Fedele F. G. 1990.

Man, land and climate: emerging interactions from the Holocene of the Yemen Highlands.

In: Bottema S., Entjes-Nieborg G., van Zeist W. (eds), *Man's role in the shaping of the Eastern Mediterranean landscape*, pages 31-42.

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PROCEEDINGS OF THE INQUA/BAI SYMPOSIUM ON THE IMPACT OF ANCIENT MAN ON THE LANDSCAPE OF THE EASTERN MEDITERRANEAN REGION AND THE NEAR EAST
GRONINGEN / NETHERLANDS / 6 - 9 MARCH 1989

# Man's Role in the Shaping of the Eastern Mediterranean Landscape

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OFFPRINT

A.A. BALKEMA / ROTTERDAM / BROOKFIELD / 1990

Man's Role in the Shaping of the Eastern Mediterranean Landscape, Bottema, Entjes-Nieborg & van Zeist (eds)
 ISBN 90 6191 138 9

# Man, land and climate: Emerging interactions from the Holocene of the Yemen Highlands

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ABSTRACT: The prehistoric succession in the eastern Yemen Highlands (2000-2200 m above sea level), comprising "mesolithic", neolithic, and Bronze Age cultures, is described, alongside the standard depositional sequence for the region. Village-dwelling, cattle-breeding, aceramic neolithic groups are correlated with a mid-Holocene paleosol (5280-4000 cal. BC) indicating a high watertable in upland valleys and abundant vegetation. Subsequent Bronze Age farmers mainly living off caprines and sorghum (ca 2900-1800 cal. BC) may have exerted excessive economic pressure on a fragile ecosystem tending towards desiccation. That peaked when renewed tectonic uplift lowered the watertable and altered the landscape geometry. Cultural and climatic causes of environmental deterioration were escalated by tectonic interference, leading to the widespread desertion of today.

## 1 THE REGION AND THE PROBLEM

Regional survey and site excavations in the eastern Highlands of Yemen, above 2000 m in altitude, have begun to provide a basis for reconstructing Holocene sequences in a part of the Arabian Peninsula whose prehistoric archaeology and environmental history were unknown until a few years ago. In this paper I will summarize and discuss some of the results of the Italian Archeological Mission to the Yemen Arab Republic (MAIRAY, IsMEO, Rome), which has been working in that country since 1983 under a bilaterial cooperation agreement.

The core of North Yemen is high-mountain country. The Yemen and Asir Highlands form the backbone relief of the southwestern Arabian Peninsula, the Asir being the mountain ranges of western Saudi Arabia (Fig. 1). This mountain system corresponds within the peninsula to highly peculiar eco-zones, which are more African in character than Middle Eastern. But these rugged mountains only represent one physiographic division of Yemen, as this country has impressive landscape diversity, manifest in other equally important physiographic and ecologic zones.

To the south and west, Yemen is bounded by the Indian Ocean and that torrid inlet, the Red Sea, along which rifting and tectonic uplifting are still creating a narrow coastal plain, the Tihamah. Imposing escarpments contour the massive mountain block of the Yemen Highlands, ranging in elevation from 2000 to 3600 m and chaotically dissected. In addition to past volcanism and rifting, during the Oligocene-Miocene and Pleistocene periods, the uplifting of the Highlands still is a cause of tectonic instability (Fedele in press c).

The uplands are scarred by wadis (widian in Arabic) or seasonal streams, which disappear into the vast stretches of stony-grassy semi-desert and sandy desert to the north and east. This is the margin of the "empty quarter" or Rub' al-Khali, one of the harshest deserts in the world. The eastern Highlands of Yemen fall off onto the sand-covered Ramlat Sab'atayn Desert, a lobe of the Rub' al-Khali.

