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PALAEOENVIRONMENT AND ANCIENT VEGETATION OF BALUCHISTAN BASED ON CHARCOAL ANALYSIS OF ARCHAEOLOGICAL SITES

STEPHANIE THIEBAULT

French Archaeological Mission, Musée Guimet, 6 Place d' Iéna 75116, Paris, France

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For the past five years the French Archaeological Mission has been orienting its research towards both archaeology and palaeoenvironment, more particularly by studying the process of sedimentation, by carrying out geological surveys and palaeobotanical studies based on analyses of burnt remains such as seeds or charcoal.

These analyses enable us to learn about vegetation change, possibility of climatic fluctuations and influence of man on the vegetal environment during the Holocene.

These analyses have been undertaken in relation to human settlements such as Mehrgarh (VII to II millennia B. C.), Lal Shah (third millennium B. C.) and the newly excavated site of Nausharo (Harappan culture).

The technique used in identifying numerous charcoal remains allows one to calculate the percentage of dissimilar taxa, and therefore, knowing ecology of species one can infer palaeoenvironments. Thus, in this area, the identification of several thousand samples gives us promising results. For instance, in three settlements (with differences in percentages), the most important component is Tamarisk (*Tamarix sp*) which requires water and salty soils and which, at present, constitutes the riverine forest.

Key Words : Palaeoenvironment; Charcoal; Kachi Plain; Baluchistan Archaeological Sites

INTRODUCTION

THE Kachi plain, located in Baluchistan, in western Pakistan, is a northern extension of the Indus plain. The plain exhibited evidence of intensive human settlements more than ten thousand years ago. Several archaeological sites such as Pirak, Mehrgarh and Nausharo have been recently excavated by the French Archaeological Mission directed by J. F. Jarrige[1] in collaboration with the Department of Archaeology, Government of Pakistan.

I will introduce the two main excavated sites: the first, Mehrgarh, gives evidence of a large and deep archaeological area extended over more than two hundred hectares. Early settlements (Neolithic aceramic) has been tentatively dated by Jarrige to seventh millennium B. C. Then there are continuous archaeological levels till the third millennium (Bronze Age). In this period, there is a real agglomeration with the craftsmen area (Fig. 1). Few kilometres away from

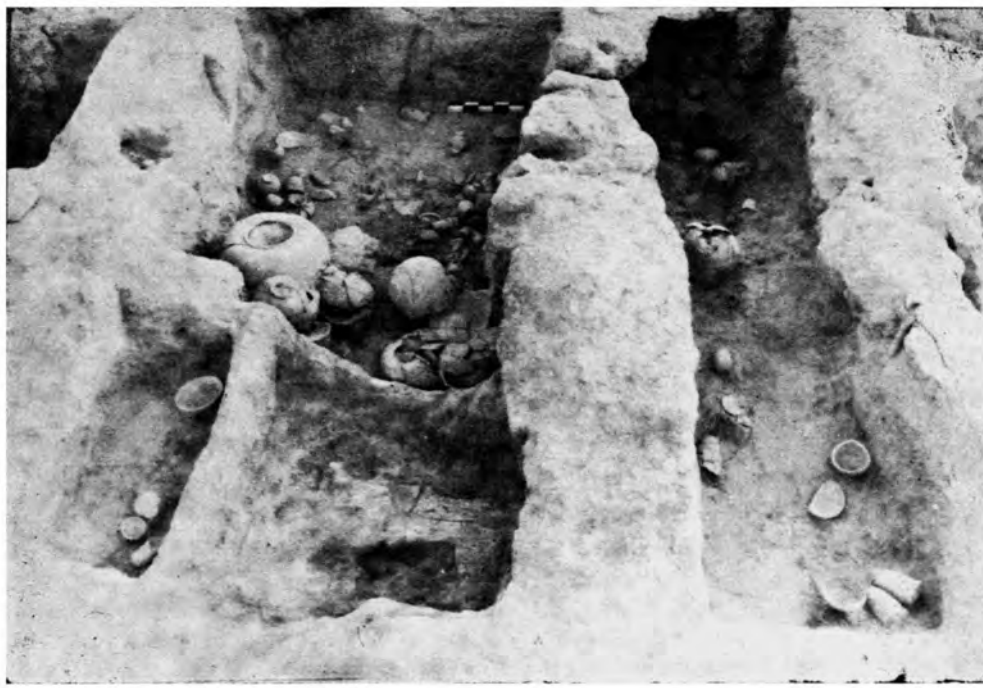

FIG 1 The archaeological site of Mehrgarh 1 (end of fourth millennium B.C.). Locus CXXXVII (photo: Jarrige).

