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The Rise and Fall of Seasonal Mobility among Hunter-Gatherers

The Case of the Southern Levant¹

by Daniel E. Lieberman

Most hunter-gatherers use circulating mobility strategies, moving frequently from habitat to habitat on a seasonal basis because it avoids the problem of resource depletion around sites. New evidence for seasonal mobility from the southern Levant indicates that while most Upper Pleistocene hunter-gatherers employed circulating mobility strategies, migrating seasonally from the highlands to the lowlands, both archaic humans 60,000–80,000 years ago and Natufians 12,000 years ago employed radiating ones. Radiating mobility is inherently unstable in most environments because of resource depletion and is documented ethnographically only among hunter-gatherers in rich environments with plentiful, storable resources (such as marine habitats) or in situations of trade with agriculturalists and/or pastoralists. Both archaic humans and early modern humans compensated for the resource depletion caused by radiating mobility by intensifying their subsistence strategies—but with different effects. Archaic humans appear to have responded with more hunting, whereas the Natufians broadened their subsistence base not only by relying more on hunting but also by intensively gathering cereals, storing food, and ultimately inventing agriculture.

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has published (with R. H. Meadow) "The Biology of Cementum Increments (with an Archaeological Perspective)" (*Mammal Review* 22:57–77), (with J. Shea) "Behavioral Differences between Archaic and Modern Humans in the Levantine Mousterian" (*American Anthropologist*, in press), and "Life History Variables Preserved in Dental Cementum" (*Science*, in press). The present paper was submitted in final form 27 v 93.

It is a long-standing assumption in anthropology that hunter-gatherers tend to be mobile and agriculturalists tend to be sedentary. While ethnographic and archaeological studies (e.g., Eder 1984, Price and Brown 1985, Preucel 1990, Kelly 1992) have shown that not all agriculturalists live in permanent villages and not all hunter-gatherers are constantly on the move, this dichotomy appears to be generally correct. Frequent seasonal movement from habitat to habitat may be a quintessential hunter-gatherer strategy, unique to humans,² but little is known about its nature and evolution during the Palaeolithic. How ancient is the pattern, how did it evolve, and how and why did it eventually change?

The southern Levant, the southeastern corner of the Mediterranean basin, is a particularly interesting region in which to study the evolution of hunter-gatherer seasonal mobility because of several important events that occurred there. First, at least two kinds of humans lived in the region in the course of the Upper Pleistocene. Early anatomically modern humans, recovered at Qafzeh and Skhul, hunted and gathered in the Mediterranean forest zones of the southern Levant approximately 115,000 to 80,000 years ago, while archaic humans (Neanderthals), found at Kebara, Tabun, and Amud, inhabited the same region approximately 100,000 to 50,000 years ago under relatively similar environmental conditions (Valladas et al. 1988, Schwarcz et al. 1988, Grün and Stringer 1991, Bar-Yosef 1992, Mercier et al. 1993). Although there are clear morphological differences between archaic and early anatomically modern humans (Trinkaus 1992),³ both hunted the same animals, made similar Middle Palaeolithic tools, and even occupied some of the same sites. The archaeological similarities between sites associated with the two kinds of humans

2. Chimpanzees, gorillas, and orangutans, for example, tend to live in relatively small territories and preferentially use certain areas within these ranges on a seasonal basis (MacKinnon 1974, Vedder 1984, Goodall 1986, de Boekhorst, Schürmann, and Sugardjito 1990). The only documented examples of seasonal mobility among primates are a few groups of highland baboons, who live at such extreme altitudes that they must move seasonally from lower to higher elevations within their territories (Whiten, Byrne, and Henzi 1987). Such migrations, however, are on a much smaller scale than those regularly observed in human groups.

3. There is little agreement whether early anatomically modern humans and archaic humans (e.g., Neanderthals) should be assigned to the same species (see Tattersall 1986, Stringer and Andrews 1988, Wolpoff and Thorne 1992). While this is an important problem, it is beyond the scope of this paper. The numerous derived characters of each group clearly warrant that they be separated on some taxonomic level, but in this paper I make no assumptions as to whether they could have interbred.

raise the question whether there were any significant behavioral differences between them (Wolpoff 1989).

