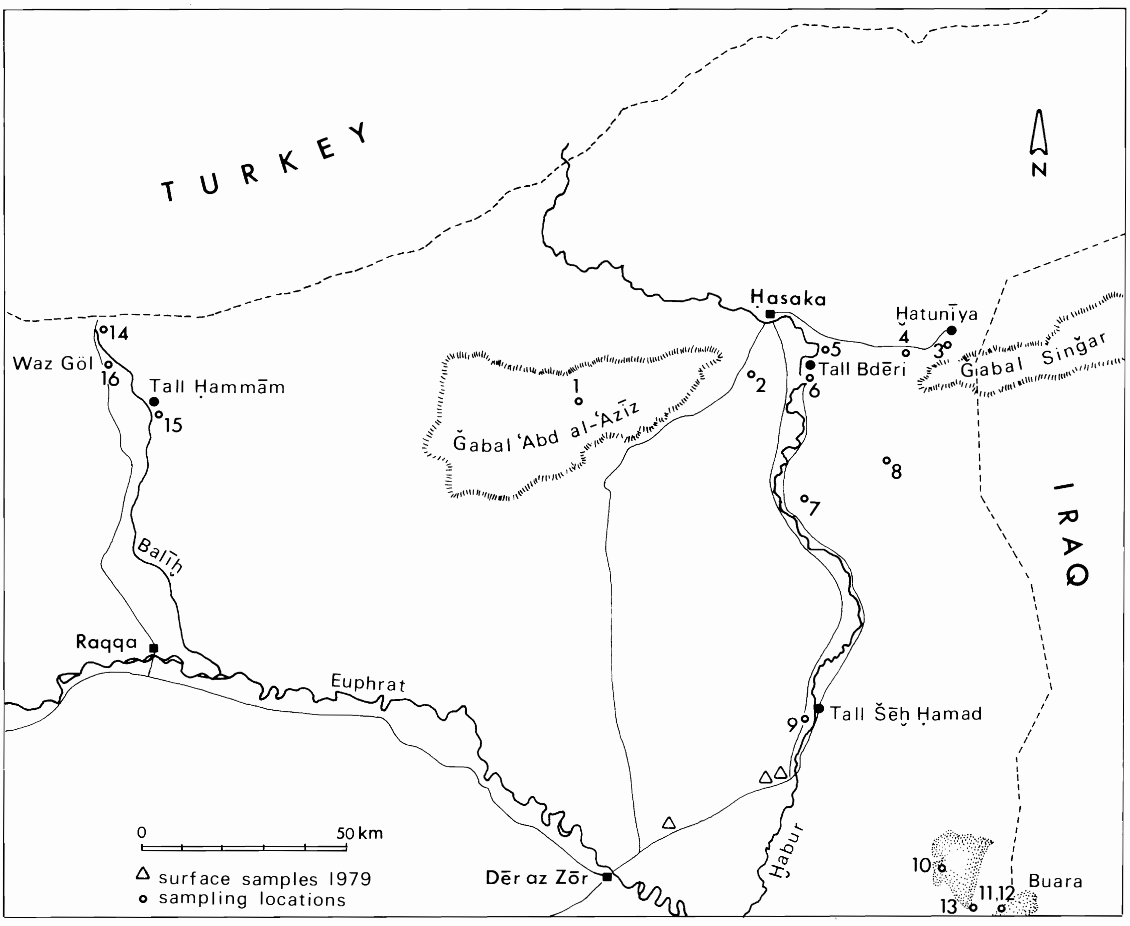
1. Ğabal 'Abd al-'Azīz. A mountain ridge up to about 900 m high, west of Ḥasaka, oriented WSW to ENE. The southern slopes are rather gentle whereas the northern slope is steep, giving the mountains an asymmetric form (WIRTH, 1971). The western part shows scattered trees of *Pistacia khinjuk*, especially on the northern slope. All trees are rather old, no young ones were noticed. They grew between elevations of about 500 and 900 m. According to PABOT (1957) arboreal species on these mountains also include *Crataegus azarolus, Prunus tortuosa* and *Amygdalus orientalis*. The herb vegetation was clearly different from that in the steppe. Locally Boraginaceae were dominating. Flowering *Hypericum* plants were found along wadis. Further, Compositae, Caryophyllaceae (*Dianthus* spec.), *Verbascum, Eryngium* and *Althaea* were met with.

2. Mā' al-Faiḍāt. The saline depression dried up about three weeks before we visited the area, according to information from a local farmer. The dried up basin was covered with red algae with a top layer of gypsum crystals. About 90 % of the slopes around the basin were covered by grasses. A depression, which is separated from Mā' al Faiḍāt by a chain of low hills, drains to this lake by a narrow ›canal‹, along which *Typha latifolia* was found. Mā' al-Faiḍāt is surrounded by cultivated fields.

3. Ḫatunīya. The lake of Ḫatunīya is surrounded by a deposition of crust layers of salt or gypsum on the banks. The sampling location was situated about 500 m from the lake close to a canal used for the irrigation of cotton fields. The local vegetation was lush, including cf. *Erigeron, Scirpus maritimus, Cynodon dactylon, Vicia* spec., Gramineae, *Juncus* cf. *maritimus*, cf. *Lotus* and *Centaurium* spec.

Abandoned fields in the neighbourhood showed a vegetation cover of 10–20% formed by *Alhagi, Tamarix,* some *Prosopis*, cf. *Suaeda* and other Chenopodiaceae.

4. 11.5 km west of Ḫatunīya. Vegetation included *Peganum harmala, Centaurea* spec., *Tamarix, Evax* and Gramineae.



61 Sampling locations in northeastern Syria. From all places surface samples were analysed; (c) indicates that a coring was carried out. 1. Ğabal 'Abd al 'Azīz, 2. Mā' al-Faiḍāt, 3. Ḫatunīya (c), 4. 11,5 km west of Ḫatunīya, 5. road-fork Ḥasaka-Ḫatunīya-Bdēri, 6. Bdēri (c), 7. Rašidīya (c), 8. 'Ain Ḥawzīya (c), 9. Šēḫ Ḥamad (c), 10. ar-Rōda, 11. and 12. Buara (c), 13. Wādī 'Ağīğ, 14. Balih (c), 15. Pre-Ubaid sample Tall Ḥammām, 16. Waz Göl (c).
△ : surface sample presented by BOTTEMA & BARKOUDAH (1979)

The area between Ḫatunīya and Ḥasaka is partly cultivated for cereals. The uncultivated parts show soils rich in gypsum.

5. Road-fork Ḥasaka-Bdēri-Ḫatunīya. Shrubs of cf. Chenopodiaceae. Few identifiable plants. Soil rich in gypsum.

6. Bdēri. The sample covers the topmost cm of the core taken from a former meander of the Ḫābūr, at the edge of an irrigated cotton field, about 100 m from the tell of Bdēri.

7. Rašīdīya. The landscape of Rašīdīya is hilly with many small salt-lakes, presumably the result of salt-mining activities. A vegetation of *Tamarix*, cf. *Salicornia*, other Chenopodiaceae and grasses was found in a narrow zone around some of the lakes.

8. 'Ain Ḥawzīya. Near a small settlement a streamlet fed by a spring ran down from a hill. Around this spring *Typha angustifolia, Lagurus* cf. *ovata, Cynodon dactylon, Cyperus* spec., cf. *Ceratophyllum* and Caryophyllaceae were found. In the spring itself frogs and fishes were present. Cyperaceae and Gramineae dominated the vegetation along the streamlet.

9. Tall Šēḫ Ḥamad. Between the cotton fields and a field with sunflowers an old meander of the Ḫābūr was partly used for irrigation. The soil was sandy. The vegetation on the sampling location included *Echinochloa crus-galli, Tamarix, Cyperus longus, Datura* and *Cuscuta*.

10. Ar-Rōḍa. Ar-Rōḍa is a saline depression, during the winter period usually filled with water. The vegetation covered less than 5% and included *Artemisia herba-alba*, Chenopodiaceae, Gramineae, Caryophyllaceae, *Evax, Hordeum,* Compositae and Geraniaceae.

11. and 12. Buara. The border of the saline depression of Buara was covered with a vegetation in which *Halocnemum* cf. *strobilaceum* was dominant. Here sample 11 was collected. Along a streamlet fed by a spring *Tamarix* was frequent. In the salt plain an outcrop with *Phragmites* was present about 50 m from the place where sample 12 was collected.

13. Wādī 'Ağīğ. – *Artemisia scoparia* was most conspicuous in the vegetation. Various grasses were found including *Hordeum* spec. In this area, very close to the border with Iraq, the absence of grazing permitted the presence of a rather natural steppe vegetation.

4.3 Discussion of the pollen spectra

The results of palynological examination of the surface samples are shown in table 14. The values for pollen types are expressed as percentages of a pollen sum which includes the arboreal pollen types and the upland herb pollen types. The most important pollen types are presented in a bar diagram as percentages of the pollen sum (Fig. 62). Values lower than 0.5% are given in numbers.

The samples of Bdēri (sample 6) and Tall Šēḫ Ḥamad (sample 9) were collected between irrigated fields in the valley of the Ḫābūr. In Bdēri these were cotton fields, in Šēḫ Ḥamad also sunflowers were grown. As these plants are insect-pollinating they are very poorly represented in the pollen record.