The Highlands belong today in the

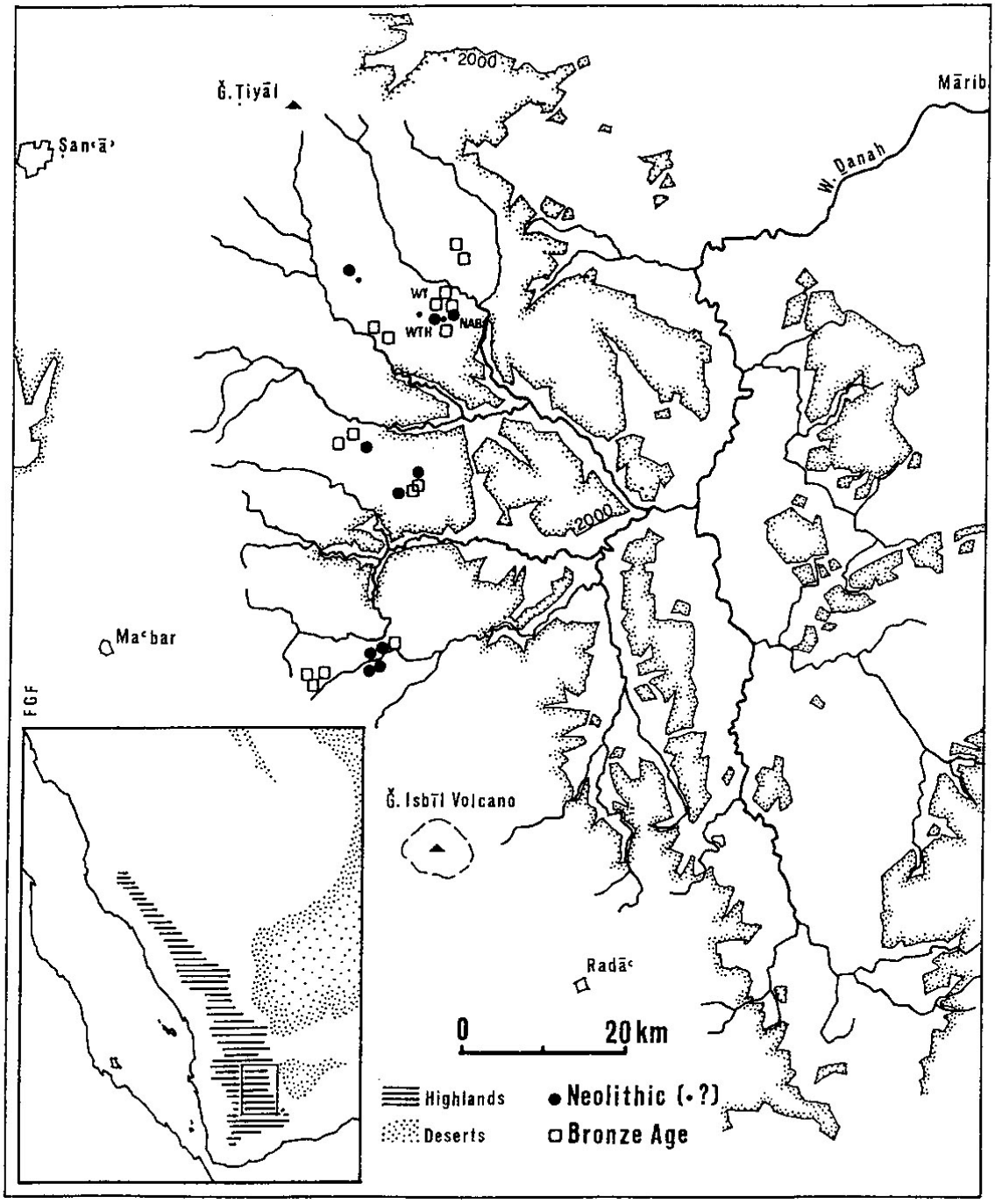


Fig. 1. Map of the central part of the eastern Highlands of North Yemen, emphasizing the Wadi Danah drainage and the 2000 metre contour line. The main prehistoric sites are plotted; NAB = An-Nagid al-Abyad, WTH = Wadi at-Tayyilah, WY = Wadi Yanaʿim. Inset map shows he Asir-Yemen Highlands in the southwestern part of the Arabian Peninsula (F.G. Fedele 1989).

belt of monsoonal rains, but the eastern part of the mountains is less strongly affected and here a sub-arid regime normally obtains. Some monsoonal influence can be perceived as far north and inland as the higher Asir (Whitney 1982). In the eastern Yemen Highlands, southern monsoon winds are responsible for a major rainfall season from July to September, during which 200-400 mm of orographic rain in the form of frequent thunderstorms can fall on the eastern Highlands. At the beginning of this season, wadis are usually turned by heavy outpours into raging torrents. However, completely dry years are known to occur as well (Blume 1976; Kopp 1981; Fein and Stephens 1987).

From this short description it should be clear that the landscape history of Yemen must owe a great deal to the interplay of rainfall, aridity, and tectonics. Investigations of this interplay and the superimposed activities of prehistoric man have begun, through a comparative study of man-environ-

ment relationships across the environmental spectrum of the region, from coast to plateau to desert, and obivously through time. The undertaking is far from completion, however, and several ecological compartments still await deeper inspection.

## 2 LAND AND CLIMATE

### 2.1 Depositional sequences in North Yemen

In this paper I intend to confine myself to the Holocene of our main study area in the eastern Highlands, at an altitude of 2000-2200 m above sea level. Information from other areas will be used where relevant. The study area lies about 50 km southeast of the North Yemen capital, San'a', and includes the upper and middle reaches of the Wadi Danah drainage. This is the wadi system which flows down to Marib, the famous ancient Sabaean capital on the desert margin.

The whole eastern Highlands region now has very low population densities, both of humans and animals. In contrast, the archaeological maps we have constructed for the Neolithic and Bronze Age, although incomplete (Fig. 1), point to higher population densities than today. Thus it is immediately apparent that the recent desertion contrasts with the situation during an earlier part of the Holocene, up to at least the 3rd millennium BC. (All dates in this paper are calendar dates, unless otherwise indicated.)

