74-29,776

SIMMS, Alfred E., 1934-
LOCATIONAL DETERMINANTS OF EARLY
POST-PLEISTOCENE SETTLEMENTS IN
THE NEAR EAST.

The City University of New York, Ph.D., 1974
Anthropology

Xerox University Microfilms, Ann Arbor, Michigan 48106

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SETTLEMENTS IN THE NEAR EAST

by

ALFRED E. SIMMS

A dissertation submitted to the Graduate Faculty in Anthropology in partial fulfilment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1974

This manuscript has been read and accepted for the Graduate Faculty in Anthropology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

July 18, 1974
date

John D. Speth
Chairman of Examining Committee

August 24, 1974
date

Melvin Ember
Executive Officer

Richard Blanton

Gregory Johnson

H. Martin Wobst

Supervisory Committee

The City University of New York

Abstract

LOCATIONAL DETERMINANTS OF EARLY POST-PLEISTOCENE

SETTLEMENTS IN THE NEAR EAST

by

Alfred E. Simms

Adviser: Professor John D. Speth

A hypothesis regarding a possibly greater diversity in factors promoting a prolonged wild cereal maturation period in pre-agricultural site vicinities than in early agricultural site vicinities is tested in this paper. A comparative environmental analysis of the cereal-collecting potential of selected pre-agricultural and early agricultural site vicinities throughout the Near East is made. The environmental criteria employed are based on the phenological characteristics of wild wheats and barley; that is, the relationship exhibited between climate and the maturation of wild cereals. A review of the current state of knowledge regarding the paleo-environment of the Near East indicates that early post-Pleistocene climate did not differ markedly from that of the present, thus justifying and environmental moder which employs the maturational characteristics of wild cereals under modern climatic conditions.

The length of wild cereal maturation periods in a given locale are governed by the number and differential quality of the wild cereal micro-environments available; such micro-environments correspond largely to distinct physical features. The unit of investigation of this study

is a topographical analysis of nine pre-agricultural and early agricultural site vicinities for the purpose of estimating and comparing relative durations of potential wild cereal maturation periods. Nine pre-agricultural and early agricultural site vicinities were analyzed and ranked according to the amount of potential harvest time available within each respective site vicinity. The pre-agricultural sites ranked highest as a group, with four of the first five pre-agricultural sites vicinities tested among the first five positions.

The support given the above hypothesis by this study is qualified by the small number of sites tested. Further confirmation waits upon the availability of additional site reports of early Holocene settlements.

INTRODUCTION

It has been proposed that many pre-agricultural settlements in the Near East relied heavily on wild cereal-collecting (Flannery 1969: 80; Perrot 1966: 480-483). The occurrence of sickle blades, mortars and storage pits in many early Holocene sites lends support to this position. Pre-agricultural settlements then should be partially constrained by variables affecting wild cereal-collecting.

Given the seed-dispersal mechanism of wild grasses (page 14), a potential harvest period within a single wild cereal micro-environment is brief, and wild cereal-collecting must be done rapidly. Among the means of effectively utilizing local stands of wild grasses would be the employment of large task force collecting intensively over a relatively homogeneous area in which wild cereals mature nearly simultaneously, or the employment of a large task force (or smaller task force) collecting over varied locales in which wild cereals mature progressively over a prolonged period. On the assumption that the mustering of large task forces of collectors would require at least a seasonal mobility among individual pre-agricultural communities (Steward 1968: 322), the long term relatively sedentary nature of early Holocene communities in the Near East (Flannery 1972: 23) makes the employment of smaller community-based task forces the more likely subsistence practice. As an important locational determinant, it could be then expected that pre-agricultural site locales would show greater diversity in factors promoting a prolonged wild cereal maturation period than early agricultural site locales.

A comparative environmental analysis of the cereal-collecting potential of selected pre-agricultural and early agricultural site vicinities throughout the Near East is made in this paper. The environmental criteria used in this analysis are based on the phenological characteristics of wild wheats and barley; that is, the relationship exhibited between climate and the maturation of wild cereals. Most of the phenological data utilized were obtained from field work I conducted in northern Galilee during April and May of 1973. As described in chapter three, the length of maduration periods (and potential harvest time) of wild wheats and barley in a given locale is directly related to the number and differential quality of the wild cereal micro-environments available. While such micro-environments vary widely in size and potential yield, maturation factors impose collection periods of similar brief duration on all of them (page 14). Wild cereal micro-environments are determined by areal variations in soil depth, soil moisture, rainfall, temperature, drainage and relative exposure to sunlight. Much of this variation is caused by differences in angle of slope and directional orientation; thus the resulting wild cereal micro-environments correspond largely to distinct physical features. Locales in zones of wild cereals consequently present a mosaic of cereal-collecting potentialities, and should not be regarded as homogeneous environmental zones.

The unit of investigaiton of this study is a topographical analysis of each site vicinity for the purpose of estimating and comparing relative durations of potential wild cereal maturation periods. Each site vicinity is analyzed within a ten kilometer radius (the reasons for the selection of this geographical limit are given on page 24). The term "site vicinity" is employed with reference to this spatial boundary. A major working assumption is:

> The presence of mortars, sickle blades, storage pits and bins in many early Holocene sites constitutes reasonable evidence that such settlements functioned as both collecting and processing center for wild and/or cultivated cereals.

This paper is organized into four major sections. Chapter One considers the present state of paleo-climatic evidence, chapter two examines environmental factors in wild cereal collection, and Chapter three contains a description of the analytical model employed, together with mine site vicinity analyses, topographic maps, archaelogical evidence and paleo-botanical data. Conclusions form the fourth and final section.

PALEO-ENVIRONMENTAL EVIDENCE

The quaternary paleo-climate of the Near East is still poorly understood (Farrand 1971: 529), and the available evidence is often contradictory. The two major geographical areas of investigation are the Levant (Neev and Emery 1967; Picard 1963, 1965; Rossignol 1961, 1962, 1963; Tchernov 1968) and the Taurus-Zagros range (van Zeist 1967; Wright 1968). These regions contain the natural habitat zone of the potential domesticates including the "distributional center" of wild emmer (the upper Jordan Basin) and wild einkorn in southeastern Turkey and northern Iraq (Harlan and Zohary 1966; Zchary 1969: 48-49).

The Levant

Rossignol (1961, 1962, 1963) has conducted Pleistocene pollen analyses from borings along the coastal plain of Israel in the vicinities of Ashdod and Haifa. The Haifa borings include palynological material of post-Tyrrehenian (Wurm) date, represented at Ashdod only by sterile sands. The climatic reconstruction formulated by Rossignol at Ashdod (1961, 1962) consists of alternating moits periods represented by an autonomous grass-sedge association (Graminae-Cyperaceae) coincident with the presence of allochtonous spores from Egypt indicative of periods of greater run-off from the upper Nile Valley. The relative drier periods were represented by a goose-shrub association (Chenopodiacea-Ephedra), also native to Israel. Pollen analysis further north at Ashdod revealed a similar fluctuation of pollen types, but the Chenopod association was much less abundant and spores from Egypt nearly absent due to greater distance form the Nile. With regard to the Haifa borings, Rossignol (1963: 213) concluded:

> In the region of Haifa, the recent evolution of climate is indicated by that of the vegetation: the climate is mediterranean, and its fluctuations are of minor amplitude: first slightly more humid, then drier, finally more humid again at the end of the period considered.
> (translated from french)

A companion study of sediment deposits from the Haifa borings supports Rossignol's analysis. Slatkine and Rohrlich (1963: 159) state:

> The relative fineness and the uniformity of the clavey-silty sediments seem to confirm the hypothesis of a relative stability of the region during the Pleistocene. The sedimentary data, confirmed by pollen analyses, indicate that the climate has not undergone marked variations during the Pleistocene age and that it differed little from today.

Further evidence of Mediterranean climatic conditions during the Pleistocene is found in the presence of eluvial deposits of _terra rossa_ soil in continental Kurkar - consolidated sand dunes of Quaternary date found along the coast of Israel (Picard, 1963: 95). _Terra rossa_ soils are considered a typical products of Mediterranean climatic conditions (Butzer 1964: 90, 207), and form the major soil type within the Mediterranean zone in Israel today (M. Zohary 1962: 10; map 1). Picard (1963: 99) reports:

> Sandwiched between the Kurkar, the red loamy sands were already defined as eluvial soil. They should be regarded as products of weathering under the influence of Mediterranean climate, as a kind of terra-rossa-loam intermixed with sand...

These intercalations of eluvial soils have also yielded artifacts of "Upper to Middle Mousterian", "Prenatufian" and "Neolitic" to "Early-Bronze" date (Picard 1963: 97).

In a study of upper Pleistocene rodent fauna recovered from archaeological cave sites, Tchernov (1968) obtained vastly different results. The faunal materials utilized were from the sites of Oumm-Qatafa (Neuville 1951), Kebara (Turville-Petre 1932, Garrod 1954), Wadi Fallah (Nahal Oren) (Stekelis and Yisraeli 1963), and Abu-Usba (Stekelis and Haas 1952). Oumm-Qatafa is located in the Judean Desert, about twenty kilometers from the present shore of the Dead Sea, while the other sites are located in the Carmel range. The time period covered by the four sites apparently spans a period from the last interglaciation to the early Holocene with a cultural sequence ranging from Acheulian at Oumm-Qatafa, "Upper Palaeolithic", Aurignacian, Kebaran and Natufian at Kebara, Natufian and Neolithic at Fallah, and Neolithic at Abu-Usba (Tchernov 1968: 9).

Tchernov's study is based upon a diachronic analysis of the presence and relative proportions of various rodent fauna reflective of different biotopes (i.e. "Mediterranean wood and maqui dweller", "Mediterranean steppe and garigue dwellers", "rock dwellers" and "Swampy steppe dwellers", Tchernov 1968: diagram 6b). The results of his analysis "show no correlation with global climatic fluctuations, but rather a clear trend which points to a desiccation process proceeding from south to north" (Tchernov 1968: 133). He further states:

> While the forest was enlarged at the expense of swampy areas, the bare-rock biotope became enlarged (especially at the end of the Upper Pleistocene) at the expense of the desiccated Mediterranean garigues, which in turn widen along the Upper Pleistocene at the expense of the wooded areas; the direction of change is swampy steppe - forest - garigue - bare rocks. A bare-rock region in a semi-arid climate is the only biotope found today in the surrounding of Oumm-Qatafa cave. In the Carmel area the desiccation was more gradual so that there is a similarity between the division in the Carmel during the Upper Palaeolithic and the biotoped suggested for Oumm-

> Qatafa region in the Upper Palaeolithic; or between the Carmel region in the Upper Palaeolithic-Natufian and present-day or historical Syria; or between the Carmel in the Natufian-Neolithic and the northern Galilee region of today.

A central question in Tchernov's interpretation is how accurately changes in faunal composition reflect general 'climatic' change, rather than other environmental variables such as tectonic or eustatic activity. Farrand (1971: 577 and see below) notes the evidence for the tectonic subsidence of the rift valley of the Jordan and the lowering of the Lisan Lake more than 200 meters to the minimum level of the Dead Sea during the late Quaternary, a factor of great importance in accounting for the presence of a large proportion of swampy steppe-dwelling rodent fauna at Oumm-Qatafa during the last interglacial or interpluvial and their subsequent disappearance.

An additional problem concerns how well the fauna found within a cave site is representative of the surrounding environment for a given period. The deposition of rodent fauna in the caves of Israel is accomplished through the activity of predatory birds, particularly the owl (*Tyto Alba*), and the resulting faunal assemblages could be expected to reflect the dietary preferences of such predators. The influence of dietary preference has been used to criticize paleo-climatic interpretations based on the frequency of *Gazella* and *Dama* at Carmel cave sites (Rust 1950; Hass 1952a, b; Hooijer 1961).

A further problem is apparent in that at no one site is there an unbroken suggestion of faunal assemblages for the entire time period concerned. Tchernov (1968: 8) therefore extrapolates data from other studies (Bate 1937a, b), and transposes faunal successions from one site to another. In the biotopic sequence outlined for Oumm-Qatafa (Tchernov

1968: diagram 6B), for example, only the initial "Acheulian" phase is based upon rodent fauna actually recovered at the site, while at Kebara, Tchernov (1968: 9) was forced to use faunal materials collected from Turville-Petre's dump, which Tchernov treated "as a uniform complex."

Further information regarding late Quaternary paleo-climate has been obtained from geological and paleo-botanical studies in the Jordan Valley. Of significance is the relationship between climatic change and changes in former levels of the Dead Sea. The concept of a pluvial lake associated with former levels of the Dead Sea originated with Lartet (1865). More recent studies include those of Picard (1965) and Neev and Emery (1967). The evidence outlined below is drawn from the study of Neev and Emery and from a review by Farrand (1971).

The Dead Sea Rift Valley is a structural trough whose main period of development (graben tectonics) occurred during the Quaternary. Formerly connected with the open sea, the pluvial lake occupying the Dead Sea Rift Valley had been reduced and land-locked by tectonic activity about 70,000 to 100,000 years ago. The succeeding "Lisan Lake" stage was marked by deposits of gypsiferous and calcarious lacustrine marls (Lisan), and lasted until approximately 20,000 years ago, when combined tectonic-climatic activity further reduced the lake level some 190 meters. At this time the Dead Sea and Lake tiberias came into existence. Based on the former volume of the Lisan Lake, which extended from the southern shore of the present Dead Sea and probably incorporated all of the Lake Tiberias Basin, Farrand (1971: 544) believes that tectonic activity alone is insufficient to account for the diminution in the Lisan Lake level, and that "climatic desiccation must also be invoked". Neev and Emery (1967: 24) similarly attribute the reduction of the Lisan Lake to increased aridity as well as to tectonic activity.

The dating of the Lisan Lake stage was based on an estimation of the thickness of the average annual lamina or deposit of marls, together with a series of radiocarbon samples. Paleo-climatic fluctuations were reconstructed from radiocarbon dates obtained from organic materials found within alternating layers of rock salt and detrital sediment. These alternating deposits are indicative of variations in run-off/evaporation ratios, and therefore of changes in relative humidity. According to Neev and Emery (1967: 28-30, figs: 16-17), a period of arid climatic conditions coincided with the end of the Lisan Lake stage. This period of greater aridity was followed by a humid episode at the approximate junction of the terminal Pleistocene-early Holocene, with one associated radiocarbon date of 9850 $\pm$ 150 years B.P. (Neev and Emery 1967: 28, fig: 16). Farrand (1971: 559) cites supporting geological and paleo-botanical studies in the Hula Basin (Horowits 1968, 1969) and El Jafr Basin, southeast of the Dead Sea (Huckreide and Weisman 1968), where climatic sequences were apparently in phase with events in the Dead Sea region. With regard to climatic conditions during the terminal Pleistocene, Rossignol's pollen core analysis at Haifa, and the Jordan Rift Valley studies cited above agree that this period was one of the increased humidity.

The Taurus-Zagros Range

Information concerning the paleo-climate of this region rest largely on the studies of paleo-botanical data and glacial fluctuations by van Zeist and Wright (1963). Pollen profiles were obtained from sediment core samples from a number of lakes and springs in the Zagros range of western Iran, particularly Lake Zeribar. The ecological and floristic interpretation of this material was aided by surface pollen samples from the Iranian and Anatolian Plateaus, and from pollen transects extending from the Anatolian Plateau across the Zagros to the Mesopotamian Steppe (Wright, McAndrews and van Zeist 1967: 416). The relationship between modern pollen rain samples and vegetational zones was analyzed and compared with pollen core samples. Any similarities noted from the basis for reconstructing past vegetation and, by extension, former climatic conditions.