Samples 3, 4 und 5 originate from the area between Ḫatunīya and Ḥasaka. The soil is very rich in gypsum in parts of the area. On suitable soils dry-farming is possible and cereals are grown. The samples from the cultivated areas in the north do not show pollen of Cerealia-type in the amount one would expect. In the uncultivated areas they are found more often. The pollen grains attributed to the Cerealia-type measure 40–45 μ, which means that they could also originate from wild grasses (Beug, 1961). Samples 7, 8, 10, 11 and 12 were collected in overgrazed areas. Together with fuel cutting this overgrazing destroyed most of the natural vegetation. In Wādī 'Ağīğ (sample 13) no grazing took place and a steppe vegetation, which looked rather natural, was found.

Arboreal pollen values are in general very low in the surface samples as can be expected from a treeless landscape (table 15). *Pistacia khinjuk* was the only tree species met with, growing scattered in the mountains of the Ǧabal 'Abd al-'Azīz. It is represented best in the corresponding sample. Nevertheless, the value is only 1.1%, indicating that *Pistacia* is under-represented in the pollen rain as is suggested by studies from Wright *et al.* (1967) and Bottema & Barkoudah (1979).

All the other arboreal pollen types are the result of long-distance transport. *Pinus* has the best dispersal and reaches an average value of 3.7%, even at this long distance from its most nearby stands in southern Turkey and northern Iraq. *Quercus cerris*-type is present in 11 samples out of 13 with an average value of 0.8%. *Olea* and *Ostrya* are known to have a good pollen dispersal, nevertheless their values are very low (table 15). Tree pollen seems to be distributed over the area rather evenly, as is concluded from the percentages in the surface samples.

The two samples from Buara show remarkably high values for *Pinus*. When Chenopodiaceae, because of their abundance around these sampling locations, are excluded from the pollen sum, the *Pinus* value in both samples is about 22%. The samples closest to Buara, i.e. Ar-Rōḍa and Wādī 'Ağīğ, show values of 4.6 and 2.7%, respectively, on the basis of a comparable pollen sum.

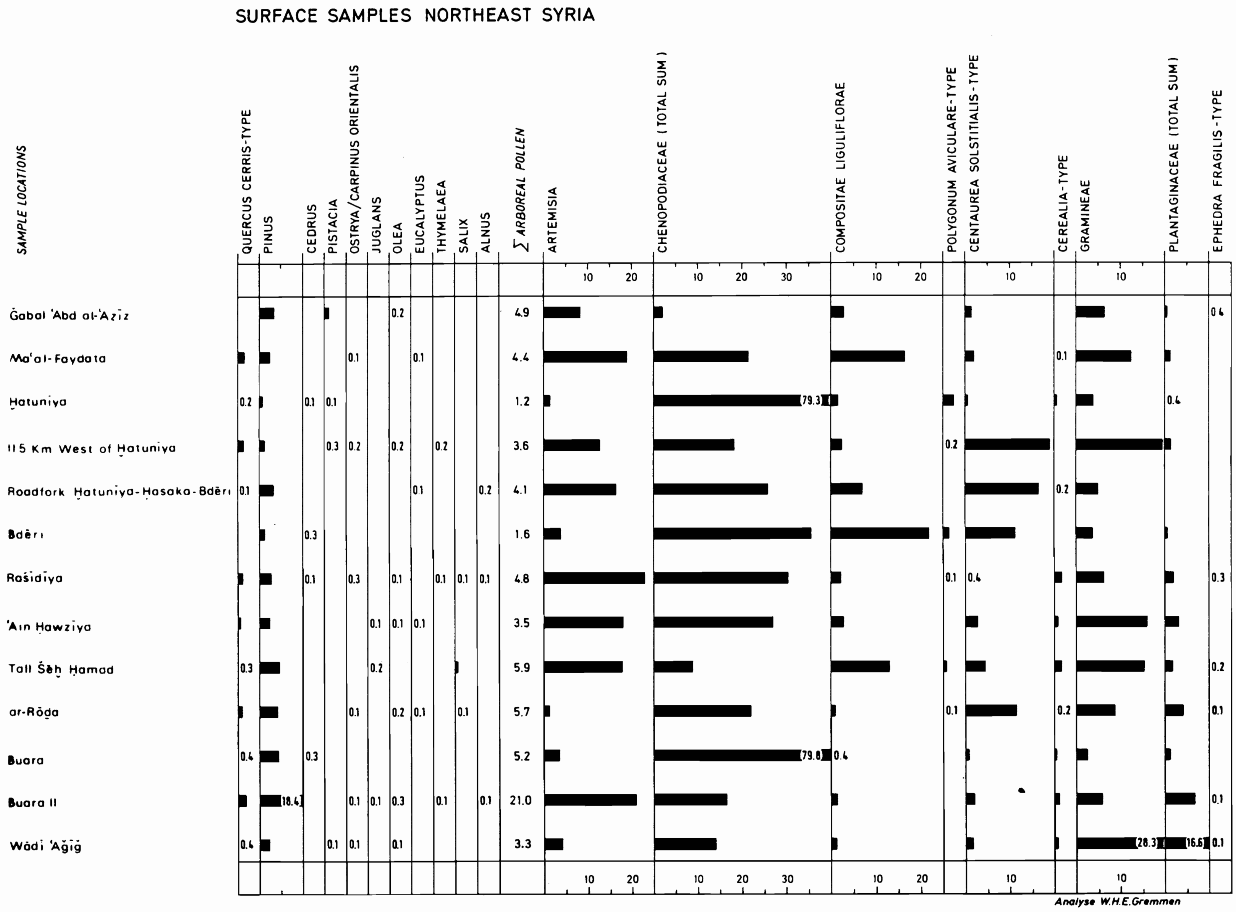
Assuming an identical influence of long-distance transport also in these locations, the only way to explain the difference is to accept a very low local pollen production in Buara, apart from the Chenopodiaceae. In that case pollen types other than *Pinus* resulting from long-distance transport such as trees should be represented better in Buara, too. The value of these arboreal types amounts to 1.0% for Wādī 'Ağīğ and for Ar-Rōḍa 0.7%. For Buara and Buara II these values are 3.2% and 3.0%, respectively. This pleads in favour of the explanation given above.

In the area studied the average precipitation decreases from more than 300 mm in Ḫatunīya to about 100 mm in Buara. This difference, however, hardly finds expression in the surface sample pollen records.

Pollen of *Centaurea solstitialis*-type, *Polygonum aviculare*-type and Ranunculaceae are found more frequently in surface samples from the north. Pollen of *Ephedra* and *Plantago* species are found more frequently in the south. Pollen of *Centaurea solstitialis*-type is produced by plants which can occur in cultivated fields and which seem to spread after ploughing. On the other hand, under particular edaphic conditions the *Centaurea solstitialis* pollen type may accumulate in basins (Bottema & Woldring, 1984).

Polygonum aviculare-type pollen possibly originates from plants of ruderal habitats like roadsides and edges of fields. The group of Ranunculaceae is too large to draw specific conclusions from its occurrence.

The difference in occurrence of these herb pollen types can be explained from the difference in land use. *Centaurea solstitialis*-type and *Polygonum aviculare*-type represent plants mainly from cultivated areas. In the present vegetation Plantaginaceae are found more regularly in grazed areas. They do not occur in cultivated fields. This is also reflected in the surface sample records. In the north *Plantago* species are hardly represented (2–5%). In the south they show higher values, in Wādī 'Ağīğ even about 17%. This sample was taken in an area where no grazing took place and a rather natural steppe vegetation was met with. Three surface samples collected between Dēr az-Zōr and Ṣuwar, presented by Bottema & Barkoudah (1979), fit in very well in this picture. *Ephedra* suggests dry conditions as they occur in the southern part of the area studied. A direct correlation be-



62 The most important pollen types found in the surface samples from the syrian Ǧazīra, presented in a block diagram.

tween the occurrence of *Ephedra* pollen and low precipitation is therefore likely.

Precipitation differences do not show up more clearly in the pollen records because identification to species level is not possible. Moreover, overgrazing and fuel cutting may depress vegetation diversity.

5. Pollen Diagrams

5.1 Presentation of the results

In the pollen diagrams the values of pollen types are expressed as percentages of a pollen sum which includes the arboreal pollen types and the upland herb pollen types. These types are shown at the left-hand of the column indicating the pollen sum. To the right-hand of this column the pollen types are shown which are not included in the pollen sum. They are expressed as percentages of this pollen sum as well.

In the diagram of Buara the Chenopodiaceae are excluded from the pollen sum. They are often found in high amounts and show very strong changes indicating local origin. On the basis of the reference material an attempt was made to establish a certain number of pollen types within the Chenopodiaceae. This had been attempted before without much result for Northwestern Iran (Bottema, 1986). The subfossil pollen of Chenopodiaceae met with in the Buara samples showed many intermediate or transitional types. Because of this uncertainty the total percentage of all Chenopodiaceae pollen types is also indicated at the right-hand side of the pollen diagram.

5.2 Buara

5.2.1 Core location

Buara is a shallow salt-lake on the border between Syria and Iraq. During the summer large parts of the lake dry up creating favourable conditions for large-scale salt-mining activities.