Mehrgarh, the second site is Nausharo. Archaeological levels are contemporaneous or posterior to the last human settlements of Mehrgarh (that is end of third millennium and the Indus Civilization).

These archaeological discoveries were the starting point of a multidisciplinary research ultimate goal of which was to study (1) changes of climate and vegetation of these periods, and (2), interaction between man and environment in this area during the last ten millennia.

But, to understand the palaeoenvironment, it is necessary to first consider geological and climatic conditions as they exist at present.

The location of these archaeological sites at the northern end of the Kachi plain, at the foot of the Brahui-hills, about 10km from the Bolan pass, leading to the passage between the Kachi plain and the Quetta plateau, confers on this area a bioclimatic individuality (Fig. 2). This area is situated inside a transitional zone at the margins of the Kachi plain. Rainfall is between 100–200 mm/yr. On the Quetta plateau (1600m altitude) rainfall is about 300mm/yr. According to Labroue *et al*[2] the two cities of Quetta and Kalat have a climate with thermo-Mediterranean tendencies while at Sibi and Jacobabad begin the semi-desert and tropical desert with rainfall $<$ 100mm/yr.

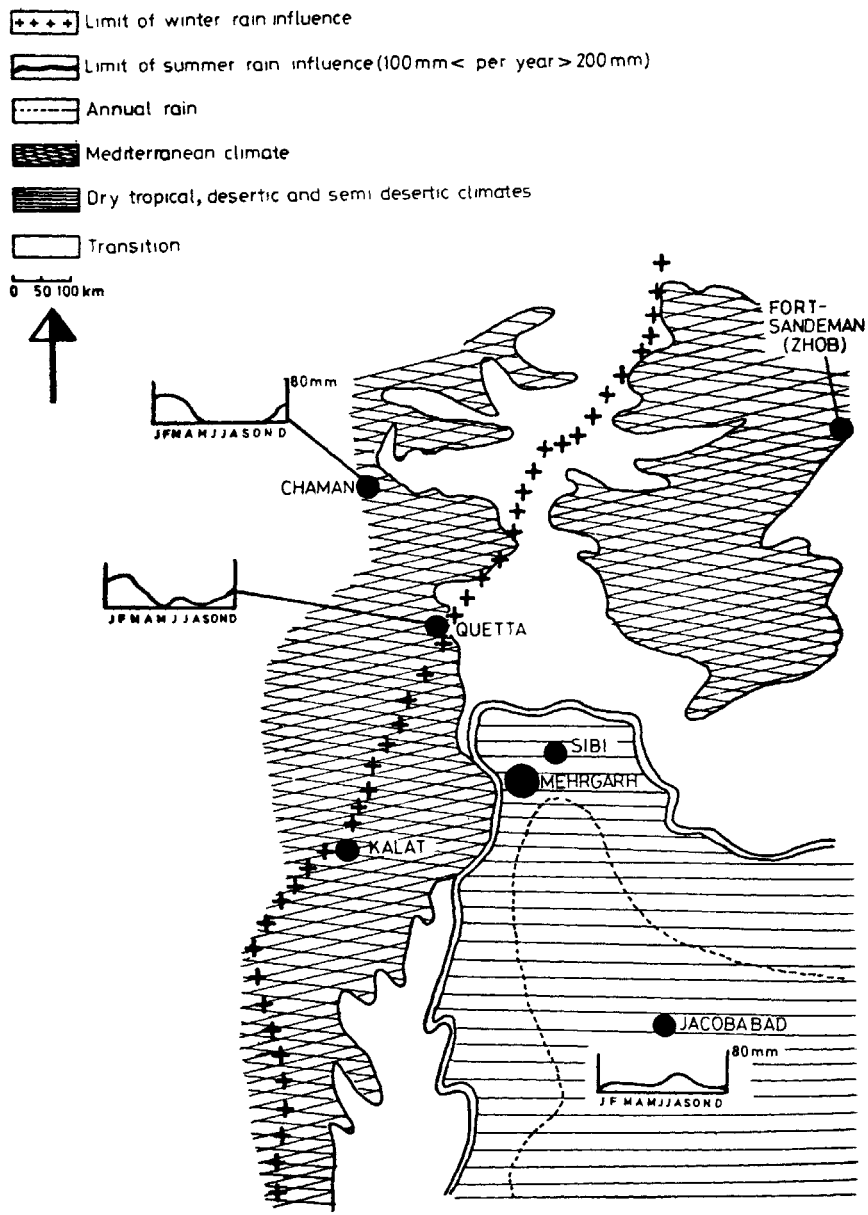

FIG 2 Map of climates of the studied area.