Four major vegetation zones in the Zagros region have been recognized. These zones are: The steppe of the Mesopotamian piedmont at altitudes up to 700 meters; a savanna "steppe forest" of the Zagros foothills and mountains of the interior plateau with altitudes ranging from 200 to 1500 meters; oak woodlands of the Zagros Mountains at elevations from 800 to 2000 meters and steppe at still higher altitudes on the interior plateaus of Iran and Anatolia at elevations up to 1400 meters (Wright, McAndrews and van Zeist 1967: 422-437).

The pollen diagram (van Zeist, 1969) obtained from Lake Zeribar indicates a vegetational sequence with initial (Zone A-1) high values for Chenopodiaceae and Artemisia (sage), together with an absence of tree pollen. The pollen zone radiocarbon dated at between 22,500 and 14,000 B.P. resembles that of the plateau steppe of northwestern Iran, suggesting a climate cooler and drier that it is today. Lake Zeribar, located at 1300 meter elevation, is presently located in a zone of Zagros oak forest. Sediment cores from the Kermanshah valley (Lalablad Springs and Lake Milogar), both at about 1300 meter elevation, give similar pollen assemblages for the same time period. During this period, van Zeist (1969: 40) concludes that "forest and steppe forest were absent from the greater part of the Zagros". Similar results were also obtained from Lake Mirabad at 800 meter elevation suggesting that the piedmont as well as the mountain ranges were also treeless at this time (Wright 1968: 336).

The succeeding pollen zone at Zeribar (A-2) dated at c. 14,000 - 11,000 B.P. showed a decrease in the percentage of Artemesia pollen and the presence of oak and pistachio as a minor element in the pollen profile. Zone B (11,000 - 6,000 B.P.) exhibits a gradual increase in tree-pollen percentages, and an oak-pistachio steppe forest is postulated for that period (van Zeist 1969: 40). After about 6,000 B.P., the steppe-forest vegetation changed into oak forest, the present natural vegetation of this part of the Zagros. A similar transition to oak forest was observed in the pollen diagram from Lake Mirabad.

Van Zeist (1969: 44-45) makes the following evaluation of late Pleistocene-early Holocene climatic conditions in the Near East: the colder and drier period preceeding 14,000 B.P. was one in which forests and steppe forests could only have survived in "refuge areas" at relatively low elevation and with high precipitation, such as the Levant, western Syria and southwestern Turkey. During the early Holocene (10,000 - 8,000 B.P.), the climate of the Near East still had a drier character than it has today, but since early agricultural sites such as Beidha, Ali Kosh and Ramad are presently located on the lower rainfall limits of dry-farming, the amounts of annual precipitation could not have been less than they are at present. Van Zeist believed that this apparent contradiction can be explained by the occurrence of drier summers as result of higher temperatures or longer rainless periods, rather than smaller absolute amounts of rainfall. The growth cycle of cereals, legumes and other annuals would not have been affected, since they are dependant on precipitation received from the autumm through the spring. Van Zeist, therefore, posits that at about 10,000 B.P. the distribution of wild cereals in the Near East was similar to that of the present.

H. E. Wright (1968: 325) notes the presence of moraines and cirques in the Zagros mountains during the Pleistocene at levels low enough to indicate a snowline "1200 to 1800 meters lower than today", with a "much colder climate". The lack of organic material for radiocarbon dating in glacial deposits, however, required Wright to concentrate on paleo-limnological evidence for his analysis of late Quaternary climate in the Near East. This analysis is largely based on palynological evidence from Lake Zeribar, as in van Zeist's, but Wright's interpretation differs significantly.

Noting the resemblance between pollen zone A-1 from Lake Zeribar and the steppe vegetation of the Anatolian and north-west Plateaus, Wright (1968: 338) postulates that wild einkorn, with its major distribution in the interior plateaus and mountains up to 2000 meters in elevation, might have grown abundantly throughout the Zagros mountains and piedmont prior to 14,000 B.P. while emmer and barley were confined to Pleistocene refuge areas. Wright (1968: 335) correlates the appearance of an oak-pistachio savanna (and consequently wild emmer and barley as components of this vegetation zone) in zone B some 11,000 years ago with the advent of "incipient food production" at such sites as Zawi Chemi Shanidar and Karim Shadir. Climatic change, according to Wright, therefore, had a direct bearing on the transition to food production.

Summary and Conclusions

With regard to the Levant, present paleo-environmental evidence indicates that "climate change was not very marked during late Quaternary time (Farrand 1971: 57). Alternations in pollen sequences during the late Pleistocene are based primarily on shifts in relative amounts of rainfall received by a basically Mediterranean climate. M. Zohary (1962: 65) accordingly states:

> the plantgeographical territories (i.e. of Palestine) may have shifted to the west and north at one period and at the east and south at another, but no substantial changes in the basic makeup of the flora and vegetation occurred.

Paleo-environmental changes in the Taurus-Zagros region were apparently more drastic, involving the total or near-total absence of Mediterranean-type flora during much of the Pleistocene. Rather than oscillations in precipitation and flora as in the Levant, late Quaternary climatic sequences in the Zagros consisted of unidirectional succession of vegetation formations.

The paleo-environmental evidence presented above indicates that by the early Holocene, climatic conditions in the Near East were similar to present-day conditions. My employment of a model of pre-agricultural settlement location based upon the phenological characteristics of wild cereals under modern climatic conditions is therefore justified.

FACTORS IN THE GROWTH OF WILD CEREALS

Climatic Factors

Wild wheats and barley are native to the Mediterranean-type climate of the Near East, which is characterized by a distinct bi-seasonal division into mild, rainy winters and hot, dry summers (M. Zohary 1962: 20). These annual grasses are important constituents of the "sub-mediterranean" oak park-forest vegetation belt extending from Palestine to Iran, and which receives from 400-1000 mm. of rainfall over the winter months (Zohary 1969: 55).

Germination of the wild cereals follows the first autumm rains, and along with many other annuals, they begin to mature in the spring at the end of the rainy season. Year-to-year variations in temperature have a pronounced effect on the maturation period of annuals, and in years with mild winters "the flowering period is apt to occur a month or more earlier" (M. Zohary 1962: 26). Temperature variation as a function of altitude is also significant, with the maturation period of a given plant species progressing continuously over a month or more from sea level elevations to mountainous zones (M. Zohary 1962, see also pages 28-30 and table 1).

A primary phenological distinction between wild and cultivated wheat and barley is the immediate disarticulation of wild cereal spikelets upon maturation. Zohary (1969: 57) states:

> Under the dry hot weather that characterizes the end of the growing season, this process (i.e. disarticulation)

> is very abrupt. In a given site and for a given wild cereal, plants mature quickly and simultaneously. Thus, wild cereal fields showing masses of maturing ears shed their fruits and turn into barren dry stands within one or two weeks! There is only a very limited time interval in which the grain of wild cereals can be effectively collected. If an extremely dry warm spell ("hamsin") happens to occur at maturation time (and these spells are quite frequent in this season) shedding of fruit can be completed in a matter of two or three days, and the potential harvesting period shortened even more.

Harlan (personal communication) believes that the effect of hamsins together with lower cereal yields in drought years may have set "some sort of population limitations for scarcity periods".

Edaphic Factors

Another factor in the growth of wild cereals is the soils with which they show "close affinities" (Zohary 1969: 48, 52). Zohary reports the following relationships (1969: 48, 52):

a) The close affinity of wild emmer to hard limestone and basaltic bedrocks, where it usually builds up mixed stands with wild barley. The associates soil types are terra rossa and basaltic soils (M. Zohary 1962: 10, 12).

b) The relative or complete absence of wild emmer on marls (see below and table 1).

c) The affinity of wild einkorn to basaltic soils, marls and limestones.

Harlan (personal communication) reports with regard to southeastern Turkey:

a) Wild einkorn is the dominant large-seeded annual grass on basalt, and wild barley on limestone.

b) Wild einkorn "grows better on the more level alluvium than wild barley".

The locational relationship between terra rossa soils and many Natufian sites has been noted by Bar-Yosef (1970: 183). Similarly, van Liere and Contenson (1964) have observed the association between Natufian sites and the Quercus-Pistachia zone. This vegetational association is most characteristic of terra rossa soils (M. Zohary 1962: 101).

During the field work I conducted in April and May of 1973 in the Galilean hills (late April and May comprose the wild cereal maturation period in Galilee), I noted that the absence of wild emmer on marls is particularly marked. Marly soil types contain high amounts of calcium carbonate, and the light rendzina soils in Galilee are of such a type (M. Zohary 1962: 11; Soil Map of Israel, Israel Department of Surveys, 1970). In over two weeks of observation, I never encountered a single stalk of wild emmer wheat within a zone of light rendzina soil, although wild barley grows there in abundance. Immediately beyond the orders of such soil zones, wild emmer is a common component of the grass cover.

Inter-Specific Factors

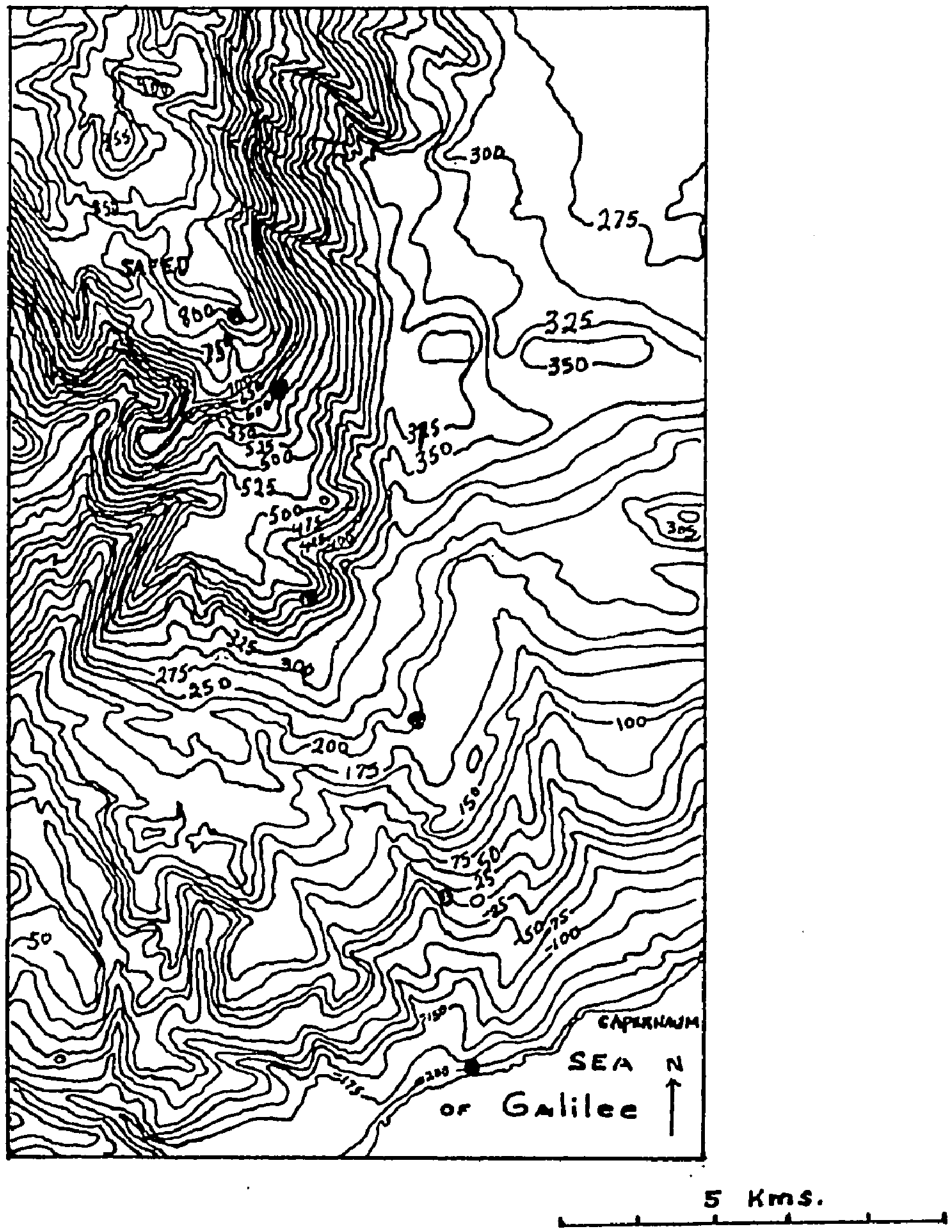
Differences in maturation time exist among wild wheats and barley. Zohary (1969: 57) observes that in mixes stands, wild barley "matures some one to three weeks earlier" than wild emmer wheat (see table 1). Harlan (personal communication) similarly notes that "barley and einkorn are likely to mature before emmer". Those locales with two or more wild cereals, therefore, afford the opportunity to collect additional harvests over the same range within a period of several weeks.

The potential effectiveness of such a doubled collecting range, however, would be contingent upon the yields of the wild cereals. Einkorn and goatgrass (Aegilops speltoides) are the dominant wild cereals in Diyarbakir province in southeastern Turkey (Harlan 1967: 201), yet goatgrass is a very low-yield wheat which was never domesticated, and was probably no more than marginally utilized by cereal collectors. Differences also exist in tolerance to average temperatures. Wild emmer wheat is not found far below sea-level elevations in the Jordan Valley (Zohary: 1969: 52; see also table 1), while wild barley is generally not found at altitudes greater than 1500 meters (Zohary 1969: 53).

Altitudinal Factors

As noted on page 14, temperature variation as a function of altitude is a significant factor in the maturation of wild cereals and other annuals. Zohary (1969: 57) notes the gradual maturation of wild emmer wheat over a 1600-meter elevation range in northern Palestine from the end of April to early June. Harlan (1967) observed a similar correlation between altitude and wild cereal maturation in southeastern Turkey and noted the possibility of lengthening a potential harvest period by collecting wild cereals as they mature at gradually increasing elevations.

During the period from April 28 to May 15, 1973, I observed the maturation of wild emmer and barley over a 1000-meter transect extending from the vicinity of Capernaum near Lake Tiberias to the town of Safed in the hills of northern Galilee. At the suggestion of Daniel Zohary, I employed six observation stations at 200-meter altitudinal intervals; from 200 meters below sea level near Capernaum to 800 meters at Safed (Map 1). Multiple observation points were necessary since there is a



Map.1. Wild Cereal Observation Stations. From Topographical Map of Israel; Israel Department of Surveys, 1971.

good deal of variability in wild cereal maturation time at any single time and place due to micro-environmental variations (see page 2 and below). In order to isolate the effect of altitude alone on the maturation time of wild cereals, it is necessary to determine the condition of the majority of cereals at given times and elevations (Zohary: personal communication). This was done by taking daily one-hour walking surveys in the vicinity of each observation station. Each survey covered several kilometers of terrain (and consequently a variety of micro-environments), and fifty wild cereal samples (half of emmer and half of barley, except where emmer was absent - see table 1) were collected on each survey. At the further suggestion of Daniel Zohary, a constant elevation was maintained on each survey by following map elevational contour lines as closely as possible.