In an attempt at understanding the "double helix" of landscape variation and human action, an assessment will be made of the mutual effects of landscape and humans (see sections 3 and 4). Distinguishing between the differential roles of physiographic and climatic changes within the "landscape" factor will be more difficult. The landscape background and its changes will be considered first.

In the eastern Highlands a generalised sedimentary sequence is emerging, whose most complete occurrences have been studied in the An-Nagid al-Abyad and Wadi at-Tayyilah valleys, 60 km southeast of San'a' (Marcolongo and Palmieri 1986, 1988; Fedele in prep.). In this area as well as elsewhere in the Highlands, Holocene terraces on the lower slopes are mainly composed of re-deposited aeolian silt, intergrading lower down in the sequence with alluvial sediments. From bottom to top, the standard sequence is the following (Fig. 2), varying in thickness from 1 to 4 metres:

I. the lowermost of 4 distinct strata, which represent different depositional conditions, is a conglomerate indicating high-energy transport of a torrential type;

II. a complex of sandy-silty-clayey units follows, alluvial and then more colluvial in origin; there is lateral variation to evaporitic deposits near former springs (travertine or calcareous sinter); an alternating wet-dry regime seems to be indicated;

III. complex II is topped by a dark grey band, more or less truncated at the top, rich in organic matter and accumulated $CaCO_3$ (Fig. 3); this is a B-type horizon of a paleosol, which I called the Thayyilah paleosol, from Wadi at-Tayyilah (Fedele 1986, 1988; see below);

IV. finally, complex IV consists of aeolian silt and slope-wash lenses of sand and gravel, largely affected by aeolian deflation; today hammada surfaces are common, as well as exfoliation of desert varnish from rock faces.

The Thayyilah paleosol appears to represent a useful pedostratigraphic marker over a wide area (Fedele, unpublished survey data). It was dated on humic acids to 5750±500 BP (Rome, unpubl.; Marcolongo and Palmieri 1986). This date calibrates to about 5280-4000 BC according to the "Radiocarbon" 1986 curves (Pearson et al. 1986) and compares well with dates for organic-rich units of pedogenetic origin in similar sequences from Saudi Arabia (see section 2.2 below). Both information from central Arabia and our own observations point to the occurrence of a weak and variable, but widespread, pedogenetic event around the 6th millennium BC (cf. Roberts 1982). Our report of this event from the uplands of the Arabian Peninsula lends support to the contention