In the rainy season the lake is fed by the various wadis draining the surrounding hills. At the west side a spring also feeds the lake. Along a small stream running from this spring to the lake *Tamarix* was found. The coring was carried out near the place where the streamlet discharged into the lake. About 100 m from the coring place a small outcrop covered with *Phragmites* was found in the salt-plain. The border of the lake was covered by a vegetation of Chenopodiaceae dominated by *Halocnemum* cf. *strobilaceum*.

In the area around the lake an *Artemisia* steppe was found. Due to the absence of grazing the steppe vegetation was rather well developed. *Artemisia herba-alba* was dominant in most places but to the north *Artemisia scoparia* and various Gramineae were frequently found.

5.2.2 Lithology

The lithology of the core is as follows. Depths are given in cm below the surface.

0– 20 cm	ochre coloured clay with black spots
20– 25 cm	blue clay with root remains
25– 50 cm	blue-green sandy clay
50–210 cm	greenish sediment, alternating sandy and clayey; at c. 70 cm a brown band was present
210–225 cm	peaty clay
225–232 cm	blue clay; transition to
232–245 cm	brown clay; transition to
245–250 cm	yellowish clay with brown material
250–275 cm	marbled yellow-green clay
275–300 cm	soft ochre coloured clay
300–325 cm	marbled brown clay
325–340 cm	yellow-brown clay
340–350 cm	peat
350–357 cm	dark organic material
357–367 cm	grey clay with organic material
367–375 cm	yellow-ochre-grey clay
375–387 cm	ochreous loamy clay
387–400 cm	grey clay with some oxidation spots and organic material
400–416 cm	grey clay
416–425 cm	brown clay with small stones or hard clayey particles
425–432 cm	hard ochre-brown sandy clay
432 cm	end of coring

5.2.3 Radiocarbon dating

For the level of 340–350 cm a radiocarbon date of 5730±120 B. P. (GrN-13376) is obtained. The radiocarbon dating was carried out by Prof. Dr. W. G. Mook (Centrum voor Isotopenonderzoek, Rijksuniversiteit Groningen).

5.2.4 Pollen assemblage zones

The pollen diagram of Buara is presented in Fig. 63 (im Anhang). Samples at the depths 320, 390, 410, 420 and 430 cm were prepared, but contained too small a quantity of pollen to be analysed.

In order to facilitate the description and discussion of the pollen diagram, pollen assemblage zones have been established mainly based upon the curves of the *Quercus cerris*-type and Gramineae. Zonation does not refer to pollen assemblage zones in any other pollen diagram.

The following pollen assemblage zones are distinguished:

Zone 1, Spectra 1–5. In this zone the percentages of *Quercus cerris*-type are relatively high, up to about 5%. Values for *Matricaria*-type and *Anisosciadium*-type are high.

Zone 2, Spectra 6–7. Gramineae are well represented. Chenopodiaceae values are very high, whereas those of *Quercus cerris*-type are low.

Zone 3, Spectra 8–14. This zone shows a better representation of *Quercus cerris*-type. *Alnus* and *Betula* are found relatively frequently as well as *Sparganium*-type. The *Plantago* species show higher percentages than in both foregoing pollen assemblage zones.

Zone 4, Spectra 15–18. In this zone the values for Gramineae are rather high again. *Quercus cerris*-type and *Plantago*-types show low percentages.

Zone 5, Spectra 19–38. *Quercus cerris*-type is present in values of 1–2%. The values for *Artemisia herba-alba*-type vary generally between 40 and 60%. The total percentages of the *Plantago* pollen types fluctuate around 5% with some peaks of more than 10%.

5.2.5 Interpretation and discussion

Arboreal pollen types display low percentages, indicating that trees were absent in the Syrian Ǵazīra during the period covered by the pollen diagram. The tree pollen grains present must have been transported over a long distance. They most probably originate from mountain areas, for instance, in southern Turkey, Lebanon and western Syria, and northern Iraq.

The very low values of *Quercus calliprinos*-type, representing the evergreen oaks, indicate that certainly Lebanon and to a lesser extent western Syria are not the areas from which the tree pollen originates. Eastern Turkey and northern Iraq are not very likely either. In these areas *Pinus*, which is represented best among the tree pollen types in the pollen diagram, does not play an important role in the vegetation. This is also shown for comparable periods in the pollen diagrams of Zeribar (van Zeist & Bottema, 1977) and Lake Urmia (Bottema, 1986). In the pollen diagram of Lake Van *Pinus* is better represented but high values are not reached (van Zeist & Woldring, 1978). One must assume that the southern part of central Turkey is the most probable area from where the arboreal pollen of Buara originates. This is also the area where nowadays most of the trees represented in the diagram can be found.

The variations in the percentages of Gramineae and *Quercus cerris*-type pollen are most striking in the Buara pollen diagram, apart from the strong changes in the Chenopodiaceae percentages. The high values for Gramineae in the pollen assemblage zones 2 and 4 could be interpreted as a result of increased humidity or precipitation. An argument against such an increase in moisture is that at the same time Chenopodiaceae show very high values, which has to be considered as an indication for dry conditions.

It is more plausible to consider the peaks in the curve of the Gramineae in pollen assemblage zones 2 and 4 as changes in the local vegetation. A decrease of grazing in the Buara area could explain the increase of the Gramineae values.

The decrease of *Plantago* pollen types in the same pollen assemblage zones is in accordance with this view. *Plantago* species can occur frequently in lightly to moderately grazed steppe vegetations (Thalen, 1979), but in pollen assemblage zones 2 and 4 they will be outnumbered relatively by pollen of Gramineae. In other pollen diagrams from the Near East it is shown that human impact on the vegetation, especially animal husbandry, goes together with an increase of the *Plantago* pollen values.

The pollen diagram of Buara and pollen diagrams of other places in the Near East, such as Zeribar, Lake Urmia, Lake Van and the Ġāb Valley, are difficult to correlate. The explanation may be that Buara is situated in the middle of a treeless plain with steppe and desert steppe vegetations, whereas the other places are located in mountainous areas where forest vegetations occur. The appearance of *Juglans* pollen could be used for correlation. The diagrams of Zeribar and Lake Urmia indicate that *Juglans* appeared between 2000 and 3000 B. P. Based on the radiocarbon date and assuming that the sedimentation rate was more or less constant, the appearance of *Juglans* in the Buara diagram could be dated at about 2500 B. P.

The *Alnus* and *Betula* pollen grains, especially found in pollen assemblage zone 3, most probably originate from isolated stands of trees growing at high elevations in the mountains (Zohary, 1973). Nowadays both species are absent or very rare in Syria and Iraq (Hegi, 1981; Mouterde, 1966, 1970; Post, 1933). The pollen was presumably transported by air from central and eastern Turkey or even from northern Iran.

Cerealia-type pollen does not play an important role in the diagram of Buara. The grains found were generally not larger than 40–45 μ. They may originate from wild grass species (Beug, 1961) and do not necessarily indicate agriculture. The lack of distinct Cerealia pollen is not surprising because in the Buara area dry farming is not possible.

A stable vegetation pattern seems to have established in the period covered by pollen assemblage zone 4, which presumably lasted 4000 years and ends in recent time. More often trees are found which could have been cultivated, such as *Juglans, Pistacia* and *Olea*. However, they will not have occurred in the area around Lake Buara. The very high value for *Centaurea solstitialis*-type in sample 34 (25.6%) must be explained as a strictly local phenomenon. The problem of high *Centaurea solstitialis*-type pollen values in diagrams from the Near East is discussed by BOTTEMA & WOLDRING (1984).

It can be concluded that the modern climate in northeastern Syria was already established for the time covered by the Buara diagram and that no climatic changes took place during the last 6000 years. This view is in accordance with other palynological information (van ZEIST & BOTTEMA, 1982). Studies of the modern vegetation and the results of archaeological and geomorphological investigations in the Syrian Ǧazīra lead to the same conclusion (FREY & KÜRSCHNER, in: ERGENZINGER *et al.* Z. Bibliog. Nr. 27).

5.3 Ḫābūr

From a freshly eroded west bank of the river Ḫābūr near Tall Šēḫ Ḥamad samples were collected for pollen analysis. The sediment is a filling of the Ḫābūr valley. The age is difficult to determine. Radiocarbon dating is not possible because of the low organic content. According to ERGENZINGER *et al.* Z. Bibliog. Nr. 27 about 2 m of sediment have been deposited in the Ḫābūr valley during the last 2000 years.

The profile sampled was 280 cm deep. The upper 45 cm were disturbed by cultivation activities and therefore not sampled. Alternately more and less sandy clay was deposited. At 280 cm sandy gravel deposits were found. Sampling was not continued below that level.

Pollen preservation was very poor and only ten samples were analysed and used to construct a diagram (Fig. 64, im Anhang). Pollen of herbs such as Chenopodiaceae and Compositae dominate the pollen record. Presumably they represent the vegetation of the riverbanks and the cultivated fields in the river valley. Arboreal pollen types are hardly represented. One could expect a riverine forest to be reflected in the pollen spectra with *Populus euphratica* and *Tamarix* species. They are thought to have formed riverine forest and especially *Tamarix* can tolerate a high degree of salinity. Remnants of the Populetea euphratica (ZOHARY, 1973) are found along the river Ḫābūr. Due to poor pollen preservation *Populus*, whenever present in the sediment originally, will certainly have disappeared. In certain conditions corrosion of pollen occurs. This causes serious identification problems and is known to be highly selective (BOTTEMA, 1975; WEINSTEIN-EVRON, 1986).