Table 1 shows the results of this study. Each observation records the condition of the majority of the cereal under consideration at a single elevation at a given time. The stages of maturation employed represent morphological changes easily discerned by eye. The stages I utilized are basically variations in the consistency of cereal spikelet when crushed between thumb and forefinger. The criteria for the identification of the stages of maturation include four stages for wild barley - first stage: unformed kernel, second: milky kernel, third: waxy kernel, fourth: mature, followed by the disarticulation of cereal spikelets from the plant. In the case of wild emmer wheat, I have employed three stages of maturation - similar to stages two through four of wild barley (table 1).

Although local maturation are impressionistic, a pattern is apparent when several elevational ranges are considered jointly. Thus the time differential between the maturation of wild barley at succeeding 200-meter altitudinal intervals averaged three and one-half days, or approximately 57 meters altitudinal increment per day. While table 1 lists only one instance of the maturation of wild emmer between elevational points, maturation time intervals and altitudinal intervals similar to those of wild barley could be expected (Zohary: personal communication). Stands of wild emmer and barley are largely barren one week after their general maturation. Total wild cereal maturation seasons are limited in duration; in Palestine it is restricted to six weeks over an elevational range of 1500 - 1600 meters (Zohary: 1969: 57). Should a hamsin occur during this period, the maturation time would be greatly reduced (see page 15). A brief period of warm weather during the spring of 1973 had slightly accelerated the maturation of wild cereals in Galilee. In years with cooler weather, wild barley would mature at 800 meters elevation as late as May twentieth, five days later than observed in the present case.

Toward maturity, wild wheat and barley change from green to a sere, parchment-like color. That portion of the growth cycle in which they are collectible by the use of sickles or hand-stripping methods extends from forty-eight hours prior to maturity (while the cereal kernels are still in a waxy condition) through the spikelet-by-spikelet disarticulation of the plant (Zohary: personal communication). The duration of potential collectibility for an individual plant is three or four days. It would also be possible to collect disarticulated spikelets from the ground for a few additional days, but only with much greater expenditures of effort than by the use of sickles or hand-stripping methods.

Observation Stations:	Dates:	28th	29th	30th	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
800 meter's elevation:*	Barley	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	M
600 meter's elevation:	Barley	2	2	2	2	2	2	2	3	3	3	3	3	3	3	M	M	M	M
	Emmer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
400 meter's elevation:	Barley	2	2	2	3	3	3	3	3	3	3	3	M	M	M	M	M	-	-
	Emmer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
200 Meter's elevation:	Barley	3	3	3	3	3	3	M	M	M	M	M	M	-	-	-	-	-	-
	Emmer	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	M
Sea Level elevation:	Barley	3	3	3	3	M	M	M	M	-	-	-	-	-	-	-	-	-	-
	Emmer	1	1	1	1	1	1	2	2	2	2	M	M	M	M	M	M	M	-
-200 meter's elevation:**	Barley	3	M	M	M	M	-	-	-	-	-	-	-	-	-	-	-	-	-

* Soil type at 800 meter station (light rendzina) unsuitable for the growth of wild emmer.

** Temperatures at minus 200 meter station unsuitable for the growth of wild emmer.

Stages of maturation

Wild Barley (H. spontaneum)

1. Kernel unformed
2. Milky kernel
3. Waxy kernel
4. Mature (M)

Wild Emmer (T. dicoccoides)

1. Milky kernel
2. Waxy kernel
3. Mature (M)

Mostly disarticulated (---)

Table 1. WILD CEREAL MATURATION SCHEDULE - CAPERNAUM TO SAFED TRANSECT, APRIL-MAY 1973

Micro-Environmental Factors

Variability in maturation in a wild cereal species at a uniform elevation is due to the presence of micro-environments (D. Zohary: personal communication). Wild cereal micro-environments are formed from areal variations in soil depth and moisture content, and from variations in exposure to warmth. Conditions of warmth and dryness accelerate maturation, thus cereals in places of relatively deep soil and water deposits, as in depressed areas between adjoining slopes or valley floors, mature later than cereals on hillsides. Wild cereals on slopes with other orientations; grasses on north-facing slopes are the last to ripen.

Each topographical feature of a terrain presents different micro-environmental conditions, and regions with diverse topography therefore offer the greatest potential variability. All cereal-bearing locales can be said to consist of one or more such micro-environments. The result of such variation at a given elevation is a series of largely overlapping micro-environments of maturation within the broader context of maturation as a function of altitude.

Differences in daily temperatures must also be considered in delineating wild cereal micro-environments. Wild cereals mature in daily elevational increments of approximately fifty meters (see page 20). Wild cereal micro-environments are therefore not only delineated by terrain features, but by factors of altitude as well. Wild cereal micro-environments are herein defined as areas of varying size differentiated from surrounding terrain by factors of soil, moisture, or diurnal temperature (these factors acting singly or in some combination); within which a wild cereal species matures uniformly and which are limited in altitudinal amplitude to approximately fifty meters or less.

Table 1 records the effects of altitude only on the ripening of wild cereals, and represents a kind of minimum cereal-maturation schedule. I found that there are usually some mature cereals available at each elevational stage in the Galilean hills as much as one week before and after the majority of cereals had ripened. Similarly, Harlan (personal communication) observes that it is often possible to collect cereals over a two-week period within a few kilometers of a site in a wild cereal zone. Within the temporal limits imposed by yearly weather conditions (see page 14), it is the amount of variability in wild cereal maturation provided by altitudinal amplitude and micro-environments which determine the length of a potential harvest in a given locale.

ANALYSIS OF SITE VICINITIES

As discussed in chapter two (pp. 22 - 23), the length of a wild cereal maturation period in a given locale is foverned by the differential quality of the wild cereal micro-environments available. A comparative analysis of potential micro-environments in pre-agricultural and early agricultural site vicinities is made, utilizing two important factors in micro-environmental formation - directional orientation and altitude. The hypothesis regarding the importance of collection scheduling to pre-agricultural communities woudl be supported by evidence indicating greater variation in wild cereal maturation time (as reflected by the numbers and amount of variance of potential environments) within pre-agricultural site vicinities than early agricultural site vicinities.

The vicinities of nine archaeological sites are analyzed in this paper. The sites analyzed were chosed on the basis of the completeness of archaeological evidence, and on the availability of suitable topographical maps. Five sites considered pre-agricultural (basal Beidha, 'Eynan, Hayonim, Mureybit and basal Nahal Oren) and four early agricultural sites (Ali Kosh, Cayonu, Jarmo and Ramad) were chosen. Pre-agricultural site vicinities are analyzed first in the presentation.

As mentioned in the introduction (page 3), each site vicinity is analyzed within a ten kilometer radius. The selection of this spatial boundary is based upon ethnographic data concerning the collecting ranges of several hunting-gathering peoples, including !Kung Bushmen, the Hazda and Australian aborigines. These peoples exhibit a high dependency on gathering, which accounts for sixty to eighty percent of their subsistence base (Lee 1968: 46). Bands typically occupy base camps for a few weeks time, exploiting food resources within a given distance from camp before shifting to another campsite (Lee 1968: 60, Woodburn 1968: 105, Yengoyan 1968: 187). The !Kung gather up to a radius of six miles from camp, the Hazda "within an hour's walk of the camp" (Woodburn 1968: 187). It should be noted that the collecting radius given for Australian aborigines is applicable throughout the continent of Australia with its diverse environments, ranging from desert areas to coastal regions, and related variation in food resources (Yengoyan 1968: 186). Gould (personal communication) suspects that a collecting radius of only five kilometers would be a sufficient for spatial analysis throughout Australia, while Meggit (personal communication) believes a ten kilometers radius to be sufficient.

Method of Analysis

Transparent overlays with grids equivalent to 500m X 500m squares are placed over topographical maps of each site vicinity. The maps contain actual or interpolated 25-meter contour lines. The grid units are numbered consecutively from 1 to 1,168 - the total number of 500m X 500m squares which can be placed within a ten kilometer radius. A sample size of 467 grid units is used; this is a 40 percent sample and will be sufficient for a confidence level of 99 percent, with a realiability of ± 5 percent (Arkin and Colton 1950: table 20). The particular grids used were selected with the aid of a table of random numbers, and the corresponding grid units are analyzed with respect to the following factors:

Directional Orientation:

Map contour lines are used to determine the directional orientation(s) of the terrain within each grid unit sampled. Five possible orientations are recognized: one for each of the four cardinal points of the compass, plus a zero directional orientation for horizontal land surfaces. A terrain with an angle of slope of five degrees or less is regarded as horizontal. Directional orientations are assessed on the basis of quadrants centered on each of the cardinal points; any slope lying within 45 degrees of either side of a cardinal point is considered as having an orientation corresponding to that point. A terrain whose slope faced between north-west to north-east would therefore be considered as having a northerly exposure.

Altitude:

Altitudinal amplitude within each square is also considered in the delineation of micro-environments, with the assessment of potential micro-environments proceeding in 50-meter altitudinal increments (or fractions thereof) above or below zero meters altitude. For example, terrain within a square containing three contour lines ranging from 50 to 100 meter's altitude is considered as having three micro-environments firmed by altitude: one within the 50 - 100 meter increment, another within the 0 - 50 meter increment for the terrain beneath the lowest contour line, and a third increment of 100 - 150 meters for the terrain evident above the highest contour line.

Data Analysis

The potential wild cereal micro-environments of each site vicinity are categorized according to orientation and classified within an ascending scale of 50-meter classes (see appendix). In order to compare the potential amount of variation in wild cereal maturation between each site vicinity, the standard deviation of altitude of each directional category of micro-environment is calculated for all site vicinities. The combined frequency distribution (i.e. the total number of micro-environments in each site vicinity) is also calculated. The results are given in Table 2 and Graph 1.

Interpretation

The importance of altitudinal amplitude in the prolongation of wild cereal maturation periods has been discussed in chapter two (pp. 17 - 21; table 1). While the rate by which wild cereals mature as a function of altitude is subject to change with fluctuations in temperature (pp. 14, 20). site vicinities with micro-environments dispersed over a wide altitudinal range have a consistent advantage over site vicinities with more concentrated altitudinal ranges. The average altitudinal range of the pre-agricultural site vicinities tested exceeds the average altitudinal range of the early agricultural site vicinities by 131 meters (Table 2).

As noted in chapter three (page 22), differential maturation in wild cereals results in part from differences in directional orientation among micro-environments, with maturation generally first occurring in southeastern exposure and last in norther exposures. The relationship between differential maturation and micro-environmental orientation

Pre-agricultural sites:

	N	(M.E.)	E	(M.E.)	S	(M.E.)	W	(M.E.)	H	(M.E.)	Total M.E.	Altitudinal range
BEIDHA	440	(109)	328	(43)	380	(55)	363	(392)	460	(5)	604	1300 m.
'EYNAN	210	(61)	229	(148)	186	(87)	178	(149)	229	(40)	485	600 m.
HAYONIM	183	(95)	165	(27)	195	(143)	205	(136)	188	(85)	486	675 m.
MUREYBIT	38	(35)	42	(72)	35	(88)	38	(91)	25	(197)	483	125 m.
NAHAL OREN	96	(70)	145	(27)	105	(70)	128	(130)	144	(51)	348	300 m.
Mean S.D. per orientation:	193		181		180		182		209			600 m. (Mean)

Mean S.D. for all orientations: 189

Agricultural sites:

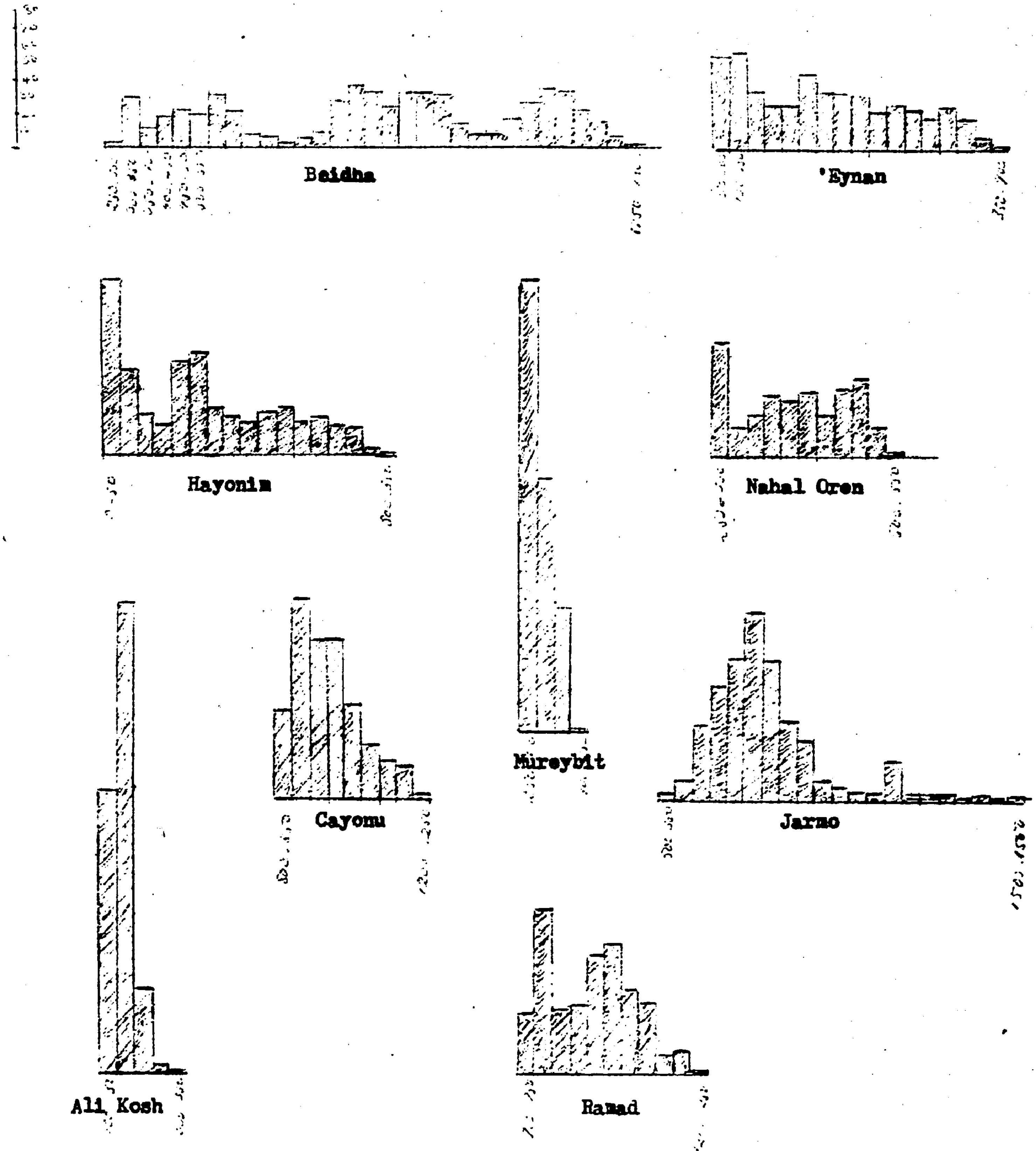
	N	(M.E.)	E	(M.E.)	S	(M.E.)	W	(M.E.)	H	(M.E.)	Total M.E.	Altitudinal range
ALI KOSH	38	(66)	74	(19)	38	(68)	34	(73)	26	(274)	500	200 m.
CAYONU	77	(84)	75	(62)	84	(185)	95	(63)	109	(83)	477	675 m.
JARMO	205	(29)	172	(64)	164	(179)	142	(234)	135	(48)	554	525 m.
RAMAD	131	(49)	112	(173)	100	(93)	111	(31)	91	(129)	475	475 m.
Mean S.D. per Orientation:	113		108		96		95		90			468 m. (Mean)

Mean S.D. for all orientations: 125

Table 2. Pre-Agricultural and Early Agricultural Site Vicinity Standard Deviation of Directional orientations.

