

HOLOCENE VEGETATIONAL DEVELOPMENT AND THE BEGINNING OF OASIS CULTIVATION IN TAYMA, NORTH-WESTERN SAUDI-ARABIA – FIRST RESULTS

*Desarrollo de la vegetación durante el Holoceno y el inicio del
cultivo de oasis en Tayma, al noroeste de Arabia Saudí – Primeros
resultados*

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SUMMARY: Cores from a large palaeolake, botanical macroremains out of archaeological features and surveys of the actual vegetation in combination with pollen surface samples provide excellent records for the reconstruction of the Holocene development of vegetation, land use and oasis cultivation in the Tayma region in north-western Saudi-Arabia.

The preliminary pollen data suggest a moderately denser vegetation cover during early and mid Holocene. However, fluctuating but high frequencies of desert vegetation throughout the sequence show the persistence of desert ecosystems in the Tayma region and confirm that stable agricultural practices always depended on irrigation. Vine pollen indicates a start of oasis cultivation at least at the beginning of the 3rd millennium BC. Whether the less pronounced, but perhaps economically significant change in vegetation during this period was the main trigger for oasis cultivation or only one among several reasons has to be decided after further investigations.

KEYWORDS: pollen, vegetation, *Vitis vinifera* L., oasis cultivation, Holocene, Tayma, Saudi-Arabia.

RESUMEN: Sondeos en un gran paleolago, macrorrestos botánicos, rasgos arqueológicos y estudios de la vegetación actual, en combinación con muestras de polen de superficie,

proporcionan un excelente registro para la reconstrucción del desarrollo de la vegetación del Holoceno, el uso del suelo y cultivo de oasis en la región de Tayma, en el noroeste de Arabia Saudí.

Los datos preliminares de polen sugieren una cubierta vegetal moderadamente más densa durante el Holoceno temprano y medio. Sin embargo, altas pero fluctuantes frecuencias de vegetación desértica, a lo largo de la secuencia, muestran la persistencia de los ecosistemas desérticos de la región de Tayma y confirman que las prácticas agrícolas estables siempre dependían de la irrigación. El polen de vid (*Vitis vinifera* L.) indica un inicio del cultivo del oasis, al menos al comienzo de la tercer milenio AC. Que el cambio, menos pronunciado pero tal vez económicamente significativo, en la vegetación durante este período fuera el detonante principal para el cultivo del oasis o sólo uno entre varios motivos, tiene que ser decidido después de posteriores investigaciones.

PALABRAS CLAVE: polen, vegetación, *Vitis vinifera* L., cultivo de oasis, Holoceno, Tayma, Arabia Saudí.

INTRODUCTION

The vegetation history provides information about the changing ecosystems and thus about changing basal natural resources as well as climate and settlement developments.

Up to now, for the whole Arabian Peninsula, information about the Holocene vegetation history is very scarce (LÉZINE *et al.*, 1998, 2007; PARKER *et al.*, 2004; GARCÍA ANTÓN & SAINZ OLLERO, 1999). Also for the Tayma region in the northwest of Saudi Arabia, there is nearly nothing known about the past Holocene vegetation and its changes (SCHULZ & WHITNEY, 1986).

Here we report first results of preliminary palynological analyses of a sabkha core in the vicinity of the oasis Tayma. The sequence starts at about 10 000 and lasts until at least ca. 4000 uncal. BP. They already give some clues to what the early to mid Holocene vegetation and climate development has been like, and when oasis cultivation was established in

Tayma. Detailed results and conclusions are, however, only available after further analysis and AMS-dating.

STUDY AREA

The study area, Tayma, situated in the northwest of Saudi Arabia, is nowadays characterized by an arid to hyperarid climate with less than 50 mm per year.

Today, different types of desert vegetation dominate in the Tayma region. Most common and widespread in North Saudi-Arabia are the so called «rimth» shrublands, dominated by *Haloxylon salicornicum*, a representative of the plant family Chenopodiaceae, and the so called «arfaj» shrublands, dominated by *Rhanterrium epapposum*, a representative of the plant family Asteraceae. On sand dunes the so called «adbir» shrublands with *Artemisia jordanica* dominates (KUERSCHNER & NEEF, 2011).

RESULTS

Up to now, 90 pollen types have been recorded. For the first ten pollen spectra the frequencies of some selected pollen types are presented in Figure 1. The different types are grouped according their ecology.