Following the Middle Palaeolithic, modern human hunter-gatherers occupied the southern Levant more or less continuously until approximately 10,300 years ago, when a second and perhaps more dramatic change occurred in the Levant—the origin of agriculture. The oldest evidence for domesticated plants comes from a period known as the Pre-Pottery Neolithic A (Bar-Yosef and Kislev 1989), which immediately follows the Natufian cultural complex, dated to between 12,800 and 10,300 years ago (Zohary and Hopf 1988; Bar-Yosef and Belfer-Cohen 1989, 1992; Henry 1989). Presumably the Natufians or their immediate descendants invented agriculture. The Natufians were hunter-gatherers, but they differed from previous hunter-gatherers in the Levant in many significant respects (Belfer-Cohen 1991): they lived in large, complex sites with permanent architecture, produced numerous sickle blades, grinding stones, and much of the first art from the region, buried their dead in cemeteries, and domesticated the dog. Most archaeologists assume that the first agriculturalists who followed the Natufians were sedentary farmers who lived in permanently occupied villages year-round, but were the hunter-gatherer Natufians also sedentary? Was sedentism a process that occurred as a *result* of domestication, or was it a process that preceded and perhaps *caused* the first food production?

Hunter-gatherer mobility in the southern Levant and elsewhere is closely linked to seasonality. Seasonal variations in rainfall and temperature impose significant constraints on hunter-gatherers who do not produce food and must therefore occasionally move to follow changes in the spatial and temporal distribution of resources. Anthropologists have long recognized that hunter-gatherer groups tend to be characterized by frequent movements from one habitat to another, but recent attention to seasonality has highlighted some basic strategies of hunter-gatherer seasonal mobility (Lee and DeVore 1968; Jochim 1976; Yellen 1977; Binford 1980; Winterhalder 1981; Kelly 1983, 1992; Speth and Spielmann 1983; Gamble 1986; Laden 1992). Hunter-gatherers usually move when the daily cost of foraging in a particular region becomes greater than the cost of moving to another. Typically, they move seasonally from lowland to highland regions or from the coast to the interior. In areas with relatively little food, hunter-gatherers tend to move frequently and to camp in the center of habitats; in rich environments they are almost always less mobile and tend to camp near ecotones, where resources from several habitats can be gathered or hunted from the same site (Kelly 1983). They generally disperse during seasons of food shortage and aggregate during seasons of bounty.

Hunter-gatherer mobility strategies vary widely but can be classified in terms of the distribution and availability of resources and the social relations of production as (1) *circulating* (or residential) or (2) *radiating* (or logistical) (Chang 1962, Binford 1980). Circulating mobility is typical of *foragers*, who depend on daily hunting and

gathering to acquire sufficient resources. It is characterized by frequent residential moves from one seasonal camp to another in a circular annual movement. Radiating mobility is typical of *collectors*, who rely on logistical organization to acquire, store, and distribute resources. It is characterized by relatively permanent base camps occupied for more than one season that are connected to seasonally occupied camps situated near key resources (Mortensen 1972, Binford 1980). The differences between radiating and circulating mobility are important because of their potential social and environmental effects.

Ethnographic and ethnohistoric records indicate that circulating mobility is a stable mobility strategy for hunter-gatherers in a variety of environments (for reviews, see Lee and DeVore 1968; Hayden 1981*b*; Binford 1980, 1991; Butzer 1982, Kelly 1983, 1992; Gamble 1986). Circulating mobility has been documented in tropical savannah or arid environments such as among the Bushmen in the Kalahari (Lee 1976, Yellen 1976), the Hadza of Tanzania (Woodburn 1972), and many Aboriginal groups in Australia (Gould 1980), in tropical forested environments such as among the Agta of the Philippines (Peterson 1978, Griffin 1989) and the Efe Pygmies in central Africa (Laden 1992), in temperate forest environments such as the Great Basin (Fowler 1971) and California (Kroeber 1925), and in temperate steppe and arctic environments such as among the Inuit (Binford 1991). Circulating mobility makes sense for nonagriculturalists in most environments because it allows them to avoid the resource depletion associated with long-term habitation of a single site or region (Halstead and O'Shea 1989). Foraging and hunting in the same region will inevitably reduce the density of exploitable resources, resulting in the need to spend more time and energy to maintain adequate levels of food intake (Hames and Vickers 1983). Circulating mobility also allows hunter-gatherers to exploit a greater variety of high-quality resources that would otherwise not be available in one habitat. Other benefits include flexibility of group size and location (Smith 1981), reduction of social stress and conflict (Lee 1979, Woodburn 1980), and lower probability of endogamy. Circulating mobility, however, involves a number of costs, including moving and transportation, limitations on property and untransportable resources, the higher risk associated with long-term storage, and increased foraging time in less well-known or well-monitored environments (O'Connell and Hawkes 1981, Gamble 1986).