S.D.: Standard Deviation

M.E.: Micro-Environments



Graph 1. Site Vicinities Combined Frequency Distributions.

raised the question as to whether some contrasting pattern in proportions of directional orientations existed between pre-agricultural and early agricultural site vicinities. No such regularities were found, however (see appendix). The high proportions of some orientations within certain site vicinities apparently reflect local topographic factors - as in the 'Eynan site vicinity, where high proportions of eastern and western orientations can be attributed to the presence of the east-facing slopes of the Galilean Hills and the west-facing slopes of Golan (map 3 and appendix). Similarly, no pattern is apparent in the values of the directional standard deviations within or between pre-agricultural and early agricultural site vicinities (table 2). The standard deviation for the combined frequency distribution of the site vicinities tested, however, shows a greater amount of variability among pre-agricultural site vicinities, which have a group average standard deviation of 189 meters as compared to a group average standard deviation of 125 meters for early agricultural site vicinities. The tendency of early agricultural site vicinities to cluster more closely than pre-agricultural site vicinities around a central value can also be seen in graph 1, where histograms of the combined frequency distributions are shown for each of the nine site vicinities analyzed.

With the important reservation that the number of site vicinities analyzed is very small, the environmental evidence indicates that there is a generally greater amount of potential collection time available in pre-agricultural than in early agricultural site vicinities. The analysis undertaken in this paper therefore lends tentative support to the hypothesis regarding the importance of site location for increased collecting time.

BEIDHA (Helbaek 1966a, 1966b; Kirkbride 1966, 1967; Perkins 1966; Raikes 1966)

Beidha is located in the Jordan Rift on a terrace situated between the Arabian Plateau to the west and the Wadi Araba to the east (map 6). The site elevation is approximately 1000 meters above sea level (Kirkbride 1966: 53). Excavations revealed the presence of six architectural levels, each accompanied by a flint industry in the PPNB tradition (Kirkbride 1967: 12). The houses were constructed of local sandstone beginning with polygonal houses (VI), continuing with round houses (V) and sub-rectangular houses with slightly curving walls (IV). Levels III and II were composed of buildings with central corridors opening into separate cells (Kirkbride 1967: 5-9). Level I consisted of sub-rectangular houses similar to those of Level IV. Soundings also revealed traces of mud-brick or pise walls accompanied by a lower Natufian flint industry, and separated from the overlying PPNB levels by two meters of aeolian deposits (Kirkbride 1967: 10; Raikes 1966: 71). The following radiocarbon dates have been reported (Raikes 1966: 72):

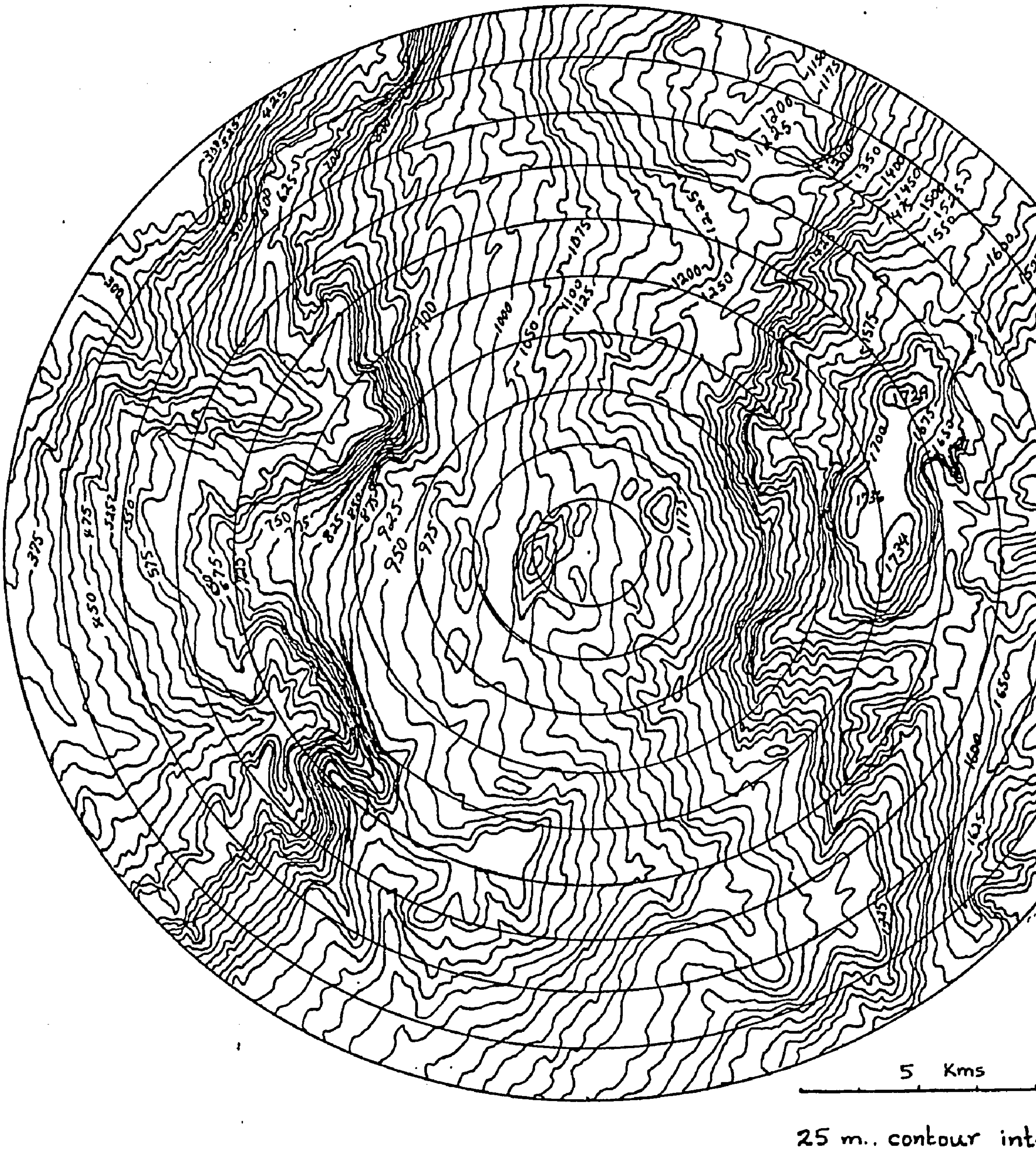
(Libby half-life)	Copenhagen Radio Carbon Laboratory:
Level VI. 6990 B.C. ± 160	(K-1086)
Level VI. 6760 B.C. ± 160	(K-1082)
Level IV. 6780 B.C. ± 160	(K-1084)
Level II. 6600 B.C. ± 160	(K-1085)

Among the locally available materials recovered were grinding implements made of a coarse basalt obtainable from a volcanic field on the Arabian Plateau fourteen miles east of Beidha. Hematite, malachite and mica were also recovered, all of which are found in the mountain of Wadi Araba, immediately west of Beidha (Kirkbride 1966: 53). Indications of trade were found in the recovery of small quantities of obsidian.

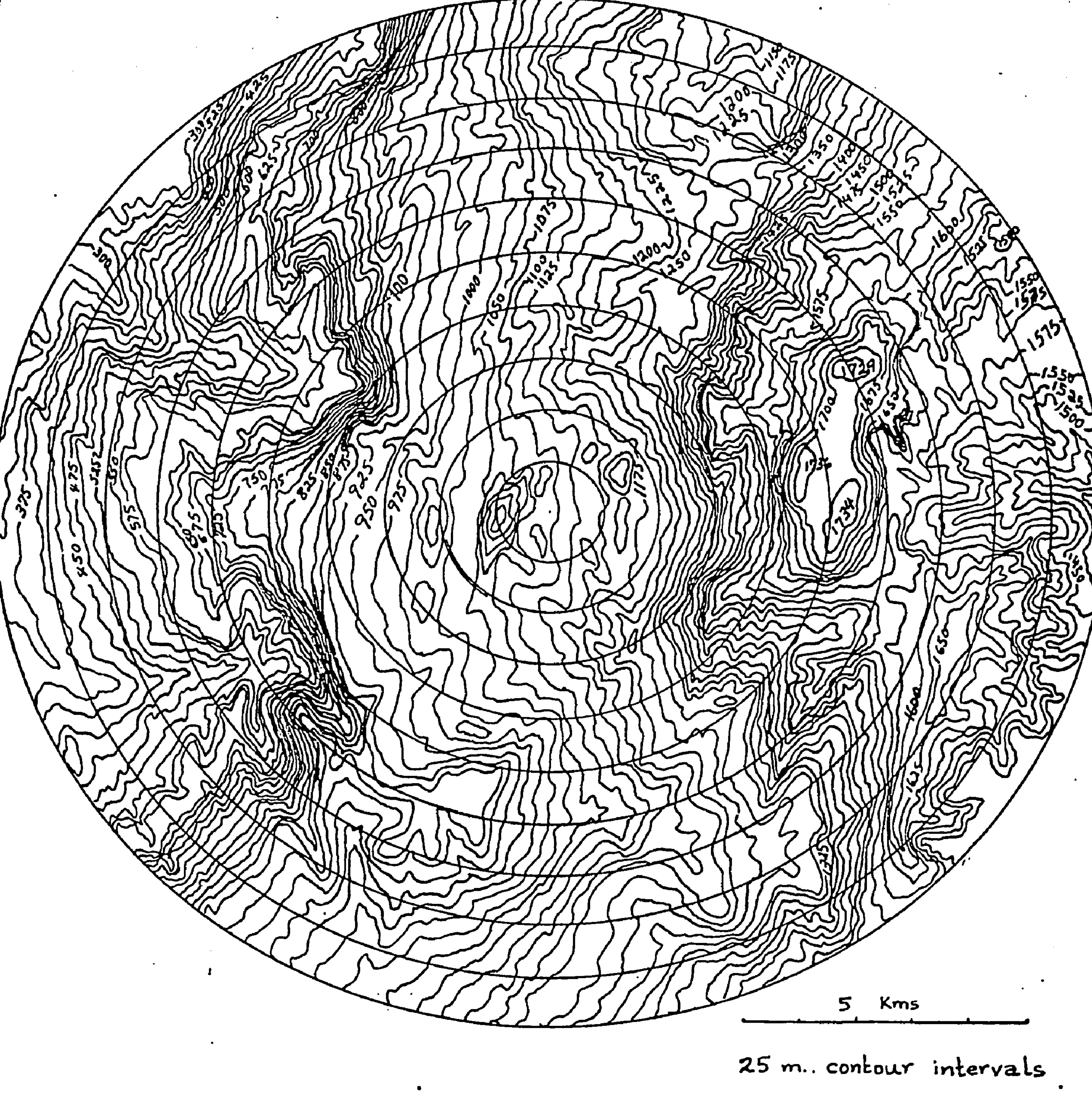
Faunal analysis revealed the presence of goats, aurochs, gazelle, wild boar, hare, jackal, half-ass and shrewmouse. A small number of unidentified rodent and bird bones were also recovered. Based on an increase in the proportion of young goats slaughtered at Beidha as compared with those recovered from the nearby Upper Paleolithic VI rock shelter of Madamagh, Perkins believes the goat was domesticated in the Neolithic levels at Beidha, and perhaps in the Natufian level as well (1966: 66-67).

Paleo-botanical analysis revealed the presence of hulled two-row barley; the impressions of this cereal were found by the thousands in clay from the walls and roof of a house in the PPNB levels (Helbaek 1966a: 62). Helbaek considers this cereal as being the most important cereal grown at Beidha. Impressions of the entire cereal spikelet were recovered, none of which evidenced loss of the brittle rachis characteristic of wild barley of wheat. On the basis of the relatively large size of the barly grains, Helbaek (1966a: 62) classifies them as an early domesticate, stating "There is no evidence of articulated internodes such as in domesticated barley so what we are dealing with is, strictly speaking, cultivated wild barley (Hordeum spontaneum)". Both Daniel Zohary and Harlan (personal communications) are critical of this interpretation, maintaining that there is no botanical reason to consider this cereal as other than completely wild. In addition to wild barley, one impression of a naked two-row barley grain (*Hordeum distichum*) were also recovered which Helbaek (1966a: 62) describes as being "a highly polymorphic transitional form not clearly demonstrated before.". Other grasses recovered included Goat-face grass (*Aegilops* sp.), Ryegrass (*Lolium* sp.) and wild oat (*Avena ludoviciana*). Wild pistachio (*Pistacia atlantica*), veth (*Vicia narbonense*), medic (*Medicago* sp.), Cock's comb (*Ononrychis crista-galli*), and Bulbous barley (*Hordeum bulbosum*) were also found.

The subsistence system evident in the PPNB levels at Beidha is apparently a mixed one, with a greater dependency on cereal collection than agriculture if Zohary's and Harlan's evaluation is correct.



Map 2. Beidha Site Vicinity. From Geological Map of Jordan; Department of Lands and Surveys of Jordan, 1954.



Map 2. Beidha Site Vicinity. From Geological Map of Jordan; Department of Lands and Surveys of Jordan, 1954.