The location of Mehrgarh and Nausharo, at the western border of the Baluch arch, is in the calcareous zone which came under tectonism during the Himalayan orogeny. Geological observations (Luc Wengler, unpublished), showed that this western limit of Kachi plain is constituted by a detrital series: the Sibi Formation which contains sedimentary carbonate formations.

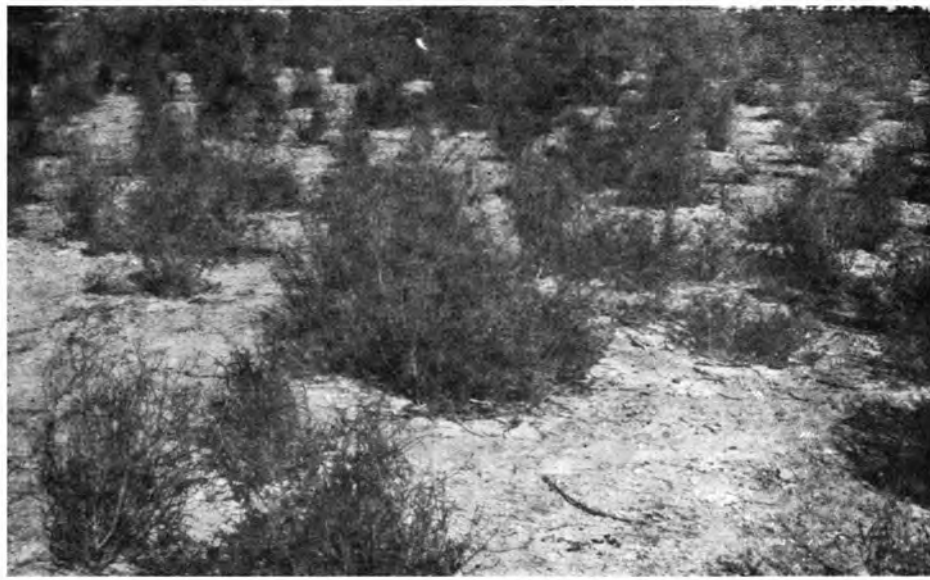

FIG 3 Steppe of *Alhagi camelorum* and *Sueda fruticosa* on the site of Mehrgarh.

Climatic and geological characteristics allow identification of five local-zones of vegetation at Mehrgarh. These are:

1. A Steppe with *Sueda fruticosa* and *Alhagi camelorum* (Fig. 3). It is the most important.
2. An extended grassy area dominated by *Saccharum munja*.
3. A formation of *Prosopis spicigera* associated with either *Saccharum munja* or *Salvadora oleoides*.
4. A riverine-forest growing in the bed of the Bolan river. Species are *Tamarix articulata, Tamarix dioica, Saccharum arondinacea, Capparis aphylla, Callotropis procera* and *Rhazya stricta*.
5. The last association has been evidenced on the ancient cultivated and irrigated fields, recently abandoned and colonized by *Rhazya stricta, Ziziphus nummularia, Saccharum munja* and *Prosopis spicigera*.

METHODOLOGY

Multidisciplinary studies in natural sciences concern: geological, sedimentological and micromorphological studies and identification of faunal remains.[3] Their aim is to try to trace the process of domestication, studying more particularly the three main species (*Bos, Ovis* and *Capra*), and identification of micro and macro vegetal remains. Pollen analysis has not yet given results. Charred grains, seeds and fruits[4,5] were collected in abundance on both sites, and these have yielded

much information on food plants e.g., the larger diversification of cereals at the beginning of the Chalcolithic.

The analysis of burnt wood comprises sampling of charcoal, breaking them, and lastly identification of different wood features located on the three anatomical surfaces (transverse, tangential and radial) under the reflected light microscope and by comparison with modern burnt wood. With this fast system, a large number of samples can be analysed and diagrams can be elaborated. Moreover, this method allows species identification.

Results

Thanks to the discovery of archaeological settlements from the eighth to the third millennia B.C., the author could carry out an exhaustive analysis of numerous charcoal remains for the first time in this area. I have already pointed out that the object was to study the interaction between man and environment and to try to know the vegetation and climate of these periods. Several thousand samples were recovered and identified from the sites of Mehrgarh, Lal Shah (a third millennium excavated kiln, very close to Mehrgarh) and the newly excavated Tepe Nausharo.

These first results are based on the study of more than four thousand samples. Prevalent species are tamarisks, the Mimosaceae, associated with some *Salvadora*, vine, poplar, *Ziziphus*, *Juniperus* and probably some *Ficus*.