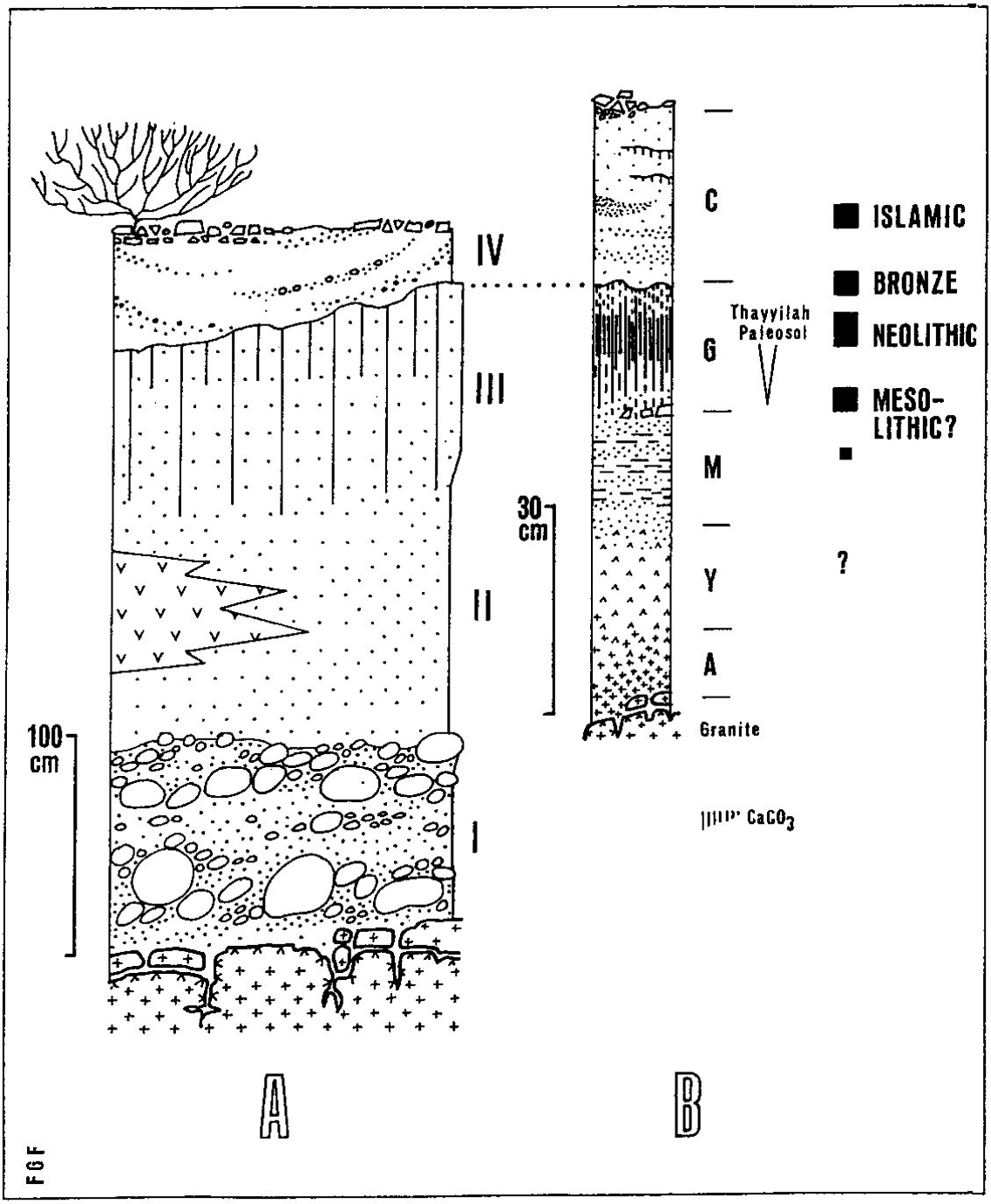


Fig. 2. Late Quaternary depositional sequences in the eastern Highlands of North Yemen, NAB-WTH area (cf. Fig. 1). A: Generalised lithostratigraphic profile (see 2.1) (Marcolongo and Palmieri 1988). B: Stratigraphy of site WTHiii on the Wadi at-Tayyilah, according to the 1984-1986 excavations; lithostratigraphic members and cultural horizons to the right profile (F.G. Fedele 1989).

that what we see here is a signal of a regional oscillation that is climatic in origin.

## 2.2 Regional comparisons

The eastern Highlands sequence is clearly comparable with situations reported from further north in the Arabian Peninsula (e.g. McClure 1978), and particularly with the sequence from western Saudi Arabia briefly described by Whitney (1982). In the high mountainous region of the Asir, tufa deposits were formed in the streambeds and near former springs about 8000-3800 BC (ca 7500-3000 radiocarbon years BC). Aeolian silt layers were then formed on the lower slopes, during an early to middle Holocene period when there was enough rainfall to support hillslope and floodplain vegetation and to serve as aeolian sediment traps. Final stream dissection began about 4300 BC (ca 3500 radiocarbon years BC) (Whitney

1982).

Between the 8th and 5th millennia BC, according to different lines of evidence (Garrard et al. 1981; Luz 1982; Roberts 1982; Rognon 1982), humid or "pluvial" conditions obtained in central and southern Arabia. In the core of the peninsula, south of a certain latitude (28° north, vide Roberts 1982), a long-term climatic trend towards aridity was interrupted by several oscillations of rainfall and perhaps temperature, and a rapid progression of rain increases resulted in a phase variously called Mid-Holocene Pluvial, Holocene Subpluvial, or Neolithic Wet Phase (cf. Brice 1978).

The problems connected with this period were discussed at length during a meeting held at Groningen in 1980, with contrasting results (Bintliff and van Zeist 1982:242-246), the early-middle Holocene southern "pluvial" was "undoubtedly a product of a climatic regime markedly different from that of the present day, in which the intertropical convergence zone (ITCZ) lay around 10° north of its modern position". The Asir-Yemen Highlands receive their moisture from southerly monsoon winds which, during the mid-Holocene "interstadial", may have been deflected more often into this area than today (Whitney 1982). The present arid climate became established about 3000-2500 BC.

It is important to note that the model of a mid-Holocene pluvial is essentially based on lacustrine episodes so far detected in low-lying desert settings. The details of stream discharge in the Arabian uplands are virtually unknown, and our own research in Yemen has yet to produce quantitative information. But, in purely climatic terms, one is tempted nevertheless to correlate the dark grey Thayyilah paleosol of the Yemem Highlands with the Holocene phase characterized by milder and moister conditions than today (Fedele 1988; de Maigret et al. 1988).

The latter part of this period may have been marked in Yemen by a series of oscillating moist and dry spells, coinciding perhaps with the time when the monsoon regime settled into its modern pattern. By the beginning of the 3rd millennium BC, whether or not the "Indus wet phase" (Brice 1978:351-356) was effective in the west, a new cycle of severe desiccation was developing in central and southern Arabia as well as elsewhere in the tropical belt (cf. Ritchie et al. 1985). As the data from upland Yemen seem to accord well with the general environmental sequence emerging for parts of tropical Arabia, I feel inclined to favour a certain climatic control for the most general Holocene changes, as discussed above with reference to the widely held ideas on the climatic change in the Arabian region. But in North Yemen it is equally clear that importance cannot be accorded to climate change alone.