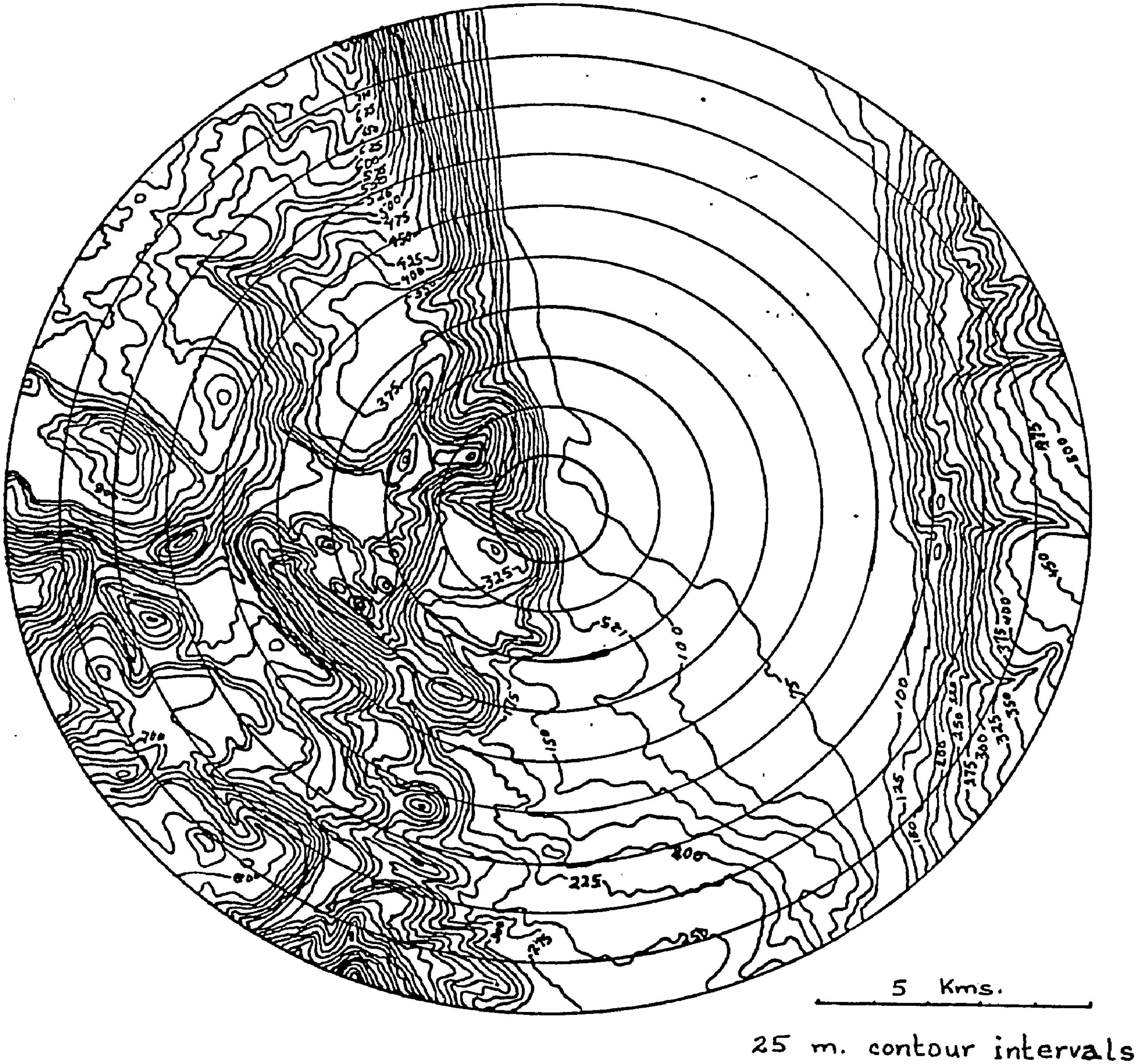
'EYNAN (Perrot 1957, 1960a, 1960b, 1966)

'Eynan (Ain Mallaha) is located in the Huleh Plain of the upper Jordan Valley, bordering a stream which gives the site its name. The site is situated at an elevation of approximately 100 meters above sea level (Topographical Map of Israel, 1972). The settlement locale is at a junction of the western border of the Huleh Plain and the eastern slopes of the Galilean Hills (map 2).

'Eynan is a large open-air Natufian site similar in artifact inventory to those of Hayonim and Nahal Oren, and covers an area estimated by Perrot to be at least 2000 square meters containing about 50 huts in each of its three archetectural levels (1966: 477). The huts are built of stone and are oval or circular in shape, often containing intermural individual or group burials (Perrot 1960a: 15). The levels are two meters in total thickness, with associated tool industries classified as Lower and Middle Natufian. No radiocarbon dates were reported.

Faunal analysis revealed the presence of aurochs, goats, deer, gazelle, wild boar, hyena, fox, hare, small carnivores and rodents (Perrot 1960a: 20). No indications of domestication were observed (Perrot 1966: 481). Waterfowl, tortoises, crustaceans and fish were also found, probably obtained from Lake Huleh, which prior to recent drainage bordered the site. Marine dentalia were also frequently found.

Indirect evidence of cereal collecting and processing included sickle blades and handles, mortars and the presence of plaster-lined pits (Perrot 1966a: 18-20).



Map 3. 'Eynan Site Vicinity. From Topographical Map of Israel; Israel Department of Surveys, 1972.

HAYONIM CAVE (Bar-Yosef 1970; Bar Yosef and Tchernov 1970)

Hayonim Cave is located in the hills of western Galilee at an elevation of 300 meters above sea level and 13 map kilometers from the Mediterranean coast. The cave is a karst formation consisting of two connected galleries situated on a terraced slope overlooking the western bank of a summer dry stream bed (the Wadi Izhar).

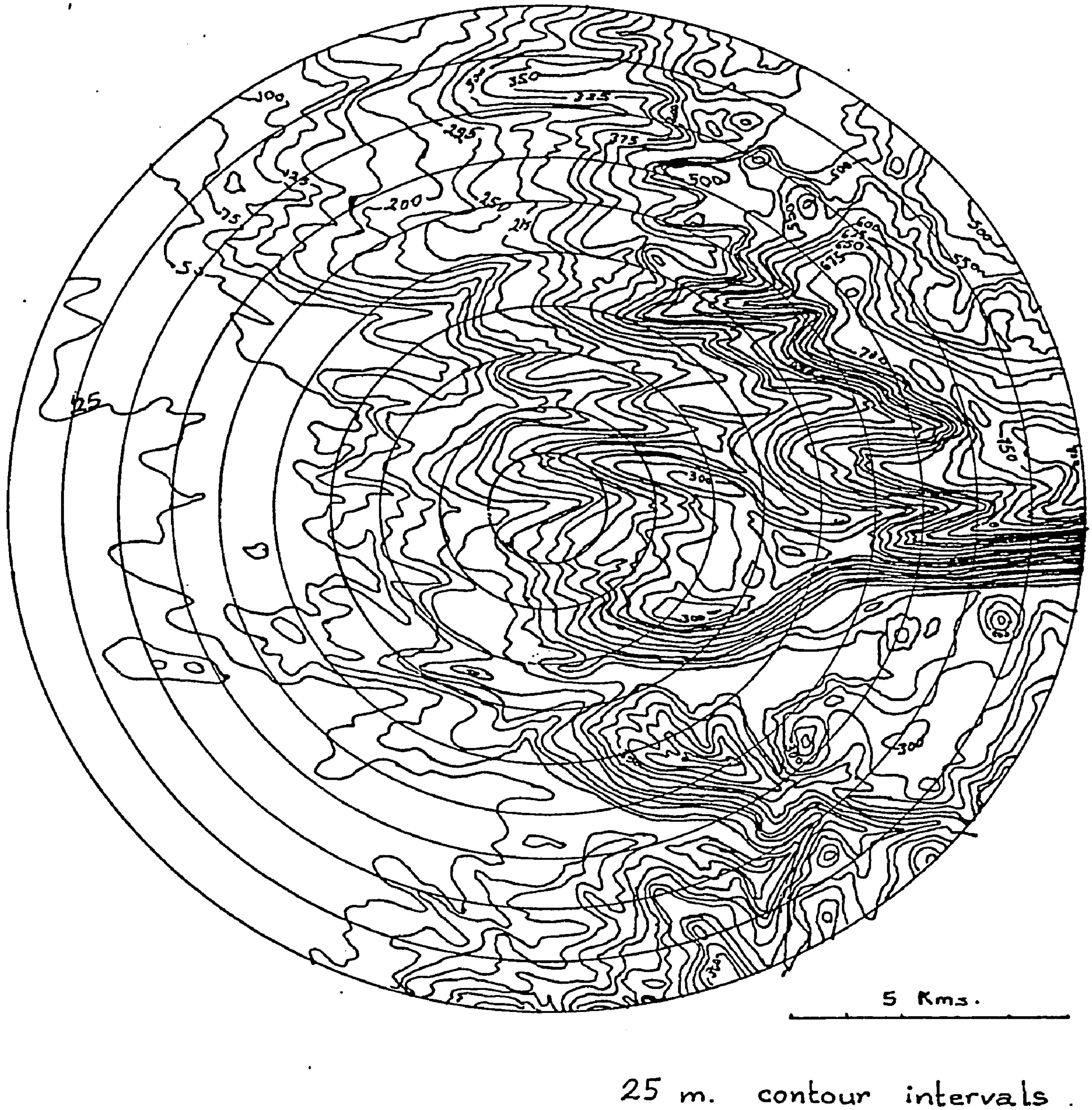
Five cultural levels were identified: Layer A contained Byzantine glass and sherds; Layer B, a Natufian assemblage; Layer C, a Kebaran microlithic industry. Beneath this lay a "Palestinian Aurignacian" level followed by a "Mousterian" industry imbeded in breccia (Bar-Yosef and Tchernov 1970: 108). No radiocarbon dates or paleo-botanical analysis were reported.

Further Natufian and artifacts recovered included hearths, mortars and pestles, lustrous sickle blades and sickle handles. On the basis of the stone and bone assemblages recovered and the percentage of tool types, Bar-Yosef observes that the Natufian level at Hayonim "closely resemble those of 'Eynan" (Bar-Yosef and Tchernov 1970: 117).

The Natufian component is believed to extend over more than 1000 square meters from the Häyonim terrace, and the Hayonim Natufian component to represent a large open-air site similar to 'Eynan and Nahal Oren (Bar-Yosef 1970: 182-184). In line with his general thesis concerning the environmental determinants of such large Natufian "base camps", the above-mentiond sites are all located within zones of terra *rossa* soils (see page 16).

Tchernov's analysis of the faunal assemblage from Hayonim Cave is primarily concerned with the reconstruction of the biotopes in the vicinity of the site (Bar-Yosef and Tchernov 1970: 121). The analysis was limited to Layer B and C. The most outstanding difference in the faunas of the Kebaran microlithic and the Natufian levels was the preponderance of micro-fauna in the Natufian, whereas bovids were most frequent in the Kebaran level. Various rodents are plentiful during the Natufian level, including *Mus musculus* (a human commensal) which was completely absent during the Kebaran occupation. Tchernov attributes the presence of rodents to a greater permanency of settlement during the Natufian phase (Bar-Yosef and Tchernov 1970: 125).

Tchernov concludes that a variety of biotopes were present during the Kebaran and Natufian occupations at Hayonim, including mediterranean wood, batha (i.e. vegetational zones characterized by the presence of dwarf shrubs and perennial herbs) and garigue (Bar-Yosef and Tchernov 1970: 139).



Map 4. Hayonim Cave Site Vicinity. From Topographical Map of Israel; Israel Department of Surveys, 1972.

TELL MUREYBIT (Cauvin 1973; van Loon 1966a, 1966b, 1968; van Zeist 1970; van Zeist and Casparie 1968)

Tell Mureybit is located in the north Syrian plain on the eastern bank of the Euphrates, 86 kilometers southeast of Aleppo. The site, bench-marked at 297.20 meters altitude, is presently situated near a 250 mm. rainfall isohyet (van Loon 1968: 266, 280). Initially excavated by van Loon (1966a, 1966b, 1968), Mureybit was later excavated by Jacques Cauvin of C.N.R.S. (1973). Work at the Mureybit site has terminated with the end of the 1973 season since the surrounding region is due to be flooded as a result of dam construction on the Euphrates.

Cauvin (1973 and personal communication) divided the succession of cultural levels at Mureybit into three phases: Phase 1 is characterized by a Natufian lithic industry and round huts; Phase 2 by the disappearance of geometric microliths and the first appearance of obsidian and rectangular architecture; Phase 3 by the joint occurence of round and rectangular architecture and "evolutionary" changes in the lithic industry, the following radiocarbon dates were given (Cauvin: personal communication):

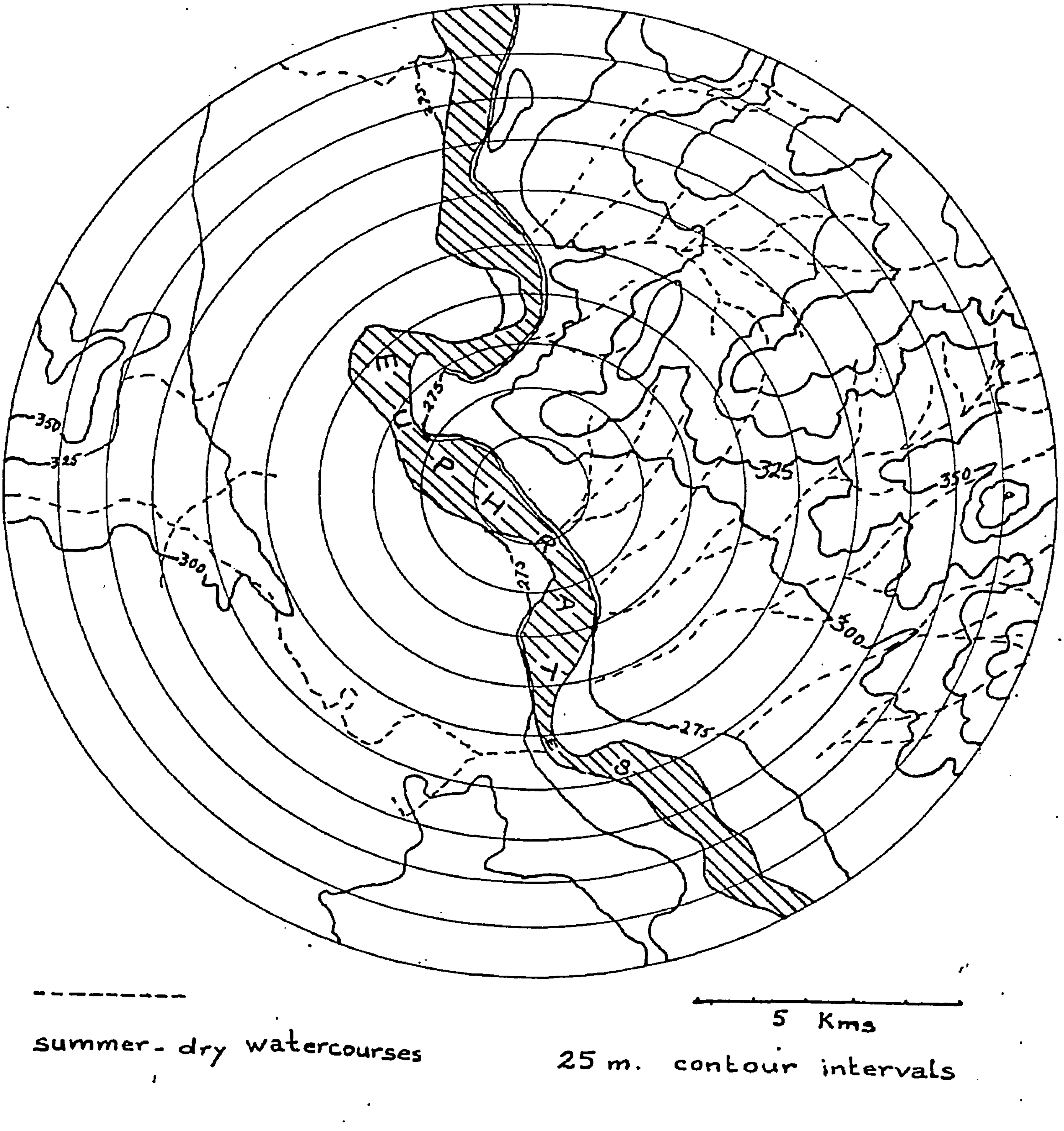
Termination of Phase 1:	(Louvain)	607	8640 ± 140 B.C.
Phase 2:		604	7780 ± 140 B.C.
		605	8640 ± 170 B.C.
		606	8510 ± 200 B.C.