Our method is based on the identification of different wood features, briefly described here. Tamarisk[6,7] (Fig. 4) is a wood with diffuse porous vessels circular in cross section with 100–200μ diameter, the rays are 10–15 cells wide, height upto 2mm, heterogeneous with several rows of marginal square cells, the parenchyma is abundant, paratracheal and storied.

Poplar (Fig. 5) is a wood with diffuse porous, with very numerous, solitary or in radial multiples, mostly of 2–3, sometimes of 5–7, the rays are fine, uniseriate, occasionally partly biseriate, the height is 5 to 30 cells, Homogeneous. Cells appear very narrow in the tangential view. *Vitis* (Fig. 6) heartwood presents porous ring and a gradual reduction of pore size from the early wood to late wood. Rays are multiseriate (5–20 cells wide) and the height is $>$ 2mm, often upto 5mm, heterogeneous cells, scalariform perforation plates in narrow vessels, simple perforation plates in large vessels; the parenchyma is paratracheal. Juniper (Fig. 7) is gymnosperm with tracheids and no resin canal, the average rays height is 2–5 cells with taxiodioid and cupressoid pits. Under the term Mimosaceae, I regroup trees such as *Prosopis*, *Albizzia*. *Acacia*. This family is characterized by large vessels, mostly solitary, and some species, a vague oblique or tangential pattern can be seen. The parenchyma is usually abundant, typically paratracheal, most of the rays are 2–5 cells wide, or exclusively uniseriate, homogeneous but few are heterogeneous also. The fibres have small pits, septate in some genera.

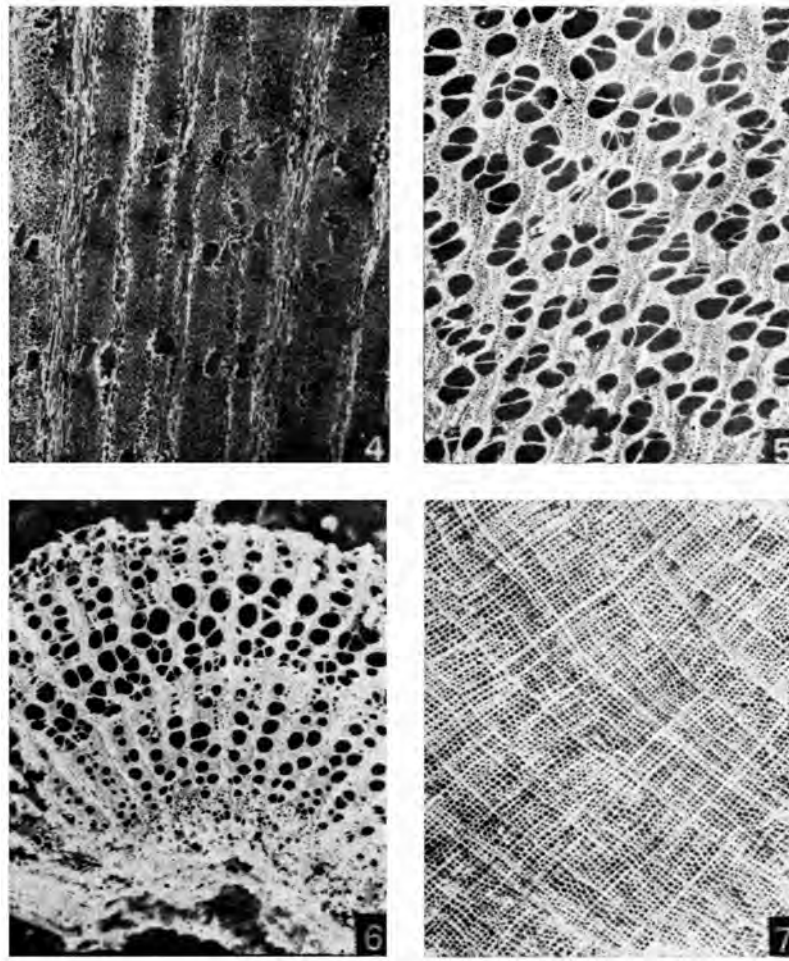

FIG 4 Photograph taken by scanning microscope; showing structure of *Tamarix* sp. from Mehrgarh, × 26.

FIG 5 Microscopic structure of *Populus* sp. from Lal Shah, × 43.

FIG 6 Microscopic structure of *Vitis* sp. from MR. 1 period VII, × 22.

FIG 7 Microscopic structure of *Juniperus* sp. from Lal Shah, × 43.