At least in our main study area, some geomorphological facts were superimposed upon climatic effects. Somewhere between strata III and IV of the generalised succession of Fig. 2, one may place a sharp renewal of riverbed erosion (Fig. 5). As it coincides with conditions of increasing aridity, downcutting at this point is most likely explained by relief rejuvenation due to tectonic causes. The results of regional geomorphological mapping (Marcolongo and Palmieri 1988; and unpublished data) support this contention.

Pronounced stream erosion following the formation of the Thayyilah paleosol seems to characterize the whole Wadi Danah basin, which represents a large sector of the eastern Highlands and the one where high population density prior to the 2nd millennium BC is best documented. A change in the basin geometry because of differential tectonic uplift is apparent throughout our study area, and geologically speaking it looks like a recent event or series of events. A sill (i.e. a parallel magmatic intrusion) connected with the latest block faulting is currently being dated by the K-Ar method.

## 3 CULTURAL EVIDENCE: THE NEOLITHIC

A separate line of evidence is provided by the cultural record. One of the main results of the Italian Mission's work between 1983-1987 has been the building up

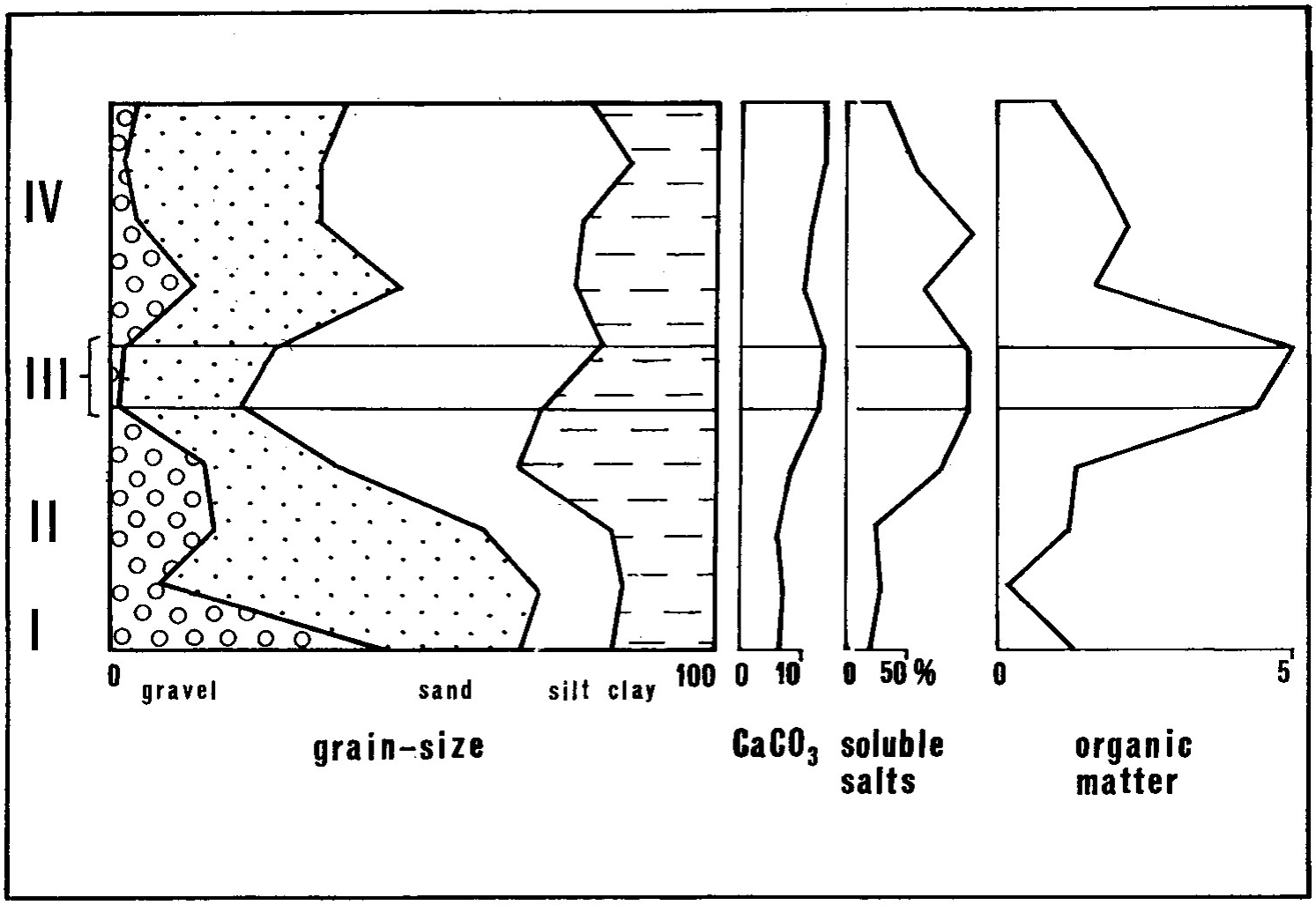


Fig. 3. Sediment analysis of an exposure on the lower Wadi at-Tayyilah; cf. Fig. 2 A (adapted from Marcolongo and Palmieri 1988).