Carbonized kernels were recovered from most of the levels (van Zeist 1970: 168-169). All of the vegetal material recovered were identified as being morphologically wild (van Zeist and Casparie 1968: 45), and included wild einkorn (Triticum boeticum) varieties thaoudar and aegilpoides, wild barley (Hordeum spontaneum), wild lentil (Lens nigricans), several undetermined species of mild vetch (Astragalus), and bitter vetch (Vicia ervilia). Several nut fragments of wild pistachio (Pistacia) were also recovered.

Citing palynological studies (van Zeist and Wright 1963; van Zeist 1967) which would not support a hypothesis of greater rainfall in the plains of northern Syria 10,000 years ago, van Zeist concludes that the wild einkorn recovered at Mureybit was probably collected in the closest present-day natural habitat zone of wild cereals - southeastern Turkey, some 100 - 150 kilometers to the north (van Zeist and Casparie 1968: 52-53). Wild barley could have been collected with wild einkorn in the same region, or possibly "wadi race" barley was obtained near Mureybit, but "it would never have occurred in large stands" (van Zeist and Casparie 1968: 53).

Cauvin (personal communication) reports that preliminary investigations at Mureybit indicate that wild barley may have been the only cereal present during Phase 1, and einkorn only appeared in Phase 2 along with the first appearance of obsidian. Cauvin speculates that einkorn was introduced from Turkey as a cultivar at an early stage of development, when no genetic differentiation had yet taken place. Daniel Zohary (personal communication) adds a caveat by observing that in his opinion it is not possible to positively discriminate between wild and early domesticated forms of wild wheat and barley without examining the rachises. Since van Zeist's paleo-botanical analysis at Mureybit is based solely upon an examination of carbonized grains, there remains a possibility that some or all of the cereals recovered were domesticated.

During the late spring of 1973, I visited Mureybit and conducted a survey of the site vicinity. Small irrigated fields of commercial crops, chiefly cotton, lined both banks of the Euphrates and extended toward the hinterland for a few hundred meters. Beyond the confined of those fields, the countryside is extremely barren, with no grasses of any kind in evidence beyond immediate vicinity of the river. The arid appearance of this region, which under normal conditions would be a steppe grassland, can be directly attributed to overgrazing and poor farming practises (D. Zohary: personal communication). The dominant forms of vegetation present were clumps of sage-brush especially evident in wadi bottoms and at the base of Hills where pockets of relative greater moisture accumulate.



Map 5. Tell Mureybit Site Vicinity. From Map of Djerablous District (in Arabic), 1950.

NAHAL OREN (Stekelis and Yizraely, 1963)

Nahal Oren is located on the western slopes of Mount Carmel on a large terrace in a valley (the Wadi Fallah) which opens on the Mediterranean coast. The site is situated near a cave entrance on the terrace at an elevation of approximately 45-55 meters above sea level (Stekelis and Yizraely 1963: 1). Three springs are located within 500 meters of the site.

Five cultural phases were uncovered: Upper Paleolithic V (Atlithian), Upper Paleolithic VI (Kebaran), Natufian, and Pre-Pottery Neolithic A and B. No radiocarbon dates, faunal or paleo-botanical analyses were reported.

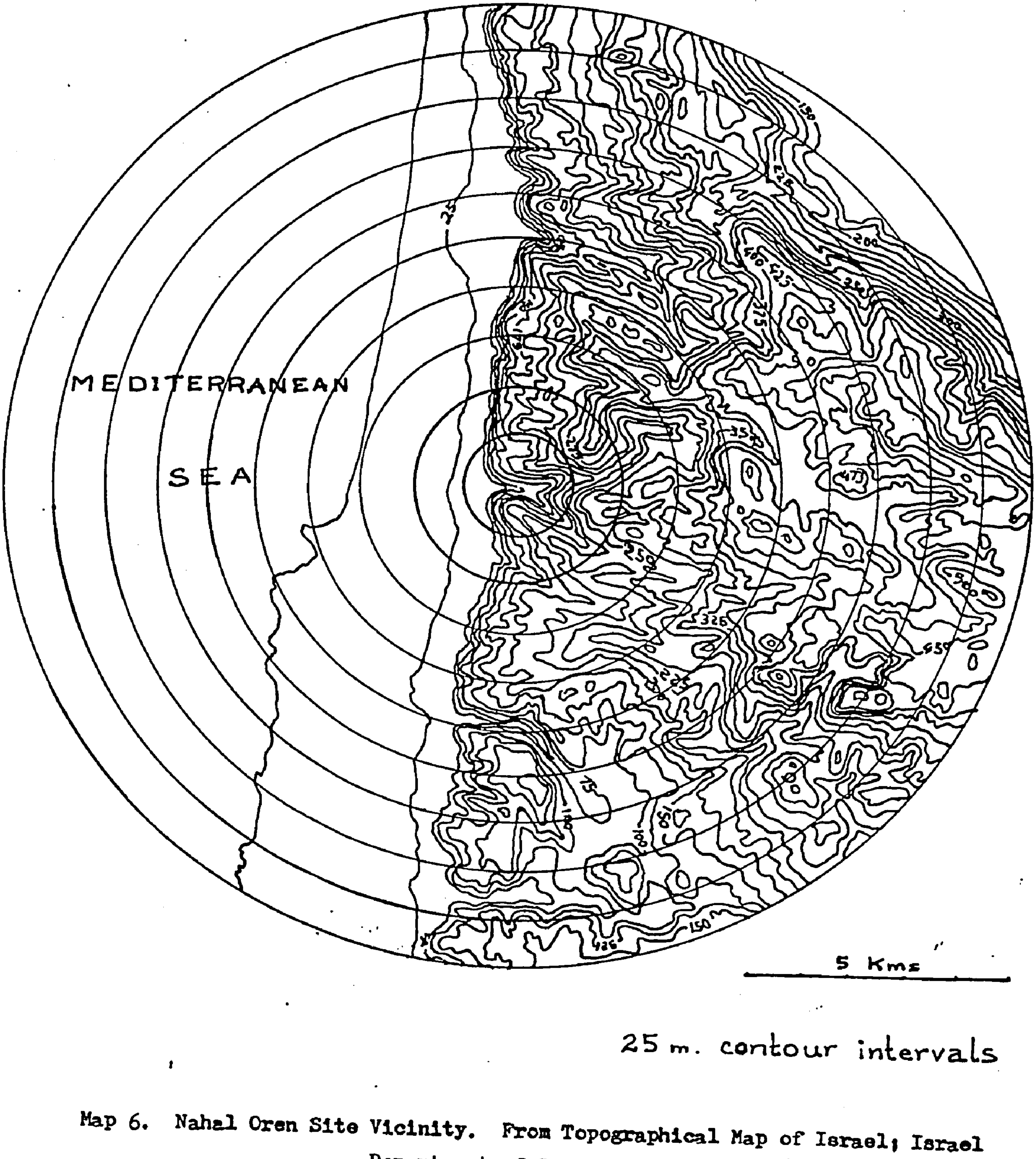
The Natufian component is estimated to cover a minimum area of 1000 square meters of the Nahal Oren terrace (Bar-Yosef 1970: 183), and included an oval-shaped house and a wall, both of dry-stone construction. Some fifty individual and group burials were also found, as well as hearths, mortars and silos. The tool industries recovered are described as belonging to the final stage of the Natufian (Stekelis and Yizraely 1963: 11). Among the tools recovered were sickle blades, sickle hafts, and harpoons.

The succeeding PPNA stratum contained fourteen round or oval houses built of undressed stones with floors made of pise or small pebbles. Flannery (1972: 32) believes that such "compounds" may represent the earlies type of permanent community in the Near East.

The tool industry is described as a continuation of Natufian flaking techniques together with the appearance of new tool types including axes, adzes and picks (Stekelis and Yizraely 1963: 6-8). Sickle blades continue "in the Natufian tradition", and obsidian was first encountered in this stratum.

The uppermost PPNB stratum was disturbed by erosion and road construction, but a large building of unreported shape and dimensions was uncovered (Stekelis and Yizraely 1963: 2). This building contained a smaller structure within it; both structures were made of undressed stones. Among the reported tool types were sickle blades, axes, and adzes.

The excavators believe that a cultural continuity exists through the Natufian and Pre-Pottery Neolithic levels at Nahal Oren, with a transition from food collection to food production occurring in the Neolithic levels as evidenced by the new tool forms (Stekelis and Yizraely 1963: 7, 11).



Map 6. Nahal Oren Site Vicinity. From Topographical Map of Israel; Israel Department of Surveys, 1971.

ALI KOSH (Flannery 1969, Helbaek 1969, Hole and Flannery 1967, Hole, Flannery and Neely 1969)

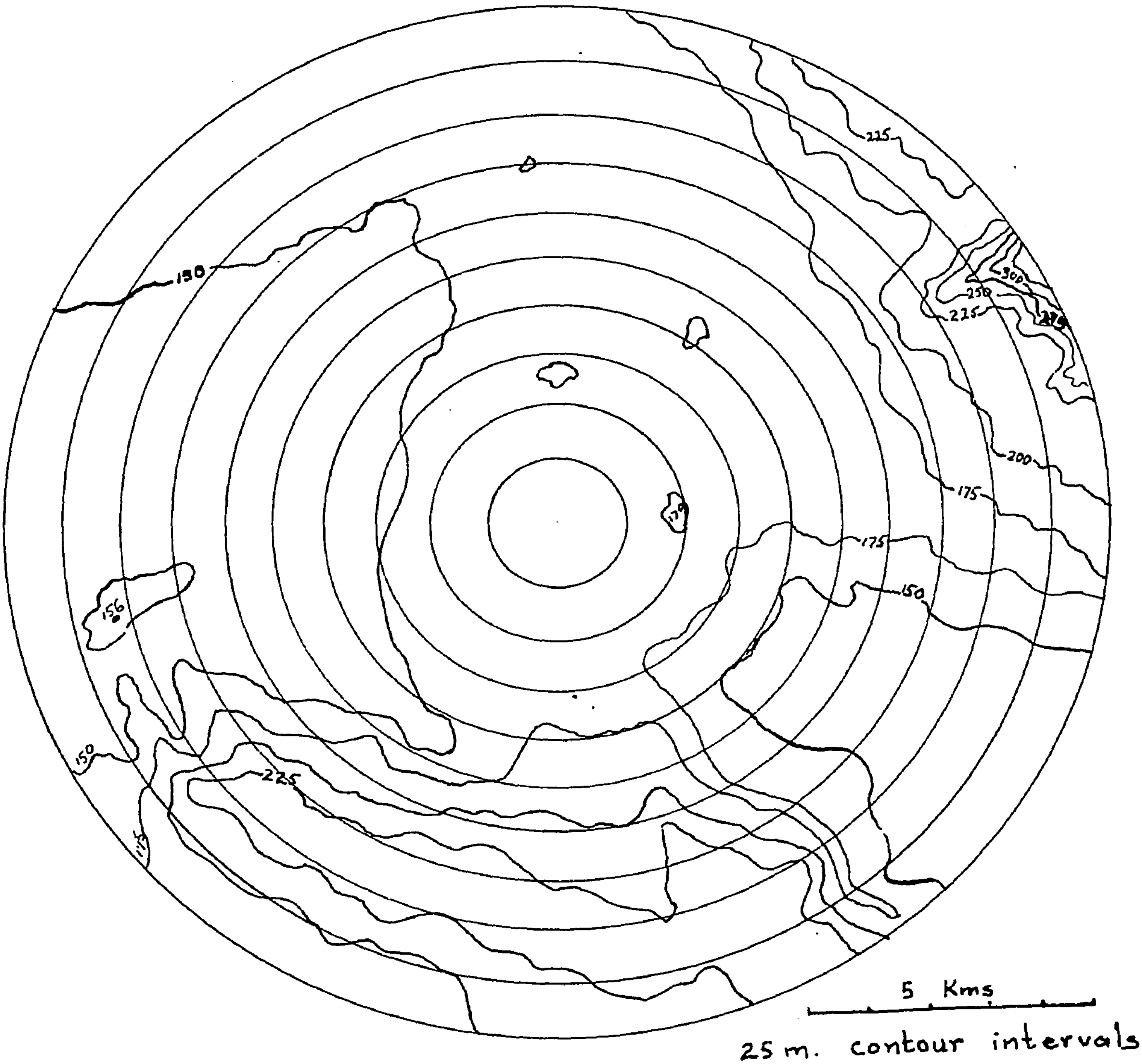
Ali Kosh is located on the Deh Luran plain in south-western Iran. The site is a mound rising four meters above the surrounding plain, which has an elevation of about 175 meters above sea level (hole et al. 1969: 29; U.S. Army Map Service, 1943, Sheet I-38 X). Seven cultural phases were identified, the earliest of which (Bus Mordeh) was correlated with strata immediately above virgin soil. This Bus Mordeh phase has the following radiocarbon dates:

Isotopes, Inc.	Date (years B.C.)
I-1496 - 7380 ± 180	5430
I-1489 - 7670 ± 170	5720
UCLA	
UCLA 750D - 9900 ± 200	7950

On the basis of typological similarities with Zawi Chemi Shanidar and Tepe Ganj-i Dareh, a maximum date of 7500 B.C. was assigned to the Bus Mordeh phase. The assigned terminal date for this phase is 6750 B.C. (Hole et al. 1969: 333, 345).

Stratigraphic zones C2 and Cl at Ali Kosh encompass the Bus Mordeh phase. These zones revealed the oldest signs of human occupation at the site, including wall stubs of untempered mud brick, as well as midden debris, ash, compost, flint blades and chipping debris (Hole et al. 1969: 34 - 36). Paleo-botanical and faunal analysis further recealed that the earliest settlers at Ali Kosh were agriculturalists and herders. Both cultivated and wild grasses were recovered (Helbaek 1969: 389), including emmer wheat (Triticum dicoccum), barley (Hordeum vulgare var. nudum), wild einkorn wheat (Triticum boeticum) goat-face grass (Aegilops crassa), ryegrass (Lolium rigidum), canary grass (Phalaris cf. paradoza), and wild oats (Avena sp.). Legumes such as medic (Medicago radiata) and milk-vetch (Astragalus tribuloides and Astragalus cruciata) were also found (Hole et al. 1969: 343, 398). Flint sickle blades and limestone grinding slabs were also recovered.

Faunal analysis revealed the presence of both domesticated and wild animals. Domesticated goats whose horn-cores differed little from the wild phenotype, but whose herd age-ratio differed markedly from that of a wild population were found. Evidence for domestication was found in the recovery of hornless sheep. Among the game animals found were gazelle, onager, wild ox and wild boar.



(Contour lines interpolated from original 250 feet contour intervals).

Map 7. Ali Kosh Site Vicinity. From U.S. Army Map Service, 1943

CAYONU TEPESI (Braidwood, Cambel, Redman and Watson 1971; Braidwood, Cambel and Watson 1969; Cambel and Braidwood 1970; van Zeist 1972)

Cayonu Tepesi is located in northern Diyarbakir Province in south-eastern Turkey, about five kilometers southwest of Ergani. The site is situated at 830 meters above sea level on the north bank of the Dicle River, a tributary of the Tigris. Diyarbakir Province forms part of the southern slopes and piedmont of the Taurus Mountains, a region which includes the northern watershed of the Tigris and Euphrates Rivers. Braidwood's interest in excavating here was based partially on the assumption that this region must have been centrally located in the post-Pleistocene natural habitat zone of potential domesticates (Cambel and Braidwood 1970: 53).