Not all hunter-gatherers, however, are characterized by circulating mobility. Hunter-gatherers of the American Northwest Coast (Ames 1985, Hayden et al. 1985), the Calusa of Florida (Marquardt 1985), and the Ainu of Japan (Watanabe 1972) lived in permanent or relatively permanent base camps from which they made short trips to specialized camps to acquire resources for storage. This radiating mobility strategy, impossible for hunter-gatherers in most environments because of resource depletion, can occur in rich marine environments with plentiful resources that are available year-round

(Yesner 1980). Radiating mobility—even sedentism—is also possible in situations with trade between hunter-gatherers and either agriculturalists or pastoralists (Testart 1982, Headland and Reid 1989). Contact sedentism, for example, has been documented among !Kung who trade with Herero pastoralists (Denbow 1984), Okiek who trade with Maasai (Marshall 1991), and Efe who trade with Lese agriculturalists (Laden 1992). Sedentism or reduced mobility among hunter-gatherers is important because it is associated with increased cultural complexity (Bender 1978, Woodburn 1980, Testart 1982, Cohen 1985, Price and Brown 1985, Bentley 1985). Although some modern hunter-gatherer groups are or were sedentary, it is not known how common sedentism was among prehistoric hunter-gatherers, largely because of the problems of identifying sedentism or other forms of reduced mobility in the archaeological record (Hitchcock 1989, Rafferty 1985, Edwards 1989, D. Lieberman 1991).

The differences between circulating and radiating mobility have significant implications for our understanding of the evolution of hunter-gatherers in the southern Levant. This study examines the history of hunter-gatherer seasonal mobility in the Levantine Upper Pleistocene by focusing on evidence for circulating and radiating mobility strategies and their effects in the archaeological record. New data on the season of occupation of sites are presented and evaluated in the context of information on subsistence, lithic technology, site distribution and structure, and resource availability from the Middle Palaeolithic through the Natufian.

The Southern Levant during the Upper Pleistocene

PALAEOENVIRONMENTAL HISTORY

The complex cultural history of the southern Levant is closely linked to the region's unique topography, biogeography, and climate. The southern Levant is only about 400 km long, with a narrow habitable area roughly 75–150 km wide. It is unusually heterogeneous in flora and fauna because it is the only land corridor between Africa and Eurasia and because it consists of five major geomorphological strips that create a diverse transect from west to east (fig. 1): the coastal plain, the central hills, the Jordan Valley, the Transjordanian Plateau, and the Syro-Arabian Desert. These geographic regions correlate well with the distribution of the region's three major plant-geographic zones: the forested Mediterranean, the stepic Irano-Turanian, and the desertic Saharo-Arabian (Zohary 1962). The Mediterranean zone covers the coastal plain, the central hills, and parts of the Transjordanian Plateau; the steppe is distributed in the Jordan Valley and on the southern and eastern margins of the Levant; and the desert borders the steppe to the south and east. Resources in the southern Levant are also temporally diverse because the highly seasonal Mediterranean climate results in marked seasonal differences in their dis-