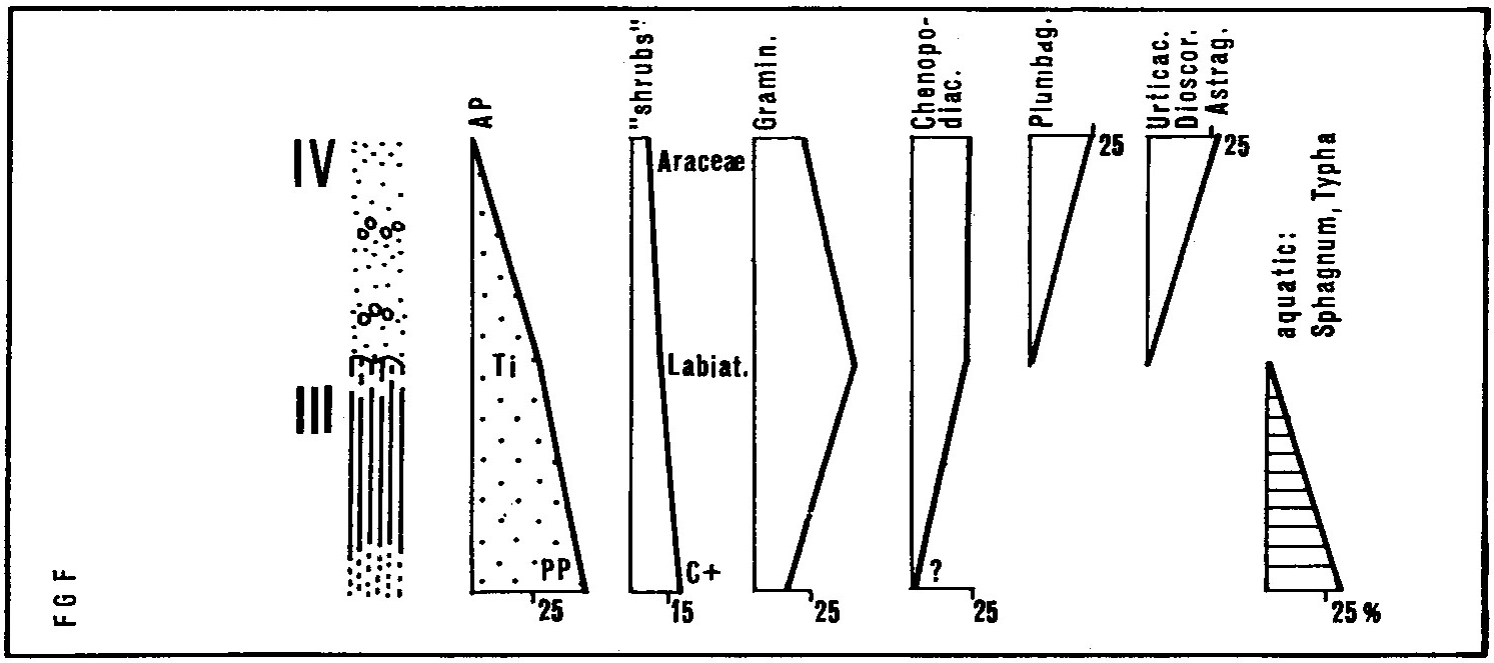


Fig. 4. Preliminary pollen analysis of samples from the lower Wadi at-Tayyilah sequence. AP = arboreal plants; C+ = Calluna, Epilobium, Lycopsis and Najadaceae; PP = Pinus silvestris and Pseudotsuga; T = Tiliaceae (redrawn by author from data in Lentini 1988).

of the first prehistoric sequence for North Yemen. Without going into unnecessary archaeological detail, we can simply speak of a "neolithic" phase, bracketed between a later or Bronze Age, which is comparatively well known, and an earlier phase, which at the moment I would suggest considering "mesolithic".

These stadial labels are obviously tentative. Unsatisfactory as they are south of the Fertile Crescent, they are still practical insofar as they convey a basic idea of the stratigraphic position and cultural contents of the units involved. In view of some archaeological similarities with eastern Africa, the neolithic and "mesolithic" phases may better be grouped under a designation such as the Late Stone Age of Yemen, in accordance with the African terminology (e.g. Phillipson 1977:22-23).

The Neolithic is the centrepiece of the Holocene prehistory of the Highlands. A dozen or so sites attributable to this phase are known (Fedele in prep.). In 1984-1986 we managed to test one of them extensively through open-area excavation, strict spatial and stratigraphic control, and total recovery by 4-mm screening. This appears to have remained the only such experiment in southwestern Arabia (Fedele 1986; and in prep.).

The cultural data point to the existence of village-living,cattle-breeding communities, with no apparent knowledge of pottery or bone tools. They have been tentatively described as representing an upland-adapted tradition specific to southwestern Arabia (Fedele 1988). A sizeable sample of animal bone has been collected by use of on-site consolidation, in spite of the heavy damage caused by sun-cracking, wind abrasion and salinization. This faunal sample is the only direct source of information on the Neolithic economy.