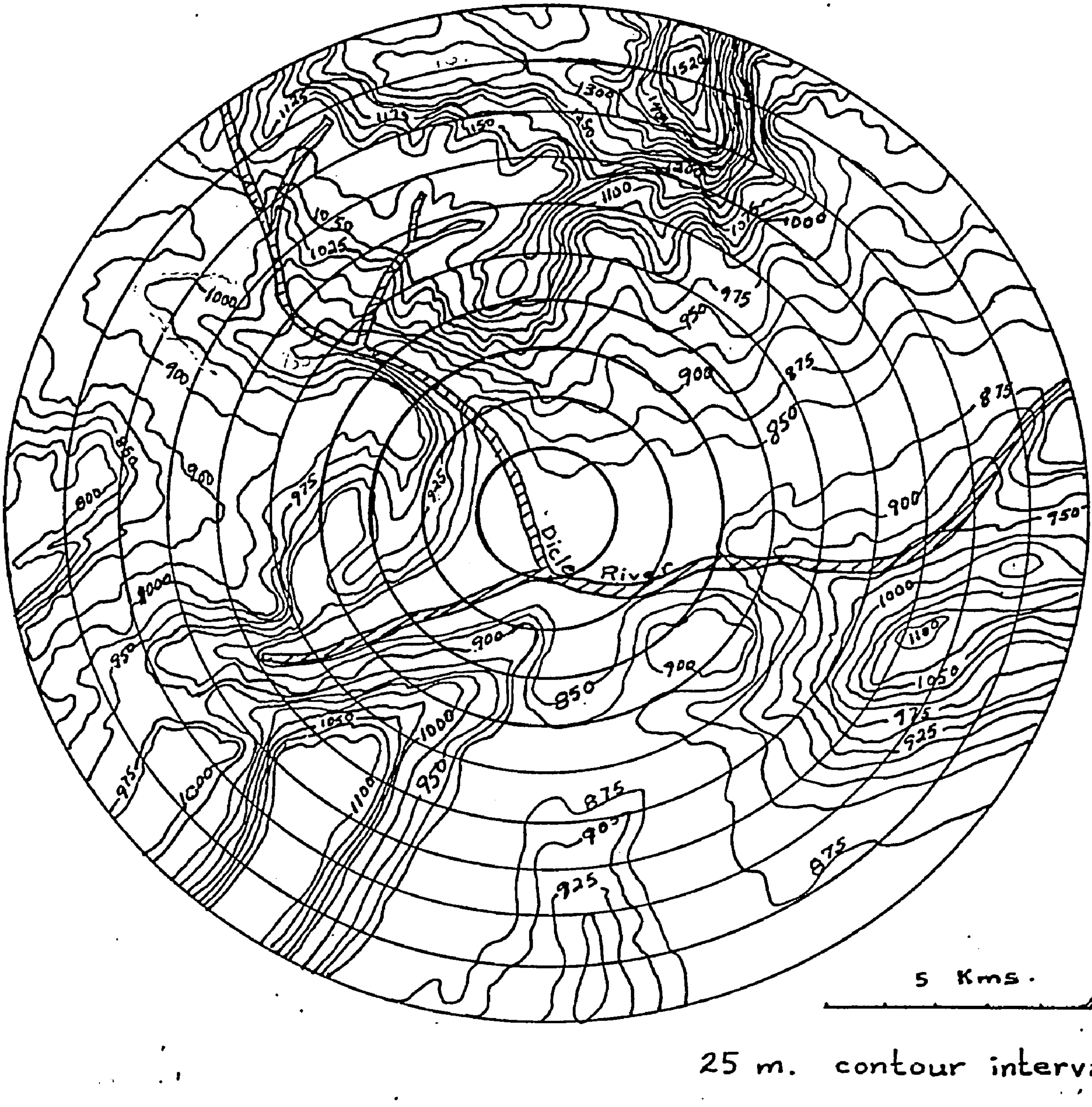
Excavations revealed five occupational phases, all preceramic, and described principally in terms of the architectural features extant in each level (Braidwood, Cambel et. al. 1971: 1238-1239; Cambel and Braidwood 1970: 54-56). Radiocarbon dates (Libby half-life) indicate an occupation period from 7500 B.C. to 6500 B.C. (Redman 1973: 70).

Indications of possible trade were found in the presence of marine shells (Braidwood, Cambel et. al. 1971: 1239; Cambel and Braidwood 1970: 56). Obsidian implements also formed part of the tool inventory, increasing in proportion to flint tools through each successive phase (Redman 1973: 70). Objects of hammered native copper were also found, and a deposit of copper and related minerals is located less than twenty kilometers from Cayonu Tepesi (Cambel and Braidwood 1970: 56).

A major concern with regard to the subsistence of the inhabitants of Cayonu Tepesi was whether a transition from wild to domesticated food resources could be documented (Braidwood, et al. 1971: 1239). Preliminary faunal analysis showed a predominant, if not total, dependence on wild animals during phases I and II. Animal remains included Bos primigenius, Sus, Cervus, Dama, Ovis and Capra. Later phases indicate a shift to domesticated forms of sheep, goat and pig. The only domesticated animal evident from the earliest phase onward is the dog.

Paleo-botanical analysis, however, revealed the presence of domesticated cereals from the earliest phases at Cayonu (van Zeist 1972: 9). The botanical material recovered included wild and domesticated einkorn and emmer wheat (Triticum boeticum, Triticum monococcum, Triticum dicoccoides, Triticum dicoccum); pea (Pisum), lentil (Lens), bitter vetch (Vicia ervilea), wild vetch (Vicia spe.), pistachio (Pistachia atlantica) and almond (Amygdalus spec.). Accounting for the cereal species found presented a problem. The wild and domesticated einkorn recovered were almost entirely of the two-seeded type (Triticum boeticum ssp. thaoudar and its cultivated form). The present-day distribution of wild two-seeded einkorn is restricted to western Anatolia and the Balkans. Only two complete grains plus a few fragments of one-seeded wild einkorn (Triticum boeticum ssp. aegilopoides) were found although this wild wheat grows abundantly in Diyarbakir and throughout southeastern Turkey, Iraq and Iran (van Zeist 1972: 9; Harlan and Zohary 1966). Similarly, although wild barley grows in abundance in the Diyarbakir area (van Zeist 1972: 10; Harlan and Zohary 1966) only two fragments of barley were recovered.

Van Zeist, believing that the present-day distribution of wild einkorn and emmer is similar to that of the early Holocene, hypothesizes that einkorn was brought from western Anatolia as a domesticate, together with admixtures of the wild form. Since wild emmer wheat is not found in western Anatolia, but is found in the southern Taurus range, van Zeist believes that it was taken under cultivation by earliest farmers in southeastern Turkey as an additional cultivar. Van Zeist concludes that "the gathering of wild cereals was of no importance" to the inhabitants of Cayonu Tepesi (1972: 10). Harlan (personal communication) adds: "The lack of barley of any sort at Cayonu is curious to say the least. It (wild) grows on the site today. I can understand that it would be ignored if the settlers were farmers, but why the farmers were not growing barley I don't understand. The situation must have been rather different at that time.".



Map 8. Çayönü Tepesi Site Vicinity. From U.S Army Map Service, 1942.

QALAT JARMO (Braidwood and Howe 1960)

Qalat Jarmo is located in the Chemchemal intermontane plain in Iraqi Kurdistan. The Chemchemal plain lies between the Kani Domlan-Jabal Tasak and the Kani Shaitan Hasan-Sagirma Dagh ridges. The site of Jarmo is situated at an elevation of about 2500 feet above sea level (Braidwood and Howe 1960: 26).

Jarmo covers an area of approximately 13,000 square meters, and containts about twelve architectural levels with a depth of deposit of twenty-seven feet (Braidwood and Howe 1960: 38; Braidwood 1967: 118). While pottery is apparently restricted to the upper third of the site, Braidwood believes there is sufficient cultural continuity to consider Jarmo a "one period" site (1967: 118). The houses consisted of rectangular multi-room structures built of pise, sometimes on stone foundations. Other site features included ovens, bins, and hearths. Braidwood estimates a maximum settlement size of twenty houses per level (1967: 120). Based on a clustering of radiocarbon determinations, Jarmo is dated at 6750 B.C. $\pm$ 200 (Braidwood and Howe 1960: 159; Braidwood 1967: 120).

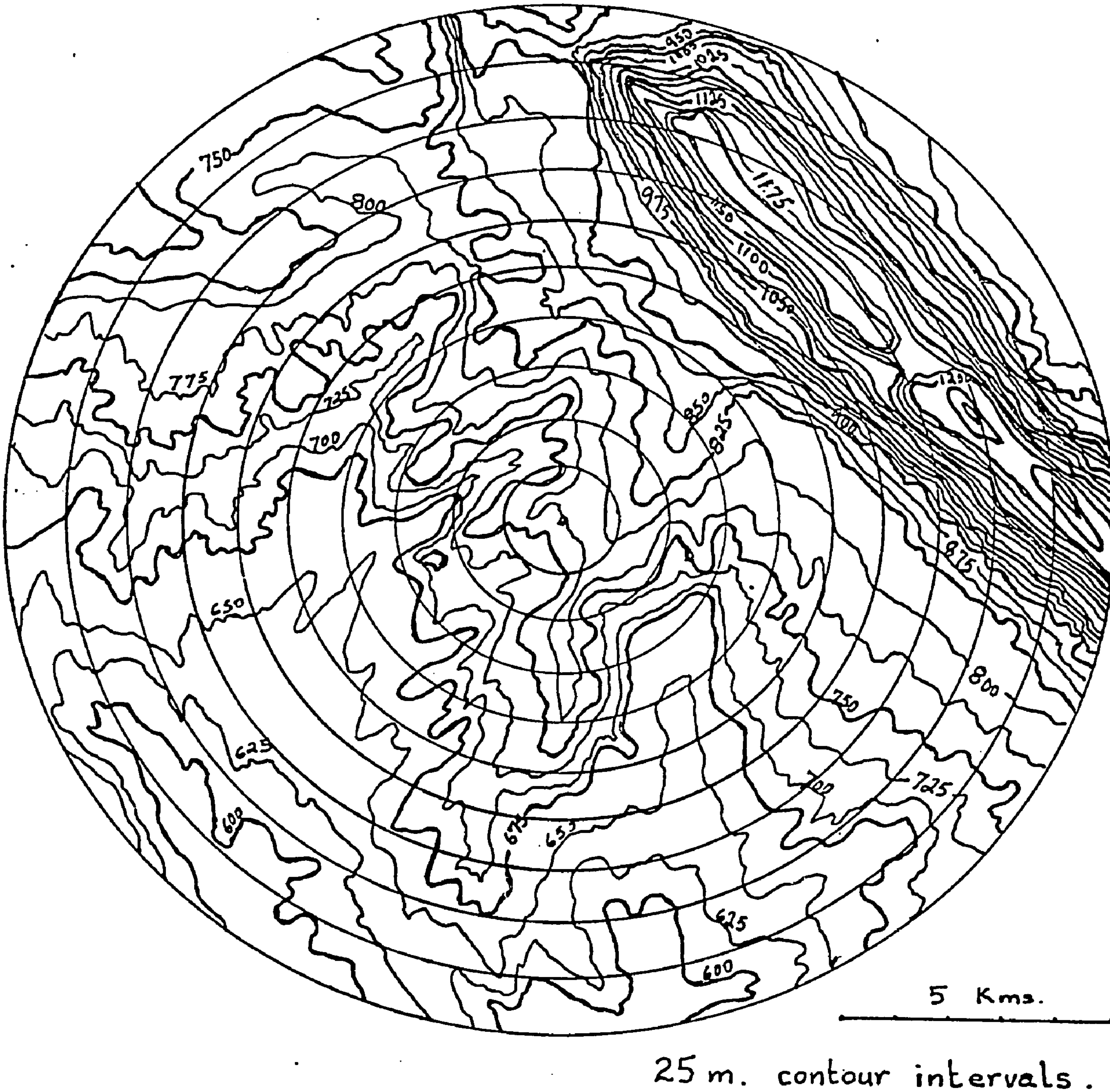
The tool industry is described as a microlithic blade-tool industry utilizing both flint and obsidian. Among the tool types found were sickle blades, some of which retain traces of bitumen. Indications of possible food preparation was noted in the recovery of mortars, pestles, and querns.

Faunal analysis revealed the presence of an equid, possible the onager (Equus hemionus), gazelle (Gazella subgutterosa), wild goat (Capra hircus aegagrus), domestic goat (Capra hircus hircus), sheep (ovis orientalis), Bovid (Bos (?) primigenius), red deer and roe deer (Cervus elaphus and Capreolus capreolus), pig (Sus scrofa), Bear (Ursus arctos), wolf (Canis lupus), leopard (Panther pardus), as well as a number of small mammals, crustaceans, fish and birds (Braidwood and Howe 1960: 47-48). Goats, sheep, dogs and pigs are currently considered among the domesticated present at Jarmo (Braidwood 1967: 118).

Among the cereals recovered was one-seeded wild einkorn (Triticum boeticum ssp. aegilopoides), domesticated einkorn (Triticum monococcum), wild and domesticated emmer wheat (Triticum dicoccoides and Triticum dicoccum), and a very primitive form of domesticated barley. The barley made up the bulk of cereal recovered, numerous specimens of which were found in clay impressions and in carbonized form. In addition to the kernels, imprints and carbonized fragments of this cereal the internodes and lateral florest were recovered. Some fragments consisting of several joined internodes indicated that the axis was not brittle as in the wild form (Helbaek 1960: 108; 1966: 358).

Imprints of spikelets and carbonized grains of emmer wheat were also recovered, indicating a "crop of conspicuously mixed character", with spokelets ranging from large coarse types similar to wild emmer to more delicate types as in domesticated forms (Helbaek 1960: 102). Other food sources mentioned include the field pea, lentil, blue vetchling, pistachio and acorn (Braidwood and Howe 1960: 47).

Daniel Zohary (personal communication) considers the present-day environmental conditions of the Chemchemal plain as ideal for initial experiments with agriculture: i.e., the combination of rich alluvial soils with moderate amounts of rainfall (about 500 mm. per year at Jarmo - van Zeist 1969: 42) - conditions which would promote the growth of cereals.



Map 9. Qalat Jarmo Site Vicinity. From U.S. Army Map Service, 1942.