The desert and steppe types Chenopodiaceae/Amaranthaceae (in the following just mentioned as Chenopodiaceae), Poaceae, Plantaginaceae, Asteroideae, *Ephedra*, *Calligonum*, *Rumex*-type and *Artemisia* clearly dominate all spectra.

The two lowermost samples are characterized by (very) high frequencies

of the Chenopodiaceae, Poaceae and *Ephedra* pollen. In contrast, pollen frequencies of *Artemisia* are low, not exceeding 10%. Tree pollen frequencies are very low.

The following 7 samples are characterized by high frequencies for *Artemisia* pollen, while pollen frequencies of Chenopodiaceae and Poaceae decreased strongly. There is a maximum of tree pollen frequencies, due to higher records for *Olea* pollen and pollen of *Dodonea*. Urticaceae/Moraceae, *Vitis* and *Ficus vasta* type appear throughout this section.

The topmost sample is characterized by a marked decrease in *Artemisia* pollen

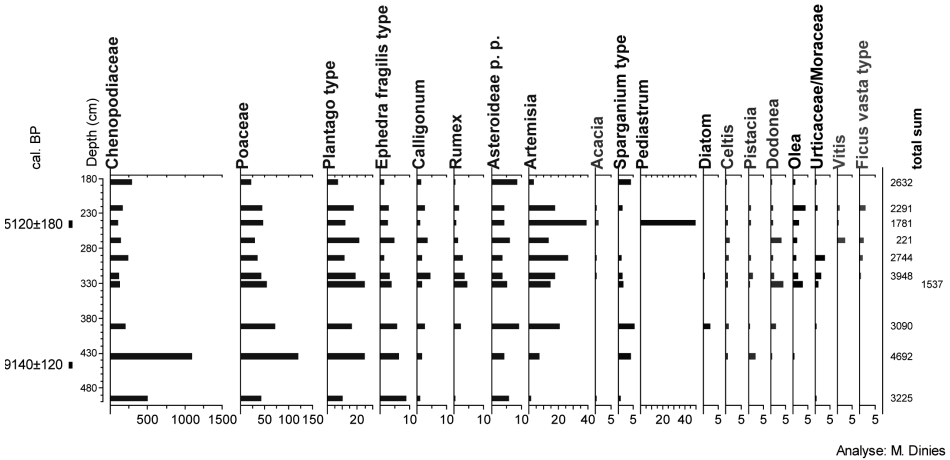


FIGURE 1. Preliminary percentage pollen diagram. All terrestrial pollen types are included in the sum for percentage calculation, exclusive Chenopodiaceae and Poaceae, because of their high overrepresentation. Pollen types are grouped in representatives of: desert (Chenopodiaceae, Poaceae, Plantaginaceae, *Ephedra*, *Calligonum*, *Rumex*, Asteroideae) and steppe (*Artemisia*), wadi (*Acacia*), lakeshore and freshwater (*Sparganium* type, Diatom, *Pediastrum*), sclerophyllous woodlands (*Pistacia*, *Olea*, *Dodonea*, *Celtis*) and synanthropic species / probably cultivated plants (Urticaceae/Moraceae, *Olea*, *Vitis*, *Ficus vasta* type).

frequency and an increase in Chenopodiaceae pollen frequency.

To study the relationship between vegetation and pollen deposition, first surface samples were analyzed. Different pollen types dominate the first analyzed modern spectra, depending on the surrounding plants stands. High frequencies of Plantaginaceae, rather high frequencies of Chenopodiaceae, and rather low frequencies of *Artemisia* seem to characterize all modern spectra analyzed so far. Tree pollen frequencies are low. Pollen of *Pistacia*, *Olea* and *Dodonea* are recorded.

INTERPRETATION AND DISCUSSION

For the interpretation of these first Holocene pollen spectra of the paleo-lake next to Tayma we have to keep in mind that we are discussing preliminary results. Therefore, we will focus on some prominent, some ecologically important and some economically interesting pollen types.

Regional vegetation development: desert, steppe and sclerophyllous woodland development. The pronounced dominance of herbaceous pollen grains, especially of Chenopodiaceae, Plantaginaceae, Poaceae, *Ephedra* and Asteroideae during the lacustrine period from about 10 000 to about 4 000 cal. BP indicate the continuity of arid environmental conditions even during early to mid Holocene times.