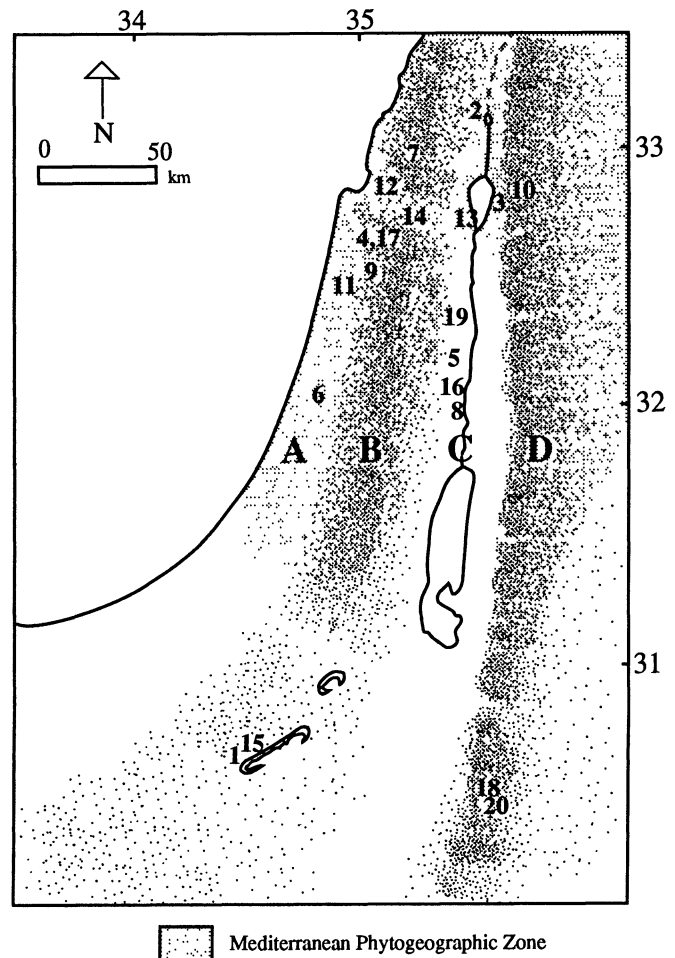


FIG. 1. The southern Levant, showing topogeographic zones, present-day distribution of the Mediterranean phytogeographic zone, and sites discussed in the text. A, coastal plain; B, central hills; C, Jordan Valley; D, Transjordanian Plateau; 1, Abu Salem; 2, Ain Mallaha; 3, Ein Gev I; 4, el-Wad; 5, Fazael VI and VII; 6, Hatoula; 7, Hayonim; 8, Jericho; 9, Kebara; 10, Nahal Ein Gev I; 11, Nahal Hadera; 12, Neve David; 13, Ohalo II; 14, Qafse; 15, Rosh Horeshe; 16, Salibiya I; 17, Tabūn; 18, Tor Hamar; 19, Urkan e-Rub IIa; 20, Wadi Judayid.

tribution. Rain falls only during the relatively mild winter from November to March; the summer is long, dry, and hot (Jaffe 1988).

The small size, the highly seasonal climate, and the topogeographic and phytogeographic diversity of the southern Levant have important consequences for hunter-gatherer mobility. Seasonal movements would allow hunter-gatherers to take maximum advantage of a rich variety of resources in both lowland and highland zones of the Mediterranean forests, the Irano-Turanian steppe, and even parts of the desert. There are no ethnographic or ethnohistoric records of hunter-gatherers in the southern Levant, but evidence from recent hunter-

gatherers elsewhere suggests that southern Levantine hunter-gatherers probably migrated from lowland to highland habitats on a seasonal basis, spending the winter and spring in the lowlands either near the coast or in the Jordan Valley and then moving into the hills or inland areas during the summer and fall. The Mediterranean forest zone, particularly on the coastal plain and in the central hills, has been the focus of hunter-gatherer activities for the past 200,000 years (Bar-Yosef 1987). Mediterranean forests provide a considerable array of edible plant resources, including cereals and legumes in the spring and summer, nuts and fruits in the fall and winter, and leaves and tubers throughout the year. They are also rich in medium-sized and large mammals such as mountain gazelle (*Gazella gazella*), red deer (*Cervus elaphus*), fallow deer (*Dama mesopotamica*), aurochs (*Bos primigenius*), and pig (*Sus scrofa*). The Irano-Turanian steppe also has a number of edible plant resources, the most important of which are cereals (e.g., barley, einkorn, and wheat) and other annuals that grow during the spring and early summer after the winter rains. This zone does not, however, provide many edible plant resources during the rest of the year and has a much lower density and diversity of medium-sized and large mammals—mainly *G. gazella* (and more recently *G. dorcas*) in the lowlands and *Capra ibex* in the highlands. Although fruits and other edible plants are found near oases in the Saharo-Arabian zone (Danin 1988), desertic regions were probably never extensively used by hunter-gatherers.

In order to reconstruct the seasonal mobility strategies of hunter-gatherers in the southern Levant in the Upper Pleistocene, we need data on how climatic changes affected the distribution of resources over time. Many details of the climatic history of the southern Levant remain unresolved, but palynological and paleontological evidence indicates that the relative distribution of phytogeographic zones has changed more than their species composition (Horowitz 1979, 1988; Garrard 1980; van Zeist and Bottema 1982; Tchernov 1988). While the southern Levant has experienced wide fluctuations in both rainfall and temperature in the past 130,000 years (fig. 2), the three major phytogeographic zones with their corresponding fauna have persisted in a fluctuating mosaic. During warm and dry periods—between 130,000 and 115,000 years ago—the configuration of the region was very similar to the present, but during relatively cool and dry periods—between 75,000 and 60,000 and between 20,000 and 14,500 years ago—the Mediterranean zone retreated to well-watered areas in the coastal plain and central hills and along rivers and lakes as the Saharo-Arabian and Irano-Turanian regions expanded (Horowitz 1979, 1988; Henry 1987a). During cool and wet periods—between 115,000 and 75,000, 60,000 and 20,000, and 14,500 and 13,000 years ago—the Mediterranean belt expanded at the expense of the stepic and desertic zones (Goldberg 1986, Goodfriend and Magaritz 1988).

Upper Pleistocene climatic changes affected the distribution of the Mediterranean phytogeographic zone

mostly *outside* the coastal plain and central hills. This core region remained *within* the Mediterranean forested zone throughout the period (Bar-Yosef 1987, 1990) while the southern and eastern peripheries of the southern Levant experienced dramatic changes (Goldberg 1986). For most of the Upper Pleistocene the Levant probably received the highly seasonal rainfall that characterizes the region today (Bar-Yosef and Belfer-Cohen 1992).