Many wood remains of *Populus euphratica* are found in the excavation of Tall Šēḫ Ḥamad. Together with the rich assortment of faunal remains, this indicates that a riverine forest including *Populus euphratica* was present in the Ḫābūr valley. Presumably the pollen diagram of the Ḫābūr covers a younger period in which the riverine forest was destroyed by man and the river valley was used for agriculture.

A correlation between the Ḫābūr diagram and that of Buara is not possible.

Further north along the Ḫābūr an old meander of the river was sampled. The core of about 5 m deep taken near Tall Bdēri turned out to be very poor in pollen. It was not possible to construct a pollen diagram from this core.

5.4 Balīḫ

Near the site of Tall Ḥammān on the east bank of the Balīḫ a coring was carried out by S. BOTTEMA, D. MEYER, F. SMIT and J. de FEYTER in October 1984. The results of the palynological examination are included in this paper (Fig. 65, im Anhang).

The pollen was poorly preserved. Arboreal pollen types are present in very low percentages, about 5%. *Pinus* pollen is found most frequently (2–4%). The non-arboreal pollen consists mainly of Chenopodiaceae with values of 25–50%, together with Gramineae and Cyperaceae. Most types are found in rather constant values.

The pollen diagram reflects very few changes in the vegetation, indicating constant climatic conditions during the period which it covers. No age can be established. Correlation with the diagram of Buara is not possible. Radiocarbon dating is out of the question, because of the low content of organic material. An indication of the age can be found in the pollen record of a sample from under the Ubaid layer of Tall Ḥammām (Fig. 65). This sample shows a dominance of *Artemisia* pollen and very low values for Chenopodiaceae, just the opposite of what is found in the samples from the Balīḫ sediment. The arboreal pollen sum is very low, consisting mainly of *Pinus*. The pollen record suggests that the Balīḫ core is unlikely to be older than the layer under the Ubaid layer, and dates back to the Ubaid period at the earliest.

As in the Ḫābūr diagram, a vegetation of riverbanks and cultivated fields seems to be reflected. Again no trace of a riverine forest was found. From the excavation of Tall Ḥammām it is known that since Assyrian times irrigation was used to cultivate the valley.

5.5 Waz Göl

5.5.1 Introduction

A core of 310 cm was collected in 1984 in the shallow lake of Waz Göl in the Upper Balīḫ area (Fig. 61) by S. BOTTEMA, H. CURVERS and F. SMIT. The sediment consisted of a fine clay. On the surface gypsum crystals were found. Most of the core turned out to be barren in pollen and only the upper part down to a depth of 50 cm could be analysed (table 16). The absence of pollen in most of the Waz sediment indicates that the lake dried up seasonally or at least repeatedly. The lake contained water in October 1982 but almost completely dried up in October 1984, as was witnessed by the second author. No streams discharge to the lake that is fed by a spring on the northeast. The clay sediment is more likely to be of aeolian than of fluviatile origin.

5.5.2 The pollen samples

Four samples (A, B, C and D) taken at 4, 6, 20 and 50 cm, respectively, have been analysed. Down to 15 cm the sediment was very soft, pointing to a very young age of the samples A and B. The pollen assemblages of the four spectra are of a different character. Arboreal pollen values range from 5.9 to 25.5%, values for herb types as Chenopodiaceae, *Artemisia*, Compositae, Gramineae, and Cerealia-type differ widely.

The diversity in pollen types is greatest in spectrum B, indicating that the most favourable conditions for pollen preservation occurred during that time. This points to a relatively high lake level, concluded especially from an abundance of *Potamogeton pectinatus*-type, *Sparganium*-type and Cyperaceae pollen and green algae such as *Pediastrum boryanum* ssp. *brevicorne* or *Pediastrum integrum*. The high water table must be a reflection of more favourable moisture conditions in a larger area around Waz Göl. The low Chenopodiaceae values demonstrate that the mud flats were covered with water up to the edge of the basin. Humid conditions are also indicated for spectrum B time by 5.7% Cerealia-type. The value of the Cerealia-type in spectrum B is four times higher than those of spectra A and C, even after a correction of the pollen sums from the two other spectra by excluding Chenopodiaceae and Compositae. Dry farming and/or irrigation facilities during the time of spectrum B must have been much better than in the time of spectra A and C.

Dry conditions prevailed during spectra A, C and D time, indicated by high Chenopodiaceae percentages, poor pollen preservation and a lower identification level resulting in lower pollen type diversity. Low type diversity and corrosive effect are in this case very probably linked to each other. Selective corrosion happened especially in spectrum A and D, as is concluded from high values of Liguliflorae and Tubuliflorae (Bottema, 1975; Weinstein-Evron, 1986).

Under constant weather conditions a corrosion gradient would have been expected demonstrating increasingly higher Liguliflorae and Chenopodiaceae values with increasing depth. The fact that this is not the case points to the effect of variation in seasonal precipitation. However, after some time oxidation would also destroy the pollen deposited under better conditions. That explains the absence of pollen in the core, apart from the upper layer.

5.6 Rašīdīya (see surface sample 7)

A short core covering 2.60 m was obtained from one of the small salt lakes near Rašīdīya. At that depth the bedrock was reached. The sediment was constant sandy clay with relatively fine gravel. Only in the upper half metre was pollen found. The results of the palynological examination are presented in Fig. 66 (im Anhang).

Arboreal pollen types are hardly found. The variety in herb pollen types is very large, indicating good conditions for preservation. Only a few changes in the pollen values are shown. Going from the bottom sample upwards, the values for *Armeria*-type and Liguliflorae decrease. Those for Liliaceae, Cerealia-type and several *Plantago*-types increase. This could be the result of incipient corrosion in the lower layers.

5.7 ʿAin Ḥawzīya (see surface sample 8)

From the spring of ʿAin Ḥawzīya 80 cm of clay sediment were collected. The results of the palynological examination are shown in Fig. 66 (im Anhang).

Arboreal pollen is hardly found. Among the herb pollen types Chenopodiaceae are most common, decreasing towards the top sample. *Artemisia herba-alba*-type shows a slight increase, like also the *Plantago* species. The value of *Sparganium*-type strongly increases; while absent in the bottom sample it shows a value of 35.3% in the top sample. A strictly local vegetation development is reflected, probably connected with the presence of the spring.

5.8 Other core localities

From more places cores were collected but these turned out to be too poor in pollen to be analysed. One core came from the valley of the Ḫābūr near Tall Šēḫ Ḥamad. The sediment was very sandy and we could not go deeper than 2.5 m. From clay deposits at the west side of Lake Ḫatunīya a 3.5 m deep core was collected. There was hardly any pollen in this sediment. A 1.5 m deep core was collected from Māʾ al-Faiḍāt. Only the upper centimetres contained well preserved pollen (see surface sample 2).

6. Conclusions

The palynological evidence presented in this paper confirms the opinion that this discipline contributes only to a limited extent to our knowledge of the vegetation history of steppic areas. The sediments collected generally are restricted to very short time periods, mostly of recent or subrecent origin. Mostly they did not yield any pollen at all or only corroded material. The sediment from the Buara saline basin was the only exception. The value of this pollen record was even increased because the sediment provided a radiocarbon date. The age of about 6000 B. P. obtained for this sequence supplied information indicating that it also covered the Bronze Age. A disadvantage of this core location is the relatively large distance to the Ḫābūr and the Bronze Age sites excavated by Kühne and his team.

The composition of the modern pollen precipitation hardly reflects differences in vegetation, rather unexpected because of the precipitation gradient that is present from north to south. In the northern part of the area under consideration, where precipitation measures 200–300 mm annually, *Centaurea solstitialis*-type, *Polygonum aviculare*-type and Ranunculaceae are more frequent than in the southern part. The reverse is found for *Ephedra* and *Plantago* types that are more common in the south, where a precipitation of about 100 mm is found.

The amount of arboreal pollen ascribed to long-distance transport informs us about the quantity of local pollen production. Low production of local pollen was either caused by extreme edaphic conditions or by overgrazing.

The pollen evidence from Buara indicates a constant climatic regime. It can be concluded that modern conditions became established at least 6000 years ago. This means that conditions for Bronze Age farming practices were not more favourable than is the case today. Crop production during that period heavily depended upon the advanced technical, organizational and political level of the population. Maintenance of farming level over a longer period may have depended upon the organization structure, but salinization of the irrigation systems and overgrazing of the hinterland may have played a role.