DISCUSSION

Fig. 8 shows that most abundant species in every level is the tamarisk. This tree grows in desert or salty-soils in the Mediterranean area and Central Asia. This tree is abundant also in the results of wood analysis[3] of *Sharh-i-Sokhta*, a Bronze Age site, in Iran, southern Seistan. At Mehrgarh percentages are divided between tamarisk and the Mimosaceae (Fig. 9) tropical and sub-tropical family. On the graph, we notice a change as far as the percentage is concerned; at Nausharo, period IB, this family becomes abundant. This fact can be interpreted as an intensive aridity, but it may be more probably the result of a choice by inhabitants.

MILLENNIUM	VII		VI		IV				III				II			
	MEHRGARH										LAL SHAH		NAUSHARO			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Dalbergia														1	0.09	0.01
Ficus ?													1	0.1	2	0.1	3	0.07
Juniperus sp.											1	0.1			1	0.09	2	0.04
Populus sp.									7	0.7	6	0.8	1	0.1	17	1	31	0.7
Salvadora							6	4.2	6	0.6	3	0.4	8	1.1	41	4	64	1.5
Tamarix sp.	203	962	269	91.4	17	68	91	64	665	70.6	679	94.9	212	30.8	626	61.3	2762	68.4
Vitis									7	0.7					3	0.2	10	0.2
Ziziphus sp.									4	0.4					3	0.2	7	0.1
Mimosaceae	8	3.7	16	5.4	8	32	38	26.7	216	22.9	21	2.9	456	66.3	315	30.8	1078	26.7
Moraceae															7	0.6	7	0.1
Oleaceae									3	0.3							3	0.01
unidentified			99	3			7	4.9	33	3.5	5	0.6	9	1.3	4	0.3	67	1.6
Total	211		294		25		142		941		715		687		1020		4035	

FIG 8 Diagram of number and percentages of different species in three archaeological sites during different periods.

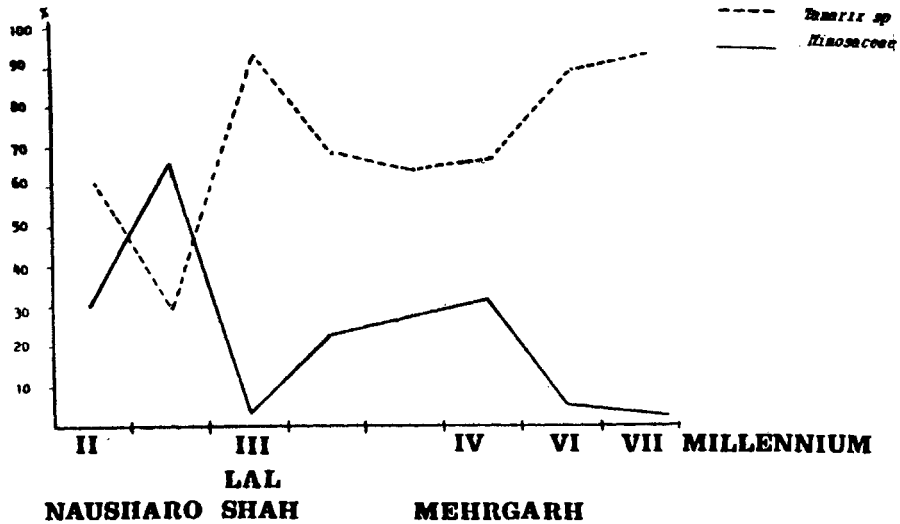

FIG 9 Curve showing anti-correlation between *Tamarix* and Mimosaceae.

After a hiatus during the fifth and fourth millennia we notice, at the beginning of the third millennium, some remarkable species such as *Juniperus*. This tree is found now a days at an altitude of (2,000 meters) on the Quetta plateau. However, its weak, evidence does not allow us to suggest climatic significance as these wood pieces could have come from burnt tools or artefacts.

The presence of rather big charcoal of vine corroborates identification of grapes made by Constantini.[4] A lot of grapes had been recovered at 3 Mehrgarh (Bronze Age) and Nausharo (Indus levels). They have been identified too in the archaeological site of Tepe Yayha, Iran, in contemporaneous settlements.[5] Poplar is present too at both sites of Mehrgarh and Nausharo. This tree grows in humid conditions (it has been evidenced too in the Bronze Age site of *Sharh-i-Sokhta*, Iran).

These first results show that the vegetational picture suggested by charcoal analysis is not very different from the present day vegetation. These semi-arid conditions, if they have really existed since the seventh millennium, suggest early irrigation technology for field cultivation in this part of the Kachi plain. We have to continue with these analyses for early periods as the number of analysed samples is very small. We have yet complete analyses of the fifth and fourth millennia material during which large craftsmanship areas and evidence of metallurgy have been recovered.

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