CULTURE HISTORY

The history of occupation of the southern Levant during the Upper Pleistocene (fig. 2), recently summarized by Bar-Yosef (1992) and by Bar-Yosef and Belfer-Cohen (1992), reflects these climatic changes. The core Mediterranean zone was continuously occupied, but the arid peripheries were inhabited only during periods of increased rainfall (Henry 1987, Goldberg and Bar-Yosef 1982). Whereas some researchers (e.g., Clark and Lindly 1989) see the region's culture history as a gradual, local evolution from archaic to modern humans in the same region, the Levant's location between Africa and Europe has always made it a meeting place of African and Eurasian biota (Tchernov 1988). While many changes in the southern Levantine archaeological record represent local innovations, others may have resulted from the migration of peoples from the north or the south.

The Levantine Mousterian and associated hominids are best known from several deeply stratified large cave/rock-shelter sites (Ksar Akil, Yabrud, Tabūn, Skhūl, Kebara, Qafzeh, and Amud) that date to oxygen-isotope stages 4–6, between 45,000 and more than 150,000 years ago (Grün and Stringer 1991, Mercier et al. 1993). Levantine Mousterian lithic assemblages are characterized by high percentages of unretouched Levallois tools (Meignen and Bar-Yosef 1989), divided into three major lithic industrial phases that are based on the sequence of assemblages from Tabūn Cave (Garrod and Bate 1937, Copeland 1975, Jelinek 1982, Meignen and Bar-Yosef 1988). The most recent, Tabūn B, is characterized by unidirectional convergent core preparation and relatively high percentages of points; Tabūn C is older than Tabūn B and is characterized by radial core preparation and low percentages of points and numerous broad flakes and retouched tools; the oldest, Tabūn D, is characterized by unidirectional and bidirectional core preparation and large numbers of blades and elongated points (Meignen and Bar-Yosef 1988).

The Levantine Mousterian archaeological record is correlated to some extent with the hominid fossil record. Anatomically modern *Homo sapiens* remains have been excavated at Skhūl, Tabūn, and Qafzeh, associated with Tabūn C industries in deposits dated to between 80,000 and 120,000 years ago (Garrod and Bate 1937, Vandermeersch 1981, Schwarcz et al. 1988), and remains of archaic *H. sapiens* have been uncovered at Amud, Kebara, and perhaps Tabūn,⁴ associated with Tabūn B

4. There is some debate over the provenience of the Tabūn 1 Neanderthal female skeleton. Garrod noted that the fossil was found