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Table 14: Percentages of all pollen taxa identified in the surface samples. The sample numbers refer to the numbers in fig. 61. + = less than 0.1%.

sample number	3	4	5	6	7	8	9	10	11	1	12	2	13
SUM = AP + NAP absolute	2247	601	875	358	1846	958	556	1782	769	461	1032	743	1016
AP = arboreal pollen %	1.2	3.6	4.1	1.6	4.8	3.5	5.9	5.7	5.2	4.9	21.0	4.4	3.3
NAP = non-arboreal pollen %	98.7	96.3	95.8	98.3	95.1	96.4	94.0	94.2	94.7	95.0	78.9	95.5	96.6
Pistacia	+	0.3	.	.	.	.	.	.	.	1.1	.	.	0.1
Alnus	.	.	0.2	.	+	.	.	.	.	.	0.1	.	.
Corylus	+	.	.	.	.	.	.	.	.	.	.	.	.
Ostrya/Carpinus orientalis	.	0.2	.	.	0.3	.	.	0.1	.	.	0.1	0.1	0.1
Lonicera	+	.	.	.	.	.	.	.	.	.	.	.	.
Casuarina	.	.	.	.	0.2	.	.	+	.	.	.	.	.
Juniperus	.	.	.	.	.	.	.	.	.	0.2	.	.	.
Quercus cerris-type	0.2	1.5	0.1	.	1.2	0.7	0.3	1.0	0.4	.	1.9	1.6	0.4
Juglans	.	.	.	.	.	0.1	0.2	.	.	.	0.1	.	.
Eucalyptus	.	.	0.1	.	.	0.1	.	+	.	.	.	0.1	.
Fraxinus excelsior-type	.	.	.	.	.	0.1	.	+	.	.	.	.	.
Olea	.	0.2	.	.	0.1	0.1	.	0.2	.	0.2	0.3	.	0.1
Cedrus	+	.	.	0.3	+	.	.	.	0.3	.	.	.	.
Pinus	0.8	1.3	3.4	1.4	2.8	2.4	4.7	4.3	4.5	3.5	18.4	2.5	2.4
Platanus	.	.	.	.	.	.	.	.	.	.	.	.	0.1
Punica	.	.	.	.	.	.	.	.	.	.	.	.	0.2
Rhamnaceae	.	.	0.1	.	.	.	.	.	.	.	.	.	.
Salix	.	.	.	.	+	.	0.7	+	.	.	.	.	.
Thymelaea	.	0.2	.	.	+	.	.	.	.	.	0.1	.	.
Ulmus	.	. 0.1	.	.	.	.	.	.	.	.	.	.	
Arnebia-type	.	.	.	.	.	.	.	2.0	.	0.6	.	.	6.8
Heliotropium-type	0.1	0.2	0.7	.	+	0.2	0.2	.	.	39.7	.	. 0.9	.
Onosma-type	+	.	.	.	.	.	.	.	.	0.4	.	.	.
Humulus/Cannabis	.	.	.	.	.	.	.	0.1	.	.	.	.	.
Caryophyllaceae	1.4	0.3	0.4	0.5	0.6	.	1.6	0.8	0.3	1.9	1.0	3.1	0.3
Dianthus-type	.	.	.	.	.	0.5	.	.	.	.	.	.	.
Spergularia-type	.	.	.	.	0.3	0.1	0.2	.	.	.	0.1	0.1	.
Atriplex-type	78.3	8.1	1.8	32.1	27.4	21.7	8.3	3.4	77.8	1.7	10.2	19.1	10.3
Aellenia-type	+	2.0	18.4	.	0.2	0.3	.	10.0	0.3	.	0.2	.	0.2
Hammada-type	0.6	7.8	4.7	1.9	2.6	3.5	0.5	6.9	0.6	0.4	6.0	1.6	2.2
Noaea-type	0.3	0.5	1.0	1.7	0.3	1.5	0.2	1.7	1.2	.	0.2	0.8	1.4
Spinacia-type	+	.	.	.	.	.	.	+	.	.	.	0.1	.
Helianthemum	0.2	.	.	.	+	0.3	.	0.2	0.3	0.2	0.5	.	0.2
Compositae Liguliflorae	0.2	.	0.3	21.5	2.0	2.7	15.5	.	0.1	.	1.3	16.5	0.1
Scorzonera-type	1.5	2.7	6.8	0.3	0.3	0.2	.	1.1	0.3	3.0	0.1	.	1.2
Compositae Tubuliflorae	0.1	.	.	7.0	0.9	2.8	4.7	0.5	0.1	0.6	3.2	2.8	0.4
Arctium-type/Jurinea	.	.	.	.	0.3	.	0.2	.	.	.	0.1	0.1	.
Artemisia herba-alba-type	1.5	12.3	16.4	3.9	22.7	18.0	17.8	1.4	3.6	8.0	21.0	19.0	3.6
Artemisia vulgaris-type	0.1	0.5	0.2	.	0.2	.	.	.	.	0.4	.	.	0.6
Carthamus	+	.	.	.	+	0.1	.	+	0.3	.	0.1	.	.
Centaurea cyanus-type	.	.	.	.	+	.	0.2	.	.	.	0.2	.	.
Centaurea scabiosa-type	.	.	.	.	.	.	.	+	.	.	.	.	.
Centaurea solstitialis-type	0.7	19.1	16.7	11.4	0.4	2.9	4.5	11.6	0.8	1.5	2.0	2.0	1.6
Cirsium-type	0.6	1.3	3.1	0.3	+	0.8	0.2	0.2	0.4	1.5	0.2	.	1.1
Cousinia	.	.	.	.	.	.	.	.	.	0.2	.	.	0.1
Evax	.	0.3	.	0.8	0.1	0.2	0.3	0.2	.	.	0.1	.	.
Filago-type	0.1	1.0	2.8	0.3	0.7	1.0	0.3	0.4	0.5	0.6	0.8	0.7	10.3
Matricaria-type	0.7	6.0	4.1	2.2	3.0	5.4	3.8	1.4	1.8	0.6	4.4	3.2	4.8
Onopordon-type	.	.	.	.	.	.	.	.	.	0.4	.	.	.
Senecio-type	0.2	2.3	1.4	1.1	0.9	2.1	1.1	0.2	0.3	0.2	1.9	1.6	0.6
Xanthium	+	0.3	.	1.4	0.6	0.1	0.2	+	0.4	0.2	.	.	0.2
Cuscuta	.	.	.	.	0.2	.	0.5	.	.	0.2	.	.	.
Crassulaceae	.	.	.	.	0.1	0.2	.	.	.	.	.	.	.
Umbilicus-type	.	.	.	.	.	0.1	.	.	.	.	0.1	0.1	.