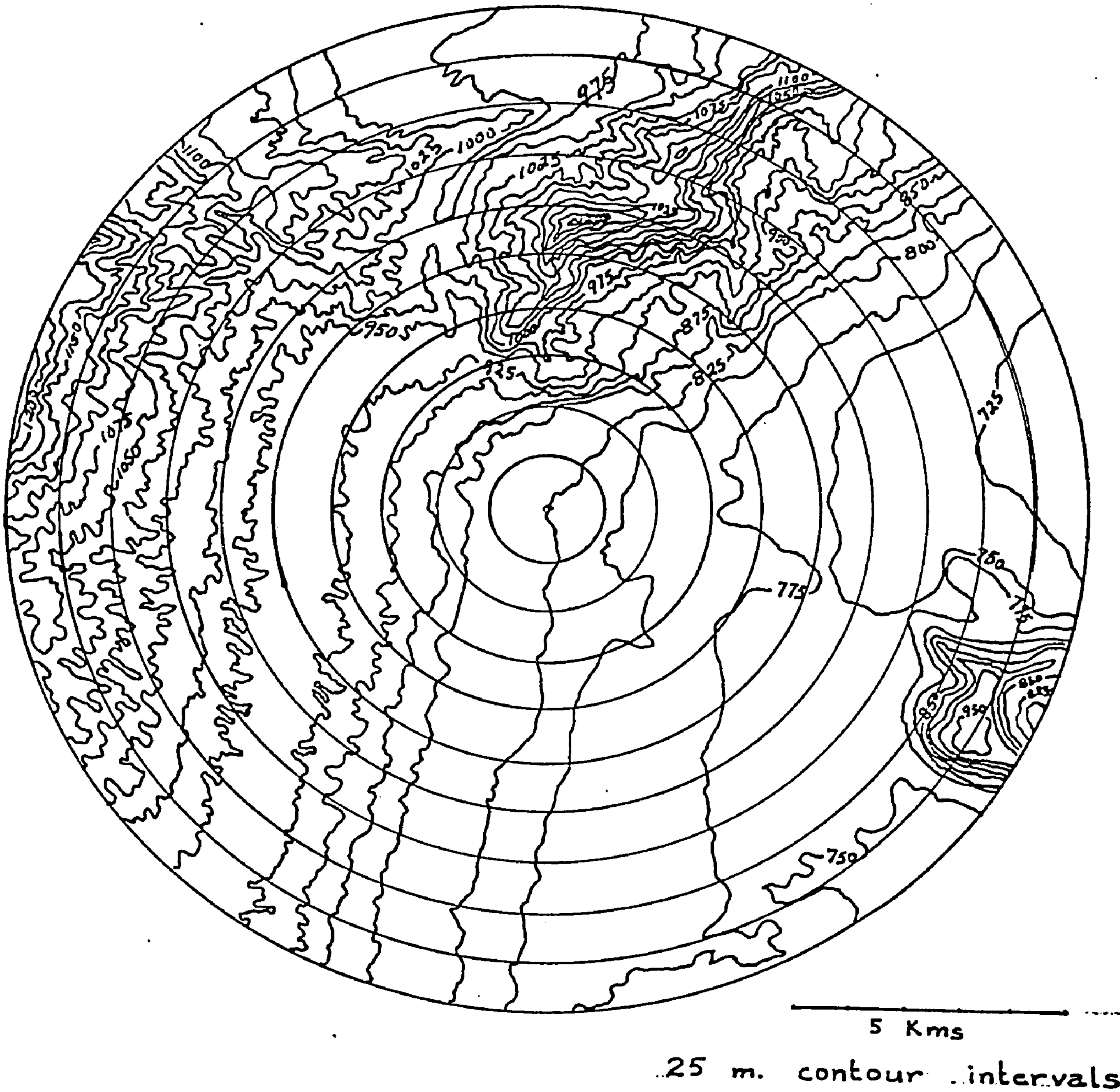
TELL RAMAD (de Contenson 1971; de Contenson and van Liere 1964; van Liere and de Contenson 1963; van Zeist and Bottema 1966)

Tell Ramad is located fifteen kilometers southwest of Damascus on a limestone plateau adjacent to the eastern slopes of Mount Hermon. The site, situated at an altitude of 830 meters, borders a perennial stream arising from a spring. The annual amount of rainfall received at Tell Ramad averages 300 mm. (Carte Pluviometrique du Liban 1955).

De Contenson (1971: 278-285) reports the excavation of three main occupation levels. Level 1, founded on virgin soil, has radiocarbon average dates of 6250 ± 80 B.C. Huts built of pisé together with a flint industry with the Contenson (1971: 279) describes as showing similarities to both PPNB and Ras Shamra VC were found. Level 2 contained rectangular mud brick houses, with a flint industry largely restricted to the Ras Shamra tradition. The radiocarbon average dates for this level are 5950 ± 50 B.C. and 5930 ± B.C. In level 3, the first ceramics were encountered of a type related to Dark Faced Burnished Ware. No architectural remains were found and no radiocarbon dates were reported for this uppermost level.

Domesticated plants were already present in the lowest layers of Ramad, and it was concluded that the "first settlers at Ramad brought the knowledge of cultivation with them from elsewhere" (van Zeist and Bottema 1966: 180). The cultivars included hulled two-row barley

(*Hordeum distichum*), emmer wheat (*Triticum dicoccum*), einkorn wheat (*Triticum monococcum*), club wheat (*Triticum compactum*) and lentil (*Lens culinaris*). Wild foodstuffs were also encountered and included almond (*Amygdalus communis*), hawthron (*Crataegus azarlus*) and pistachio (*Pistachia atlantica*). No wild cereals were reported.



Map 10. Tell Ramad Site Vicinity. From Map of Katana District (in Arabic), 1940.

APPENDIX

Site Vicinities Micro-Environmental Index.

	0 - 50					50 - 100					100-150					150-200				
	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H
BEIDHA																				
'EYNAN						2	24	-	7	22	1	26	8	20	2	-	19	1	13	1
HAYONIM	5	1	19	14	63	13	-	8	21	8	5	2	8	8	1	6	1	4	6	1
MUREYBIT																				
NAHAL OREN	-	-	-	25	43	-	2	2	14	-	2	1	4	17	-	8	5	7	15	1
ALI KOSH											8	6	12	21	126	33	12	43	38	15/6
CAYONU																				
JARMO																				
RAMAD																				

	200-250					250-300					300-350					350-400				
	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H
BEIDHA						1	-	-	1	-	5	-	-	9	1	4	-	-	7	-
'EYNAN	1	9	4	12	1	6	6	2	12	1	9	12	5	17	1	5	6	5	15	3
HAYONIM	14	-	16	23	3	15	6	25	12	2	10	2	10	6	-	4	1	9	6	2
MUREYBIT						12	34	21	35	14	14	18	49	37	29	9	20	17	19	7
NAHAL OREN	7	1	9	16	-	12	2	11	14	-	6	2	6	11	-	12	2	16	8	2
ALI KOSH	21	1	10	14	4	4	-	2	-	-	-	-	1	-	-					
CAYONU																				
JARMO																				
RAMAD																				

	400-450					450-500					500-550					550-600				
	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H
BEIDHA	2	-	-	17	-	5	-	-	18	-	6	-	3	11	-	7	-	5	19	-
'EYNAN	3	7	11	12	-	2	4	15	10	-	4	2	6	9	1	6	7	4	8	2
HAYONIM	4	-	8	7	1	2	-	12	8	3	3	11	6	7	1	6	2	6	6	-
MUREYBIT	-	-	1	-	-															
NAHAL OREN	21	3	11	10	1	2	7	4	-	4	-	2	-	-	-					
ALI KOSH																				
CAYONU																				
JARMO											1	-	-	4	-	1	-	2	6	2
RAMAD																				

	600-650					650-700					700-750					750-800				
	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H
BEIDHA	7	2	3	9	-	1	-	1	7	-	-	-	-	7	1	-	-	-	3	-
'EYNAN	4	4	7	5	3	3	6	6	4	1	4	8	8	3	2	5	7	4	2	-
HAYONIM	3	1	4	4	-	4	-	3	2	-	1	-	2	4	-	-	-	3	1	-
MUREYBIT																				
NAHAL OREN																				
ALI KOSH																				
CAYONU																				
JARMO	-	2	26	8	8	1	4	29	25	9	1	10	37	27	8	9	8	46	38	9
RAMAD											-	8	1	3	23	8	6	13	4	66

	800-850					850-900					900-950					950-1000				
	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H
BEIDHA	1	-	-	6	-	1	1	-	8	-	2	-	3	24	-	-	1	5	32	-
'EYNAN																				
HAYONIM																				
MUREYBIT																				
NAHAL OREN																				
ALI KOSH																				
CAYONU	7	1	31	4	29	24	6	52	23	12	19	9	43	11	10	16	24	36	10	6
JARMO	-	7	19	50	5	-	8	3	32	4	6	5	3	20	1	1	2	1	7	-
RAMAD	6	20	7	-	5	4	20	11	4	1	-	31	19	6	14	4	31	19	7	17

	1000-1050					1050-1100					1100-1150					1150-1200				
	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H
BEIDHA	-	2	2	28	1	-	1	3	22	-	1	-	2	30	-	6	1	1	25	-
'EYNAN																				
HAYONIM																				
MUREYBIT																				
NAHAL OREN																				
ALI KOSH																				
CAYONU	9	13	18	4	12	6	4	14	4	4	3	1	5	5	9	-	4	5	1	-
JARMO	-	2	3	4	-	1	2	1	2	-	1	4	-	-	-	5	10	-	7	1
RAMAD	10	24	10	4	2	10	19	9	2	1	3	4	4	-	-	4	8	-	1	-

	1200-1250					1250-1300					1300-1350					1350-1400				
	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H
BEIDHA	10	1	1	17		1	1	-	14		3	-	-	6		2	-	1	6	
'EYNAN																				
HAYONIM																				
MUREYBIT																				
NAHAL OREN																				
ALI KOSH																				
CAYONU	-	-	1	1	1															
JARMO	1	-	4	2	-	-	-	3	-	-	1	-	1	-	1	-	-	1	-	-
RAMAD	-	2	-	-	-															

	1400-1450					1450-1500					1500-1550					1550-1600				
	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H
BEIDHA	3	3	1	11		4	7	5	12		16	4	8	9		16	4	7	8	1
'EYNAN																				
HAYONIM																				
MUREYBIT																				
NAHAL OREN																				
ALI KOSH																				
CAYONU																				
JARMO	-	-	2	1	-	-	-	1	-	-	-	-	1	1	-					
RAMAD																				

	1600-1650					1650-1700					1700-1750					1750-1800					1800-1850					TOTAL MICRO-ENVIRONMENTS
	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	N	E	S	W	H	
BEIDHA	5	3	3	12	-	-	8	1	8	-	-	4	-	3	1	-	-	-	1	-						604
'EYNAN																										485
HAYONIM																										486
MUREYBIT																										483
NAHAL OREN																										348
ALI KOSH																										500
CAYONU																										477
JARMO																										554
RAMAD																										475

CONCLUSION

A hypothesis regarding locational determinants of pre-agricultural communities in the Near East has been tested and tentatively supported by an environmental model which employs the maturational characteristics of wild wheat and barley. To test the hypothesis that collection scheduling was an important locational determinant for pre-agricultural communities, nine pre-agricultural and early agricultural site vicinities were analyzed and ranked according to the amount of potential harvest time available within each respective site vicinity. The pre-agricultural site vicinities ranked highest as a group, with four of the first five pre-agricultural sites tested among the first five positions.

The site-specific analysis undertaken in this paper contrasts with the macro-environmental approach inherent in a recent demographic model of the transition to food production - the "Flannery-Binford" disequilibrium model (Binford 1968, Flannery 1969, Gary Wright 1971). According to this model, food production began as a response to population pressure in optimal resource zones, with population-resource disequilibrium necessitating the migration of excess population to surrounding marginal resource zones. As employed by Flannery (1969), the optimal zone from which population pressure arose in the Near East was the natural habitat zone of wild cereals and ungulates, the Mediterranean oak-woodland belt of uplands extending from the Levant through the Zagros. Gary Wright (1971) also adopted this model, incorporating climatic evidence in its defense.

A number of criticisms can be made of this approach, and in the comments following the article by Gary Wright, Hole (1971: 472-473) noted several:

a) The evidence from studies in behavioral ecology (Birdsell 1968; Klopfer 1962) indicating that populations are ordinarily maintained below the carrying capacity of the land.

b) The lack of evidence in support of a population increase immediately prior to the advent of domestication.

c) The inadequacy of present data in specifying the location and extent of optimal resource zones.

The population implications of the Flannery-Binford model become clear when one considers the amounts of wild cereals presently available. Commenting on the recovery of wild cereals in the upper Jordan Valley since grazing restrictions were imposed, Zohary (1969: 56) notes the presence of wild emmer and barley throughout this extensive region "over many kilometers". Yields have been estimated at between 50-80 kilograms over 1000 square meters (500-800 kilograms per hectare), not far below the yields locally attained under wooden plow agriculture of 500-1500 kilograms per hectare (Zohary 1969: 56). In terms of the minimum yields quoted above, one square kilometer of such land would yield about 500 metric tons of grain. Similarly, Harlan and Zohary (1966: 1978) report for Diyarbakir province: "Over many thousands of hectares it would be possible to harvest wild wheat today from natural stands almost as dense as a cultivated wheat field". Further, wild barley is "abundant in southeast Turkey and through the hilly parts of Iraq and along the slopes of the Zagros at elevations from 500 to 1500 meters" (Harlan and Zohary 1966: 1076).

While direct populations estimates for the pre-agricultural Near East are not possible, an indirect calculation has been made which infers that the early Holocene population for this region must have been of very modest size by modern standards. Interested in testing the validity of the widely-held belief that the "Neolithic Period" in the Near East was marked by rapid population growth, Carneiro and Hilse (1966) projected a number of average annual growth rates over a period of four millenia - from 8000 to 4000 B.C. These growth rates were applied to base populations of 100,000 and 50,000 for the entire Near East (i.e. from the eastern border of Iran through Egypt). This study indicates that the few millenia after the transition to agriculture were not characterized by large average growth rates, since only very modest percentage increases result in realistic population totals at the end of the 4000-year span. As Carneiro and Hilse point out, the application of a rate of only one-half of one percent on a base population of 100,000 would produce a terminal population of 46,200,000,000,000! The employment of a rate of only two-tenths of one percent in such a population still results in an impossibly high of 150,000,000 for the Near East ca. 4000 B.C.

While Carneiro and Hilse's concern centers on population growth, their study serves to indicate that (assuming some growth rate in population) only relatively small initial populations - probably in the tens of thousands - seem feasible. The concept of the natural habitat of wild wheats and barley as a largely homogeneus macro-environment, in which abundant wild cereal resources were used to the limits of their carrying capacities, suggests unacceptably high population estimates. Even if one concedes that the "natural habitat" of cereals might have been much smaller during the early Holocene, population-resource disequilibrium models remain dubious. Based on Zohary's figures quoted above, only five square kilometers of wild cereal lands in the upper Jordan Basin could supply twenty-five thousand metric tones of wheat and barley. At an arbitrary per-capita consumption rate of 500 kilograms per year, 50,000 people could be supported by this small area of cereal-bearing land.

A further shortcoming in the macro-environmental zone approach is the implausibility of placing sites located at vastly differing elevations within a similar environmental zone - as with 'Eynan and Beidha, where a thousand metter difference in altitudes exists.

The support given the hypothesis tested in this paper must be qualified by the small number of sites tested, and by uncertainties in categorizing some sites as pre-agricultural or early agricultural (note, for example, the conflicting interpretations of paleo-botanical data from Mureybit - page 42). The findings of the analysis in this paper can be described as a tendency for pre-agricultural site vicinities to exhibit greater topographical variation (and therefore longer potential wild cereal collection periods) than early agricultural site vicinities. Further confirmation awaits the availability of additional archaeological data - especially site reports of early Holocene settlements.

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