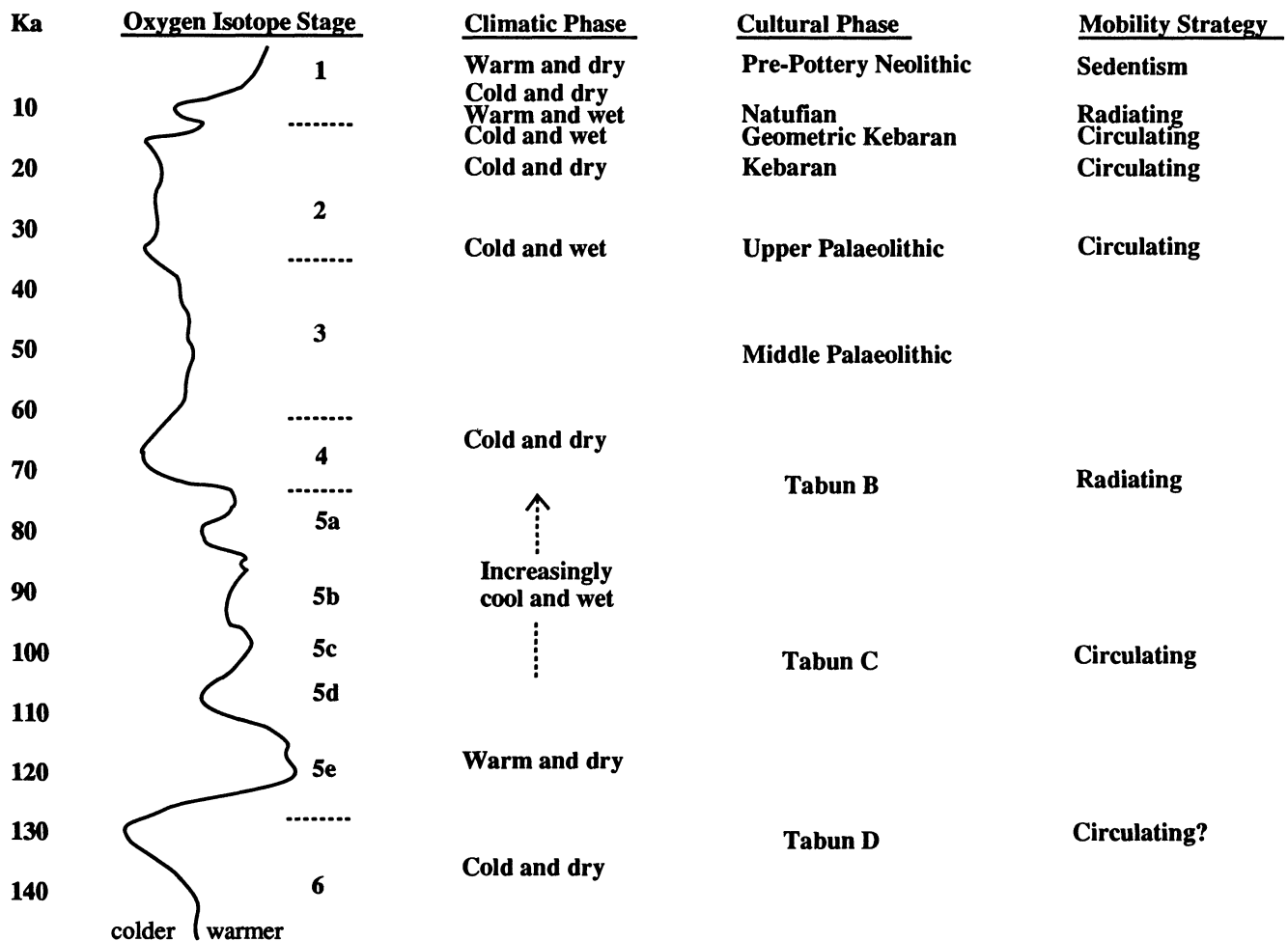


FIG. 2. Culture history, palaeoenvironmental changes, and hunter-gatherer mobility patterns in the southern Levant during the Upper Pleistocene.

industries in deposits dated to between 60,000 and 100,000 years ago (Garrod and Bate 1937, Suzuki and Takai 1970, Smith and Arensburg 1977, Valladas et al. 1987, Bar-Yosef et al. 1992). Apparently, archaic *H. sapiens* migrated south to the Levant from southeastern Europe or Anatolia during the glacial conditions of oxygen-isotope stage 4. While the morphological differences between archaic and modern humans imply some difference in behavior (Trinkaus 1992), researchers have found few archaeological indicators of behavioral contrasts between these taxa other than the relative proportion of tools attributable to the different Tabun B and Tabun C core reduction sequences. Archaic and modern humans

used tools in similar ways (Shea 1991), built fires, buried some of their dead (Belfer-Cohen and Hovers 1992), and hunted the same medium-sized and large animals. Unfortunately, there has been little investigation of the behavioral processes by which these archaeological residues were deposited. Archaic and modern humans may have used the environment differently and relied on hunting to different degrees.

The Upper Palaeolithic in the Levant, which is dated to between roughly 47,000 and 17,000 years ago (Marks 1983, Gilead 1991), comprises two different traditions, the Ahmarian and the Levantine Aurignacian. The Ahmarian, which may have evolved locally from transitional industries at sites such as Ksar Akil and Boker Tachtit (Marks and Kaufman 1983, Marks and Volkman 1986), is characterized by high percentages of blades and bladelets, with endscrapers and burins. Dates for the Ahmarian range between 40,000 and 22,000 years ago (Gilead 1991). The Levantine Aurignacian has fewer blade tools than the Ahmarian and is characterized by high percentages of burins and endscrapers that are made on flakes and thicker blanks. The typical Levantine Aurignacian appears in the southern Levant

near the contact between Tabun B and C and provisionally assigned it to Tabun C but noted that it might well be intrusive from Tabun B (Garrod and Bate 1937:166). It seems most likely that the Tabun Neanderthal comes from level B, given Garrod's initial hesitance to assign the fossil to level C and the fact that other archaic hominids have been found only in Tabun B contexts (at Amud and Kebara) and modern humans have been found only in Tabun C contexts—including a modern mandible from Tabun C. Unfortunately, the true provenience of the Tabun 1 skeleton will never be resolved.

only between ca. 32,000 and 27,000 and is restricted mostly to the Mediterranean vegetational zone, although there are a number of Aurignacian-tradition sites in the Negev and Sinai.