Umbilicus-type	.	.	.	.	.	0.1	.	.	.	.	0.1	0.1	.
Cruciferae	0.4	1.7	0.7	1.1	0.3	0.6	1.8	19.2	0.1	0.9	2.9	0.9	1.4
Matthiola	.	1.2	0.6	.	0.2	0.6	0.2	0.7	.	0.4	1.2	0.1	0.3
Cyperaceae	0.3	0.5	0.2	4.2	0.9	0.2	4.8	0.2	0.4	.	1.7	1.2	0.7
Scabiosa palaestina-type	.	.	0.2	.	.	.	.	.	.	.	.	.	.
Ephedra distachya-type	.	.	.	.	+	.	.	.	.	.	.	.	.
Ephedra fragilis-type	.	.	.	.	0.3	.	0.2	+	.	0.4	0.1	.	0.1
Crozophora	.	.	0.1	.	.	.	.	.	.	0.2	0.1	.	.
Euphorbia	+	.	0.1	.	0.1	0.4	0.2	.	.	.	0.8	0.3	.
Mercurialis annua	.	.	.	.	.	.	.	.	.	.	.	.	0.2
Frankenia hirsuta-type	.	.	.	.	.	0.9	.	.	.	.	.	.	.
Gentianaceae	.	.	.	.	.	.	.	+	.	.	.	.	.
Erodium	.	.	0.4	.	.	0.1	0.2	+	0.1	.	0.3	0.1	.
Geranium	.	0.3	1.2	.	.	0.2	.	0.2	.	0.2	0.6	0.4	.
Gramineae	4.0	19.5	5.1	3.9	6.4	16.1	15.3	8.9	2.6	6.5	6.1	12.5	28.3
Cerealia-type	0.6	.	0.2	.	1.7	0.8	1.8	0.2	0.5	.	1.0	0.1	0.8
Zea mays	.	.	.	0.3	.	.	.	.	.	.	.	.	.
Hypericum assyrianum-type	.	.	.	.	.	.	.	+	.	0.2	.	0.1	.
Labiatae	.	.	.	.	.	.	.	0.1	.	.	.	.	.
Thymus/Mentha-type	+	.	.	.	.	0.1	.	.	.	.	.	.	0.1
Scutellaria	.	.	.	.	+	.	.	.	.	.	0.1	.	.
Leguminosae	.	0.5	0.7	.	0.2	0.2	0.2	0.2	.	.	0.5	.	0.2
Anthyllis-type	.	.	.	.	.	.	.	.	.	0.2	.	.	.
Astragalus-type	0.1	0.8	0.6	.	.	.	.	+	.	.	0.1	.	0.3
Lotus-type	.	.	.	.	.	.	.	.	.	0.2	.	.	.
Onobrychis-type	.	.	.	.	.	0.4	.	.	.	.	.	.	.
Prosopis	0.3	0.3	0.1	.	+	0.2	.	.	.	.	0.2	.	0.1
Vicia-type	.	.	.	.	.	.	.	.	0.1	.	.	.	.
Liliaceae	.	.	.	.	14.3	.	0.5	.	.	.	0.1	0.1	.
Allium	.	.	.	.	.	.	.	+	.	.	.	.	0.1
Asparagus-type	0.1	.	.	.	+	0.1	.	.	.	.	.	.	.
Scilla-type	.	0.3	.	.	.	0.1	0.2	.	.	.	.	0.1	0.1
Linum	.	0.3	.	.	.	.	.	.	.	.	.	.	.
Gossypium	.	.	.	.	+	.	.	.	.	.	.	.	.
Malva	.	.	.	.	.	0.1	0.2	.	.	.	.	.	0.3
Papaver	.	.	.	.	.	0.3	.	.	.	.	.	.	.
Roemeria dodecandra-type	.	.	.	.	+	.	.	.	.	.	0.2	.	.
Plantaginaceae	.	.	0.1	.	.	.	.	0.1	0.4	.	0.5	.	0.4
Plantago coronopus-type	0.1	.	.	.	0.3	0.1	0.2	1.0	0.4	.	0.9	.	5.9
Plantago cylindrica-type	.	.	0.1	.	0.4	1.0	.	0.8	.	0.2	1.3	0.5	0.8
Plantago lanceolata-type	+	.	.	.	0.2	.	.	0.1	0.1	.	0.2	.	0.4
Plantago maritima-type	.	0.2	.	.	0.1	0.4	.	0.6	0.3	.	0.7	.	1.3
Plantago media-type	.	.	.	.	+	0.1	.	0.2	.	.	0.1	.	.
Plantago ovata-type	+	1.3	0.3	.	0.8	1.5	1.6	2.2	0.1	0.4	3.2	0.9	7.8
Plantago tenuiflora-type	+	.	.	.	0.1	.	.	.	.	.	.	.	.
Armeria/Limonium	+	.	.	.	1.2	0.2	0.2	0.4	.	.	0.1	1.2	.
Psylliostachys	0.1	0.2	.	.	1.6	0.1	.	0.7	0.1	.	0.4	1.9	0.1
Calligonum	.	.	.	.	+	.	.	.	.	.	.	.	.
Polygonum aviculare-type	2.4	0.2	.	1.4	0.1	.	0.7	+	.	.	.	.	.
Rumex acetosa-type	.	.	0.1	.	+	.	2.1	0.1	.	.	.	0.1	.
Androsace	.	.	.	.	.	0.2	.	.	.	.	.	.	.
Ranunculaceae	.	.	0.1	.	.	.	0.5	.	.	.	.	.	.
Aquilegia-type	+	.	.	.	0.1	.	.	.	.	.	.	.	.
Delphinium-type	.	.	.	0.3	.	.	.	.	.	.	.	0.1	.
Ranunculus asiaticus-type	+	.	0.1	.	+	.	0.2	.	.	0.2	.	0.1	.
Ranunculus repens-type	.	.	.	.	0.2	.	.	.	.	.	.	0.3	.
Rosaceae	2.6	0.5	.	.	.	.	.	0.2	.	0.2	0.2	0.1	.
Sanguisorba minor/Poterium	.	0.2	.	.	.	.	.	.	.	.	0.2	0.1	.
Sanguisorba officinalis	.	.	.	.	.	0.1	.	.	.	.	.	.	.
Asperula-type	.	.	.	.	.	.	.	.	.	.	0.1	.	.
Galium-type	.	.	.	.	.	.	.	+	.	.	.	.	.
Haplophyllum	.	.	.	.	.	0.3	0.5	.	0.3	.	.	0.3	.
Ruta	.	1.0	0.7	.	+	0.5	.	4.4	.	.	0.3	.	.
Antirrhinum/Linaria	.	.	0.3	.	.	.	.	.	.	.	.	.	.
Scrophularia/Verbascum-type	.	.	.	.	.	3.2	.	.	.	.	.	.	0.3
Veronica	.	.	.	.	.	.	.	0.1	.	.	.	.	.
Solanum nigrum	.	0.5	0.1	.	.	.	.	+	.	.	.	.	.
Umbelliferae	.	.	0.1	0.5	0.1	0.1	0.7	.	.	.	0.1	0.5	.
Anisosciadium-type	.	0.7	0.1	.	.	1.0	0.3	0.4	.	.	0.4	0.4	0.4
Bunium-type	0.3	0.5	0.7	.	0.1	.	.	+	.	13.2	0.2	0.1	0.1
Bupleurum-type	.	0.2	0.7	.	+	0.4	.	0.1	0.1	.	.	.	.
Ferula-type	.	.	.	.	.	.	.	+	.	0.2	.	.	.
Pimpinella-type	0.1	.	1.6	.	+	0.4	0.2	9.5	0.1	8.0	0,2	0.3	0.3
Turgenia-type	.	0.2	.	.	.	.	.	.	.	.	.	.	.
Urtica dioica-type	.	.	.	.	0.1	.	.	.	.	.	.	.	.
Urtica pilulifera-type	.	.	.	.	0.1	.	.	.	.	.	0.1	0.1	.
Valerianella	.	.	1.1	.	+	.	0.2	+	.	0.2	0.1	.	.
Zygophyllaceae	.	0.5	.	.	.	.	.	0.1	.	.	.	.	.
Peganum	.	.	.	.	0.3	.	0.7	.	.	.	0.2	0.1	.
Myriophyllum alterniflorum	.	.	.	.	.	.	.	.	0.1	.	.	.	.
Sphagnum	.	.	.	.	.	.	.	+	0.1	.	.	.	.
Potamogeton	.	.	.	.	.	.	.	.	.	.	0.1	.	.
Ruppia	.	.	.	.	+	.	.	.	.	.	.	2.5	.
Sparganium-type	+	.	.	.	0.1	35.3	1.8	0.2	.	0.2	1.4	0.3	0.2
Pediastrum boryanum	.	.	.	.	.	.	0.3	.	.	.	.	.	.
spore trilete	.	0.2	.	.	.	.	.	+	.	.	.	.	0.1
Indeterminata	0.6	1.2	1.4	1.7	.	1.1	1.4	0.3	0.5	0.9	0.7	1.1	0.6

Table 15: Representation of trees in the surface samples.

Tree	species observed	pollen present[1)]	average percentages
Pistacia	1	4	0.4
Pinus	–	13	3.7
Quercus cerris	–	11	0.8
Olea	–	7	0.2
Ostrya/Carpinus orientalis	–	6	0.2
Cedrus	–	4	0.2
Eucalyptus	–	4	0.1
Salix	–	3	0.3
Alnus	–	3	0.1
Juglans	–	3	0.1
Thymelaea	–	3	0.1
Casuarina	–	2	0.2
Fraxinus	–	2	0.1
Juniperus	–	1	0.2
Punica	–	1	0.2
Corylus	–	1	0.1
Platanus	–	1	0.1
Rhamnaceae	–	1	0.1
Ulmus	–	1	0.1

1) 13 samples examined

Table 16: Waz Göl, percentages of all pollen taxa.

spectrum depth in cm	A 4	B 6	C 20	D 50
Quercus calliprinos	.	0.6	0.7	.
Quercus cerris-type	0.3	1.8	.	.
Pinus	5.6	19.7	10.6	0.4
Humulus/Cannabis	.	0.3	.	.
Olea	.	1.6	.	.
Ostrya-type	.	0.2	.	.
Vitis	.	0.3	.	.
Juglans	.	0.3	.	.
Juniperus	.	0.2	0.3	.
Alnus	.	0.2	.	0.2
Cedrus	.	0.2	.	.
Fraxinus	.	0.3	.	.
Σ AP	5.9	25.5	11.6	0.6
Chenopodiaceae	56.2	11.1	71.3	79.5
Noaea-type	.	1.3	0.2	.
Aellenia-type	.	0.5	.	.
Artemisia	3.5	11.5	2.5	1.5
Centaurea solstitialis-type	0.9	2.2	0.3	1.3
Senecio-type	.	0.2	0.2	.
Matricaria-type	.	1.3	0.5	0.4
Xanthium	.	0.8	.	.
Carthamus	.	.	0.2	.
Filago-type	0.3	0.2	.	0.2
Tubuliflorae	7.0	1.8	0.8	3.9
Liguliflorae	13.4	2.7	1.7	10.7
Plantago lanceolata-type	.	0.8	.	.
Plantago ovata-type	.	0.2	.	.
Plantago spec.	.	0.8	.	.
Cerealia-type	0.3	5.7	0.3	.
Gramineae	8.0	23.9	1.0	0.6
Caryophyllaceae	0.2	0.6	.	.
Umbelliferae	1.0	2.4	.	.
Paracaryum-type	0.2	.	.	.
Brassica-type	.	1.4	.	0.2
Capsella-type	.	0.6	.	.
Crozophora	.	0.2	.	.
Helianthemum	.	0.2	.	.
Convolvulus	.	0.2	.	.
Calystegia	.	0.2	.	.
Cuscuta	.	0.2	.	.
Solanum nigrum ssp. villosum	.	0.3	.	.
Polygonum aviculare	3.0	2.1	8.9	0.9
Leguminosae	.	0.2	.	.
Rumex cyprius-type	.	0.2	.	.
Valerianella	.	0.2	.	.
Ranunculus sceleratus-type	.	0.5	.	.
Prosopis	.	0.3	.	.
Sanguisorba minor-type	.	0.2	.	.
Euphorbia	.	.	0.3	.
Rhinanthus-type	.	.	0.2	.
Rosaceae	0.2	.	.	.
Erodium	.	.	.	0.2
Pollen sum	575	628	595	532
Cyperaceae	0.3	24.7	1.0	0.2
Sparganium-type	0.3	4.1	0.7	.
Potamogeton pectinatus-type	.	80.3	.	.
Dryopteris	.	0.2	.	.
Pediastrum integrum/ boryanum brevicorne	0.2	48.4	.	.
Hysterix	.	15.0	.	.
Indeterminata	7.8	5.3	3.4	6.8
Pollen preservation	+−	++	+−	−−

Table 17: Percentages of taxa not included in the pollen diagram.