The fluctuations of the Chenopodiaceae and *Artemisia*, however, suggest some not very pronounced, but perhaps

ecologically and economically significant vegetation changes. Today, only *Artemisia jordanica* occurs on sand dunes in the Tayma region (KUERSCHNER & NEEF, 2011), while *Artemisia sieberi*, most common in the steppes and semi-deserts of Iran, Jordan and adjacent regions (ZOHARY, 1973), does not occur in the Tayma region. In arid lands high frequencies of Chenopodiaceae pollen, together with Plantaginaceae are commonly interpreted as indicating arid conditions. Semi-arid conditions are characterised by the dominance of *Artemisia* pollen and lower frequencies of Chenopodiaceae pollen (e.g. VAN ZEIST, 1967; BOTTEMA, 1986; ELMOSLYMANY, 1990; SINGH *et al.*, 1990; HOROWITZ, 1992; ROSSIGNOL-STRICK, 1998). At the present state of research we follow the traditional interpretation of *Artemisia* as indicator of steppe vegetation. Thus we do not assume an expansion of *Artemisia jordanica* in the Tayma region due to expanding sand dunes, but interpret higher *Artemisia* frequencies in the past as southward expansion of steppe vegetation.

The basal pollen spectra of the sabkha of Tayma, characterized by very high Chenopodiaceae frequencies and low *Artemisia* values, thus, would suggest (hyper)arid conditions. The subsequent rise of *Artemisia* pollen and the marked decrease of the Chenopodiaceae may indicate an increase of steppe vegetation, due to an increase in moisture in the region. The increase of Chenopodiaceae and decrease of *Artemisia* in the topmost sample would suggest reinforced aridity. Detailed analysis of further pollen samples and their interpretation,

considering all recorded pollen types as well as the study of the present pollen rain, will help to ascertain this hypothesis.

Until now, the half-evergreen Mediterranean and tropically distributed trees *Celtis*, *Pistacia*, *Dodonea* and *Olea* are recorded nearly consistently during the sequence, with slightly increased frequencies in the middle part of the diagram. The frequencies exceed slightly the nowadays in surface samples occurring proportions of tree pollen (SCHULZ & WHITNEY, 1986; GAJEWSKI *et al.*, 2002; LÉZINE *et al.*, 1989). These slightly increased tree pollen frequencies may indicate a wider distribution and/or increased occurrence of these trees. Nowadays sclerophyllous half-evergreen woodlands built up by *Pistacia*, *Celtis*, *Dodonea* and *Olea* are documented for the mountains farther in the southwest of Arabia and the southern Asir mountains (e. g. KUERSCHNER, 1998; KUERSCHNER *et al.*, 2008; EL-KAREMY & ZAYED, 1992). The occurrence of similar woodlands in the northern part of the Asir mountains, in the west of Tayma, is probable, today and in the past. An east- and northward expansion of these montane sclerophyllous woodlands into the plains in the west of Tayma during early and mid Holocene may be the reason for the slightly increased tree pollen frequencies.

Vine pollen records show the beginning of cultivation at the oasis of Tayma. To trace the beginning of oasis cultivation, a reliable indicator – a pollen type that includes only cultivated plants for the region under concern – has to

be spotted. Plants which are typically cultivated in oases, and especially the until now recorded seeds and fruits of cultivated plants out of archaeological context in Tayma, might be such a reliable indicator.

Until now, different cereals, lentils, beets, blackberries, almonds, pomegranates, dates, figs, olives and wine are recorded for the oasis Tayma. So far only vine pollen complies with the requirements of a primary anthropogenic indicator: The southern margins of the natural distribution area of the wild vine clearly run far more in the north (e. g. MEUSEL *et al.*, 1987; MCGOVERN, 2003) and seeds and charred wooden remains of vine are an unambiguous archaeobotanical evidence for the cultivation of vine in Tayma (NEEF, unpublished). AMS-dating of macrobotanical remains and pollen concentrations reveal an age of at least 4400 uncal. BP (ca. 3200 BC) for the beginning of vine and thus oasis cultivation.

As mentioned above, information about the environmental conditions during the beginning of oasis cultivation are of special interest. The first vine record goes along with decreased *Artemisia* frequencies. If the interpretation of *Artemisia* as steppe indicator holds true for the Tayma region as well, the beginning of the cultivation of the oasis of Tayma would have occurred during a period when vegetation became less dense, more scattered. This decline in forage may be the reason or one reason for establishing a new source of livelihood.

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