Subsistence and mobility strategies during the Upper Palaeolithic in the southern Levant remain enigmatic. Upper Palaeolithic sites tend to be smaller, less numerous, and more ephemeral than Middle Palaeolithic or Epipalaeolithic sites (Marks and Freidel 1977, Gilead 1991). Most archaeologists assume that hunter-gatherer groups during the Upper Palaeolithic were small and highly mobile (Marks and Freidel 1977, Coinman, Clark, and Lindly 1986, Bar-Yosef and Belfer-Cohen 1989). In contrast to the lithic assemblages, the faunal assemblages from Levantine Aurignacian sites are generally similar to those of the Middle Palaeolithic (most sites are dominated by *G. gazella* and *D. mesopotamica*). Very few Ahmarian sites have any preserved fauna, but the diversity of fauna from sites in the Sinai (Phillips and Gladfelter 1988) suggests that their subsistence strategies may have been more complicated than originally supposed. Few palaeobotanical and human remains have been uncovered from Upper Palaeolithic contexts (Arensburg 1977, Gilead 1991).

The Epipalaeolithic in the southern Levant represents an intensification and elaboration of the Ahmarian tradition during the Late Glacial Maximum beginning around 20,000 years ago. The Epipalaeolithic consists of three major cultural complexes: the Kebaran, the Geometric Kebaran, and the Natufian. The earliest of these, the Kebaran complex, dated to between 20,000 and 14,500 years ago, is characterized by backed bladelets that make up between 40% and 90% of the assemblage of most sites (Bar-Yosef 1990, Edwards 1990). Also present in the Kebaran are some ground stone tools such as mortars, pestles, and bowls (K. Wright 1991). Kebaran sites are small—between 15 m² and 400 m²—and appear to be restricted to areas in the Mediterranean vegetational zone below 900 m (Bar-Yosef 1981, 1990), a distribution reflecting the harsh, cold and dry conditions of the time. Although plant remains are rare, the newly discovered site of Ohalo II (Kislev, Nadel, and Carmi n.d.) demonstrates that Kebarans relied on harvesting wild cereals and presumably other plant resources that remain archaeologically invisible. *G. gazella* and to a lesser extent *D. mesopotamica* were the major prey species.

The Geometric Kebaran complex,⁵ dated to between 14,500 and 12,800 years ago, is defined by industries dominated by blades and bladelets that were modified mostly into trapeze-rectangles (Bar-Yosef and Belfer-Cohen 1989). Probably a response to the wetter climate at the end of the Pleistocene that resulted in an expansion of the Mediterranean vegetational zone, the Geometric Kebaran has a much wider distribution than the

Kebaran (Bar-Yosef 1990). Geometric Kebaran sites are similar to Kebaran sites in size and structure but extend from the El-Kowm basin in northeastern Syria into the Negev and Sinai and as far east as Jordan. Some researchers, such as Kaufman (1992), interpret the Geometric Kebaran as an intermediate stage between the Kebaran and the Natufian and have argued that the process of sedentarization and intensification that reached its peak during the Natufian began during the Geometric Kebaran. Most researchers, however, consider Geometric Kebaran adaptations similar to those of the Kebaran (Gilead 1988, Bar-Yosef and Belfer-Cohen 1989, Henry 1989).

The Natufian culture, first recognized and defined by Garrod (1932) and Neuville (1934), represents a period of explosive change between the end of the Palaeolithic and the beginning of the Neolithic. The Natufian, which is generally dated between 12,800 and 10,300 years ago (Belfer-Cohen 1991), is mainly concentrated in the southern Levant. Natufian assemblages are dominated by lunates, sickle blades, backed bladelets, burins, scrapers, and denticulated pieces and by diverse bone and ground stone tools (Bar-Yosef and Belfer-Cohen 1989, Henry 1989). The Natufian is commonly divided into an early phase, from 12,800 until ca. 11,000 years ago, and a late phase that lasted until about 10,500 years ago. Large Natufian sites are associated primarily with the Mediterranean zone. Contemporary with the Late Natufian in the arid peripheries of the southern Levant are several more mobile hunter-gatherer cultures, such as the Harifian (Goring-Morris 1987), that represent continuations of the pre-Natufian way of life.

Natufian settlements vary between 15 m² and over 1,000 m² (Bar-Yosef 1983) and are larger, denser, and more complex than earlier Levantine sites. Many, such as Ain Mallaha (Eynan), have numerous houses with circular stone foundations (Perrot 1966, Valla 1991). The skeletal remains of more than 370 humans have been recovered from Natufian sites (Belfer-Cohen, Schepartz, and Arensburg 1991), in contrast to the almost complete absence of burials from the rest of the Epipalaeolithic and Upper Palaeolithic in the southern Levant. Natufian burials are diverse, with variations in the position of the skeleton, the number of individuals per grave, and the presence and nature of grave goods (Perrot 1989). Such variations may reflect some degree of social stratification (G. Wright 1978) but could also be explained as different traditions that were limited in space and time. Natufian sites contain a wide variety of novel art forms, including incised and carved bone, shell, and limestone objects (Belfer-Cohen 1991). Rare objects such as shells from the Red Sea and the Nile Valley (Reese 1991, D. Bar-Yosef 1991) and obsidian from Anatolia suggest that exchange networks might have linked the Natufians to other cultures.