Ḫābūr

Spectrum 1: *Anchusa/Pulmonaria* 0.2, *Andrachne* 0.2, *Geranium* 0.4, *Lythrum* 0.2, *Turgenia*-type 0.4, *Hydrocotyle* 0.2;
spectrum 2: cf. *Taxus* 0.5, *Noaea*-type 1.6, Ericaceae 0.5, *Plantago ovata*-type 0.5, *Galium*-type 0.5, *Urtica dioica*-type 4.3;
spectrum 3: *Castanea* 0.2, *Humulus/Cannabis* 0.2, *Dipsacus*-type 0.2, Rosaceae 0.2, *Sphagnum* 0.2;
spectrum 4: *Plantago ovata*-type 0.3, *Pimpinella*-type 0.3, *Turgenia*-type 0.3, *Dryopteris*-type 0.3, spore trilete 0.3;
spectrum 5: *Salix* 0.6, *Sphagnum* 0.6;
spectrum 6: *Symphytum*-type 0.3, *Papaver* 0.3, *Aquilegia* 0.3;
spectrum 7: *Heliotropium*-type 0.2, *Noaea*-type 0.4, *Cousinia* 0.2, *Allium* 0.2, Umbelliferae 0.2;
spectrum 8: *Evax* 0.6, *Matthiola* 0.6, *Haplophyllum* 0.6, *Pimpinella*-type 1.3;
spectrum 9: *Dryopteris*-type 0.3;
spectrum 10: Ericaceae 0.2.

Buara

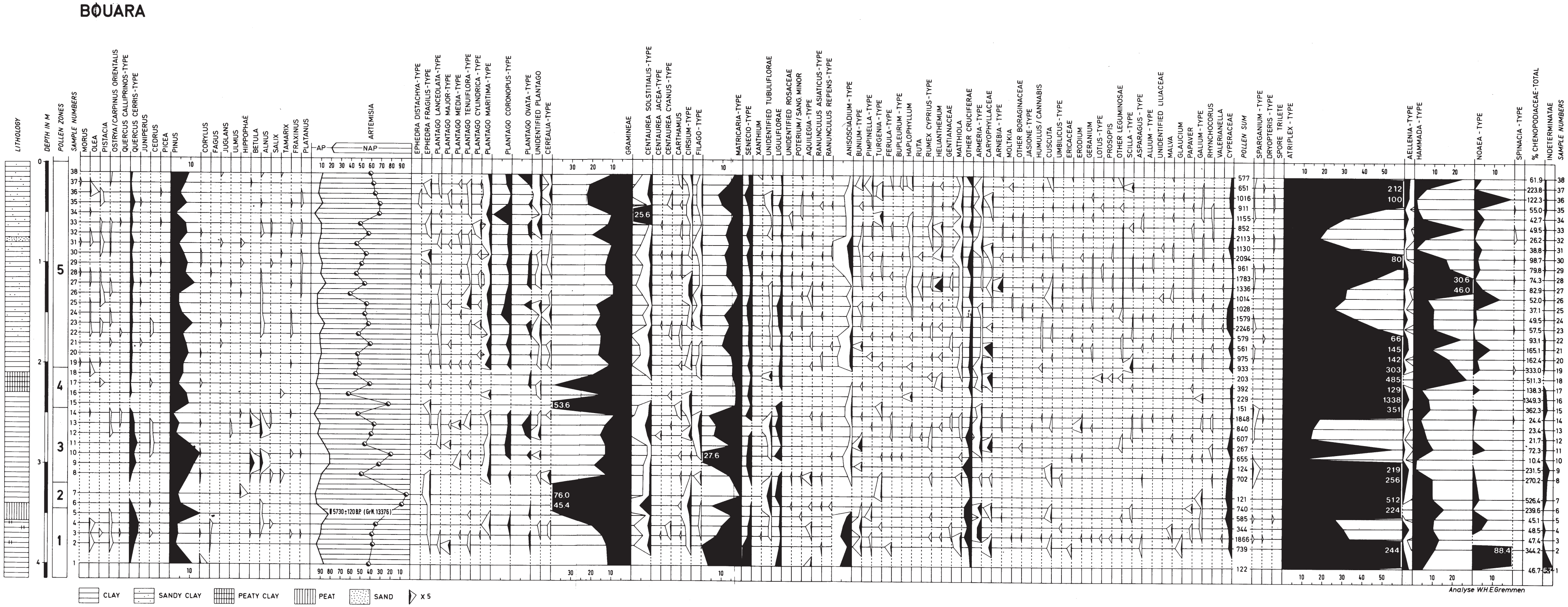
Spectrum 1: *Casuarina* 0.8, *Convolvulus* 0.8;
spectrum 2: *Convolvulus* 0.1, *Mercurialis annua* 0.5, *Polygonum aviculare*-type 0.4, Umbelliferae 0.1, *Eryngium* 0.1;
spectrum 3: *Roemeria dodecandra*-type 0.1, *Eryngium*-type 0.1, spore monolete 0.1;
spectrum 4: *Casuarina* 0.6, *Ophioglossum* 0.3, *Ranunculus sceleratus*-type 0.3;
spectrum 5: *Thymus/Mentha*-type 0.2;
spectrum 6: *Spergularia* 0.5, *Saxifraga* 0.1;
spectrum 8: *Acer* 0.1, *Frankenia hirsuta* 0.1;
spectrum 9: *Mercurialis annua* 0.8, Ranunculaceae 0.8;
spectrum 10: *Frankenia hirsuta* 0.3, *Thymus/Mentha*-type 0.1, Scrophulariaceae 0.1, *Lycopodium* 0.1;
spectrum 13: Rhamnaceae 0.1, *Centaurea nemecii*-type 0.3, *Delphinium*-type 0.2, *Urtica dioica*-type 0.1;
spectrum 14: *Polygonum persicaria*-type 0.1, *Zygophyllum* 0.1, *Batrachium*-type 0.1;
spectrum 16: *Ophioglossum* 0.4;
spectrum 17: *Scabiosa palaestina*-type 0.2;
spectrum 19: Crassulaceae 0.1, *Scutellaria* 0.1, Scrophulariaceae 0.2;
spectrum 20: *Punica* 0.3, *Thymelaea* 0.2, Umbelliferae indet. 0.1;
spectrum 21: Scrophulariaceae 0.5;
spectrum 23: *Spergularia*-type 0.1, *Tribulus* 0.1;
spectrum 25: *Frankenia hirsuta*-type 0.1, *Clematis*-type 0.1, *Delphinium*-type 0.1;
spectrum 26: *Bellis*-type 0.3, *Mercurialis annua*-type 0.1, Ranunculaceae indet 0.1, *Digitalis* 0.1;
spectrum 27: *Thymelaea* 0.1;
spectrum 28: *Abies* 0.1, *Polygonum aviculare*-type 0.1;
spectrum 29: *Vitis* 0.1, *Scutellaria* 0.2;
spectrum 30: *Scabiosa palaestina*-type 0.1, *Hypericum assyricum*-type 0.2, *Thymus/Mentha*-type 0.1, *Atraphaxis* 0.1, *Anemone nemorosa*-type 0.2, *Sanguisorba officinalis* 0.1, *Asperula*-type 0.1, *Scabiosa olivieri* 0.1;
spectrum 31: *Bellis*-type 0.9, *Zea mays* 0.1, spore monolete 0.2;
spectrum 32: *Carpinus betulus* 0.1, *Elaeagnus* 0.1, *Abies* 0.1, *Centaurea nemecii*-type 0.2, *Centaurea scabiosa*-type 0.1;
spectrum 33: *Centaurea nemecii*-type 0.1, *Rhinanthus*-type 0.1, *Anthoceros laevis*-type 0.1;
spectrum 34: *Bellis*-type 0.2, Ranunculaceae indet. 0.2, *Digitalis* 0.2;
spectrum 35: *Roemeria dodecandra*-type 0.2;
spectrum 36: *Carpinus betulus* 0.1, *Leontice* 0.1, *Scabiosa palaestina*-type 0.3;
spectrum 37: *Elaeagnus* 0.3, *Punica* 0.1, *Eryngium*-type 0.1;
spectrum 38: *Cousinia* 0.3, *Gladiolus* 0.5, *Scutellaria* 0.3, *Pteropyrum*-type 0.4, *Sanguisorba officinalis* 0.2.