The agricultural capacity is not known, but the integration of these groups into a tropical high-altitude ecosystem appears to have been efficient. Stone artefacts show both small and large, heavy-duty equipment, while some rabot-like scrapers and other stout tool types probably indicate the habitual processing of wood. Useful information about the spatial organisation of one settlement is also available. In addition to substantial elliptical huts built with large stone blocks, smaller and often flimsy structures made from organic materials have been brought to light, suggesting rather complex villages (Fedele 1986; de Maigret et al. 1988).

In the area where most work has been done, the Hawlan et-Tiyal, these settlements are correlated with the Thayyilah paleosol, or more exactly the period of geomorphic stability with which it is broadly associated. According to topography, soil and sediment evidence, and a preliminary palynological test, we have taken our data to indicate the presence of some vegetation cover, as well as high watertable conditions in many valleys (Marcolongo and Palmieri 1986, 1988).

The palynological test (Lentini 1988; see Fig. 4) is obviously preliminary and by itself inconclusive. Conifer pollen can travel very long distances in tropical wind systems (Beug pers. comm.; cf. Hooghiemstra 1988), but some at least of the pollen in the relevant samples (e.g. Typha, Sphagnum) provide sufficient indication that the Thayyilah paleosol supported greater vegetation cover than today, including some humidity-loving species. The relative abundance of humic colloids in the paleosol supports this reconstruction. Confirmatory evidence can also be found in cattle husbandry, as the development of cattle pastoralism requires suitably watered pastures, ideally within walking distance of the settlements.

Our available data would thus suggest that selected parts of the pediment slopes and wadi terraces were mantled with grass and scrub vegetation, possibly interspersed with tree stands. To what extent this picture can be generalised throughout the Yemen Highlands is unknown.

There have been dating problems, including confusion over charcoal samples sent to a radiocarbon laboratory, but through the paleosol correlation, I would date the florescene of these neolithic groups to the 6th-4th millennia BC.

## 4 CULTURAL EVIDENCE: BEFORE AND AFTER THE NEOLITHIC

The most extensively tested site, though shallow (80 cm on the average), has turned out to be stratified. The findings from the deeper levels of this site, WTHiii on Wadi at-Tayyilah, include pits, charcoal patches, and a tiny faunal sample of Bos material (de Maigret et al. 1988). A measurable radius falls in the overlap zone of wild and domestic cattle (Fedele 1988; C. Grigson pers. comm.). If importance can be attached to a single outstanding find - a figurine of unbaked clay (Fedele 1986; de Maigret et al. 1988) - this phase is apparently correlated with Pre-Pottery Neolithic B (PPNB) adaptions in the Levant.

According to this hypothesis a date in the 7th or 8th millennium BC is suggested. From a general standpoint our data, though very scanty, may point to local antecedents of the neolithic groups already illustrated. Tentatively speaking, the concept of a mesolithic or incipient neolithic phase for Yemen is perhaps permissible.

This is all we know at the moment of the early and middle Holocene part of the North Yemen sequence. When we come to post-neolithic times, the picture for a certain area of the Yemen Highlands becomes clearer. In the eastern Highlands the neolithic herders were superseded by - or evolved into - Bronze Age farmers, radiocarbon-dated to the 3rd and early 2nd millennium BC (de Maigret 1988a; radiocarbon dates, see Fedele in press b). Village life has been reconstructed, so far, from three excavated sites in the Hawlan at-Tiyal district and a number of ruins in the Wadi Danah basin (de Maigret et al. in press).

These Bronze Age farmers lived essentially off caprines and sorghum. They made pottery, apparently related to the advanced Early Bronze tradition of Palestine and Syria. Grain impressions in pottery indicate the cultivation of wheat, barley and millet (Costantini 1984). An equid bone, possibly from a donkey, was pieced together from fragments found at Wadi Yana'im, site 1 (WYi). Animals associated with Bronze Age settlements mainly include sheep or indeterminate caprines (about 90-95 percent of finds), followed by cattle, pig, gazelle, wild or domestic cat, and the above mentioned equid (Fedele in press a).

This information suggests a caprine-based, mixed-farming economy, likely to be the cause of increasing stress to the immediate environment. The diminutive size of sheep and perhaps cattle may well reflect some climatic and/or nutritional stress. As microstratigraphy and sedimento-climatic correlations at site WTHiii suggest a slight increase of slope erosion prior to the onset of full aridity, the possibility of excessive human pressure, on an increasingly fragile landscape tending towards desiccation, cannot be ruled out.

At about the same time, somewhere between the 4th and first millennium BC, a site in the Ramlat Sab'atayn Desert of Yemen, indicates the presence of hunting groups exploiting wild equids (onagers?) and gazelles. This site, HARii near Wadi Harib, is the only one so far discovered in the desert (Di Mario 1986; Di Mario et al. in press).