Rašīdīya

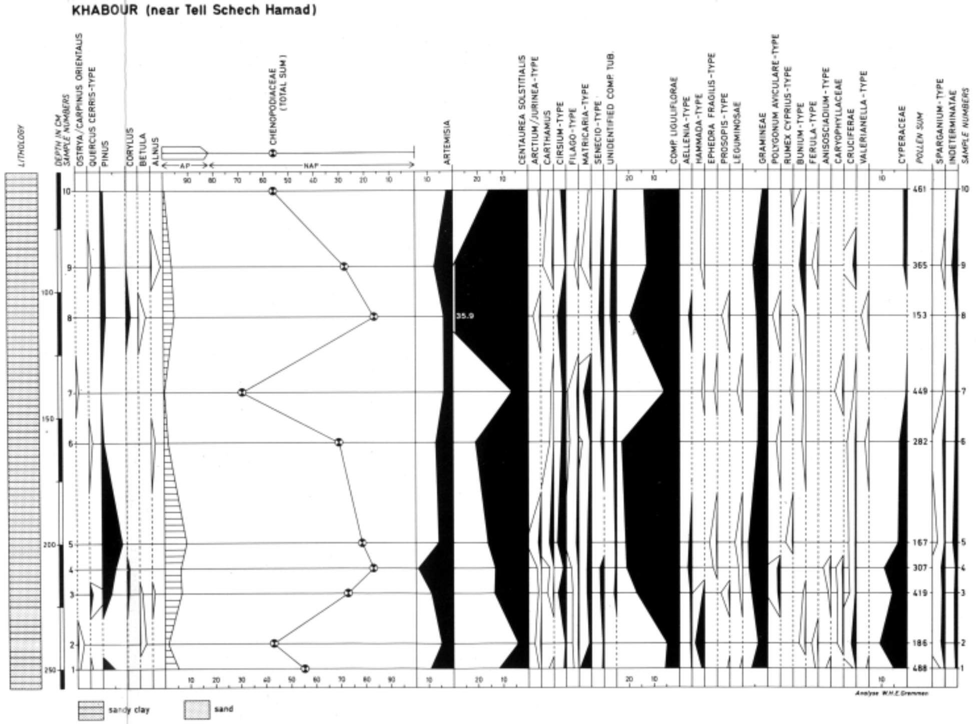
Spectrum 1: *Pterocarya* 0.2, spore trilete 0.2;
spectrum 2: *Arnebia*-type 0.1, *Andrachne* 0.1, *Hypericum assyricum*-type 0.1, *Papaver* 0.1, *Urtica dioica*-type 0.1, *Valerianella* 0.1;
spectrum 3: *Alnus* 0.1, *Casuarina* 0.2, *Cedrus* 0.1, *Salix* 0.1, *Cuscuta* 0.2, Crassulaceae 0.1, *Ephedra distachya*-type 0.1, *Gossypium* 0.1, *Roemeria dodecandra*-type 0.1, *Plantago lanceolata* 0.2, *Pteropyrum*-type 0.1, *Polygonum aviculare*-type 0.1, *Urtica dioica* 0.1, *Urtica pilulifera*-type 0.1, *Valerianella* 0.1, *Peganum* 0.3, *Ruppia* 0.1.

'Ain Ḫawzīya

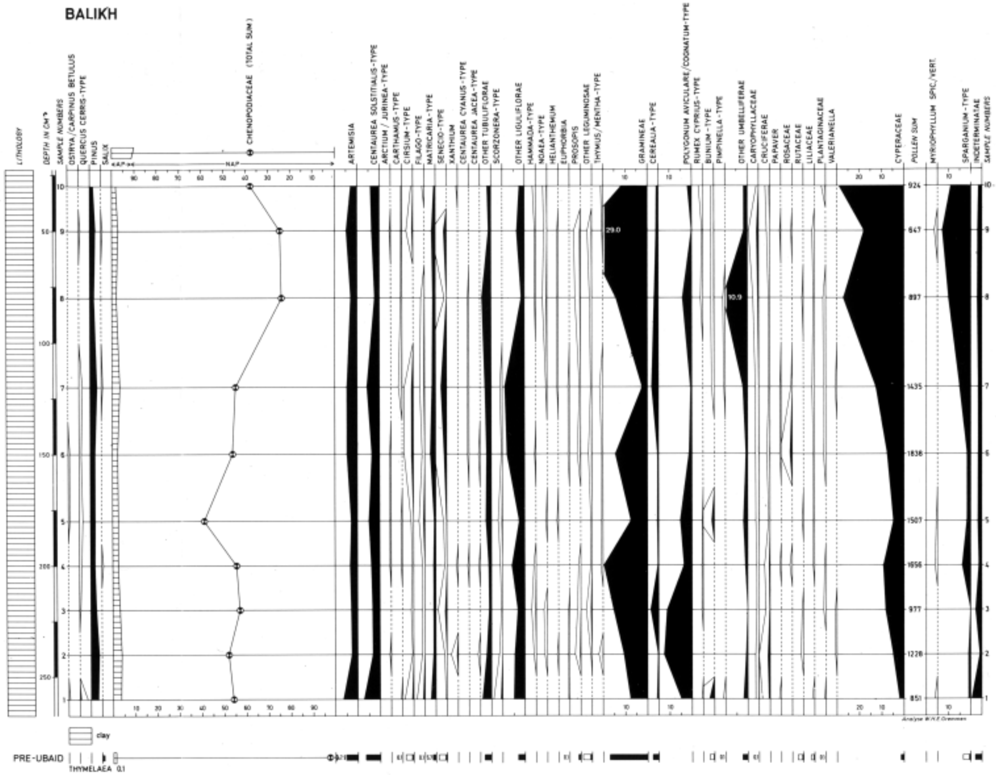
Spectrum 1: *Ulmus* 0.1, *Anchusa*-type 0.1, *Arnebia*-type 0.1, Plantaginaceae indet 0.2;
spectrum 2: *Alnus* 0.2, *Anchusa*-type 0.2, *Cuscuta* 0.2, Plantaginaceae indet. 0.2, *Veronica* 0.6;
spectrum 3: *Pistacia* 0.1, *Casuarina* 0.1, *Anchusa* 0.1, *Poterium* 0.3, *Veronica* 0.4;
spectrum 4: *Juglans* 0.1, *Eucalyptus* 0.1, *Fraxinus syriaca*-type 0.1, Crassulaceae 0.3, *Frankenia hirsuta*-type 0.9, *Erodium* 0.1, *Thymus*-type 0.1, *Malva* 0.1, *Papaver* 0.3, spore trilete 0.2.



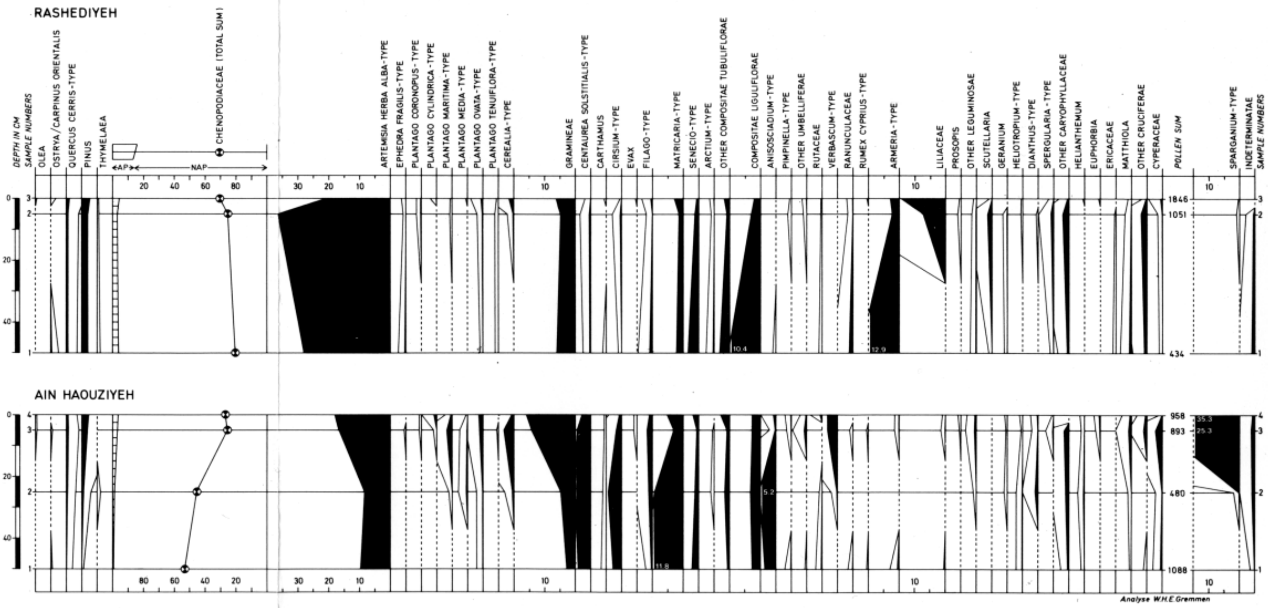
63 (im Anhang) Pollen diagram of Buara.



64 (im Anhang) Pollen diagram of the Ḫābūr.



65 (im Anhang) Pollen diagram of the Baliḫ.



66 (im Anhang) Pollen diagram of ʻAin Ḥawzīya and Rašidīya.