The pastoralists of the uplands may thus be contrasted with persistent hunting groups in the desert periphery. Different economic strategies may have been used side by side in the various ecological zones of Yemen, as is supported by a recent survey of the Tihamah coastal areas (Tosi 1986). Whether such economies represented complementary segments of the same sociocultural group, or else independent cultural entities ("cultures") of their own, is impossible to tell. But as a hypothesis, the possibility can be borne in mind of the development of specialised, complementary social units within an overall cultural and demographic continuum, encompassing the Bronze Age and perhaps the Neolithic.

## 5 HUMAN AND ENVIRONMENTAL ROLES

This admittedly coarse-grained story of man-environment interactions in North Yemen (Fig. 5) is expected to improve as more and better information becomes available. But I believe we have a good

| | | LAND | CLIMATE & BIOME | MAN |
|---|---|---|---|---|
| TODAY | | Hammada surface<br>Slope wash, deep watertable | Monsoonal, subarid/arid with flash floods | Widespread desertion<br>Sabaean kingdom |
| 1500 BC | IV | Stream dissection<br>Tectonic crisis, uplifting | Increasing aridity<br>Calcification | Bronze Age: caprine-and-sorghum farming |
| 3000 | | Lowered watertable<br>Tectonic instability | Monsoon fluctuations | ? Neolithic |
| 3500 | III | Thayyilah Paleosol: pedogenesis, c.5300-4000 BC<br>Stabilised slopes and terraces, some vegetation, shallow watertable | Holocene Subpluvial: maximum Holocene rainfall | Neolithic: cattle pastoralism (hunting in desert?) |
| 6000 | | Stream stability & slight aggradation | | "Mesolithic" |
| 8000 | II | Aeolian silt<br>Tufa deposits | Alternating moist-dry | ? "Mesolithic" |
| > 9000 | I | Torrential deposits | ? | ? |

Fig. 5. North Yemen, eastern Highlands: an interim synopsis of man, land, and climate interrelationships during the Holocene. I-IV: main lithostratigraphic members as in Fig. 2 A dates to the left are approximate, in calendar years BC (F.G. Fedele 1989).

case of tectonic control over the final collapse of agricultural fertility. In certain areas of the Hawlan at-Tiyal, late Holocene fault-controlled block movements have been responsible for a lowering of the watertable, adding to the impoverishment of soils which had been already affected by climatic desiccation. The process must have reached its terminal stage around 2000 BC.

Tectonic changes and their attendant effects on hydrology should be regarded as a major factor of biome depletion and settlement and economic shift. At a slightly later time it must have contributed decisively to the abandonment of a number of areas in the eastern Highlands. Even small-scale structural changes in the land were enough to alter the delicate balance on which the conditions favourable to farming depended. The long-term climatic trends towards aridity, far less severe in the mountains than in the low-lying parts of the Arabian Peninsula, and overforaging by domestic livestock, may not have led alone to the eventual desertion of the region.

A few centuries later, sometime in the later part of the 2nd millennium BC, a new way of life was firmly established in the lowlands alongside the desert sand-sea. This was the cultural pattern based on large dams built to capture the seasonal flood from the mountains, and connected by caravans to long-distance trade systems, a way of life concomitant with the rise of state societies around 1000 BC.

Thus in upland and interior Yemen, climate may have shaped the potential for a certain type of landscape, but within these imposed

limits the actual configuration of the ecosystem, its opportunities and lack of them, were dictated by other factors - tectonics and man. Man's role is rather hard to assess, however, and one cannot be quite sure where to pick out evidence of human mismanagement in the North Yemen sequence.

If as a heuristic hypothesis we suppose that climatic and tectonic causes of environmental deterioration were escalated by human interference, I would predict that even a limited stress placed on the local biome by browsing and mixed-feeding animals may have reached a critical peak during the 3rd or early 2nd millennium BC. At the time when the Bronze Age techno-economic system was already probably coping with spreading desiccation, renewed tectonic activity resulted in the termination of the shallow groundwater conditions. Wadi erosion and the removal of thin fertile soils could only add to the uncertainties of living in the mountains. Although the exact chronology of these facts has to be determined, the overall sequence seems to be valid.

Man's role must have been overshadowed by the role of tectonics, the geomorphological changes connected with the perennial instability of the land itself. The ultimate control of human behaviour at the population level must probably be attributed to the land (Fedele in press c). This may sound a rather negative conclusion insofar as the impact of ancient man on the landscape seems to have been no more than a contributing factor in the overwhelming environmental drama. While aware of this, I generally prefer to take a nuanced view of man's impact on the environment, with a number of grades and modes between man being full actor or full victim, across a continuum of ecological possibilities.

## 6 ACKNOWLEDGEMENTS

Special thanks are due to A. de Maigret and the other colleagues in the Italian Archaeological Mission, in particular B. Marcolongo, A.M. Palmieri and M. Tosi. H.-J. Beug, C. Grigson and H.J. Bruins have provided literature or comments, though the use here made of this information is my responsibility alone. Jill Morris has kindly revised my English text and typed most of the manuscript.

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