The Natufian coincides with major climatic changes at the end of the Pleistocene. Climatic conditions were relatively favorable during the early part of the Natufian but deteriorated rapidly during the late Natufian (Baruch and Bottema 1991). Natufian subsistence patterns

5. Closely related and contemporary with the Geometric Kebaran is the Mushabian, which is distributed on the peripheries of the Mediterranean zone on the Transjordanian Plateau and in the Negev and Sinai (see Goring-Morris 1987, Henry 1989).

changed in complex ways that are partly related to these changes. In some respects, the Natufians were resource specialists, intensively collecting wild cereals and hunting gazelle. Gazelle bones dominate almost all Natufian faunal assemblages, and cereal processing and harvesting equipment (such as sickles and ground stone tools) are very prevalent. There is also, however, an increase in the diversity of fauna in Natufian sites, with greater percentages of small animals such as hares, tortoises, and birds (Bouchud 1987, Pichon 1991, Tchernov 1991).

A number of researchers (e.g., Perrot 1966, Bar-Yosef 1983, Bar-Yosef and Belfer-Cohen 1989, Henry 1989) have linked sedentism during the Natufian with the origin of agriculture in the southern Levant. Unfortunately, evidence for Natufian sedentism is based almost entirely on data from two sites, Hayonim and Ain Mallaha, and there has been almost no evidence for the seasonal occupation of other Natufian sites or sites from previous periods. Most archaeologists (e.g., Marks and Freidel 1977, Coinman, Clark, and Lindly 1986, Bar-Yosef 1987, Henry 1989) assume that southern Levantine hunter-gatherers typically moved seasonally from lowland to highland regions, but evidence on seasonality is scarce.

Estimating Seasonal Mobility

Reconstructing seasonal mobility patterns is a major problem in the Levant and elsewhere because of the difficulty of determining the season of occupation of sites. Few unambiguous indicators of seasonality are available from archaeological sites. Seasonal activities are usually identified from the presence of animals or plants whose season of death or harvest can be determined, such as migratory species (e.g., birds), young animals whose age can be determined from tooth eruption patterns, or the pollen and seeds of plants used by the occupants of a site (Monk 1981, Davis 1983, Hillman, Colledge, and Harris 1989). These data, however, are rarely present in sufficient quantities in Palaeolithic sites, particularly in the Levant, where plant preservation is very poor. Consequently many archaeologists infer seasonality from the environmental context of sites using models of mobility or from archaeological remains that may be correlated with seasonal activities such as house structure, artifact density, or particular artifact types (Rafferty 1985, Edwards 1989, D. Lieberman n.d.a).

Seasonal bands in cementum, a little-known but important dental tissue, can provide accurate, reliable, and plentiful estimates of the season of death of animals. Cementum bands are especially useful to archaeologists because they are preserved in teeth which are common in archaeological sites and because their formation is not affected by human behavior. Cementum is a kind of bone that grows around the roots of mammal teeth in concentric bands similar to tree rings (fig. 3). When sectioned and examined under a microscope, cementum appears in alternating translucent and opaque increments: in most animals the number of bands is correlated with the animal's age at death and the outermost band is cor-

related with the animal's season of death (for reviews, see Klevezal and Kleinenberg 1967, Grue and Jensen 1979, Pike-Tay 1991, Lieberman and Meadow 1992). Opaque bands are deposited during seasons of reduced growth (winter) and translucent bands during seasons of rapid growth (spring and summer).

The biological basis for seasonal bands in cementum is related to the function and development of the tissue (D. Lieberman n.d.b). Cementum grows very slowly from a single appositional front along the margin of the gum (periodontal ligament) throughout the life of a tooth. Cementum functions primarily to anchor teeth into the mandible or maxilla by mineralizing around collagen fiber bundles, known as Sharpey's fibers, that originate in the periodontal ligament. Cementum bands are caused by two different phenomena that have been tested in controlled laboratory experiments on goats and other species (D. Lieberman 1993, n.d.b). First, seasonal changes in the magnitude and frequency of occlusal strain (deformation) result in variations in the orientation of the Sharpey's fibers mineralized during different seasons. Under transmitted polarized light, these cementum bands appear alternately opaque or translucent because they refract light at different angles (Schmidt and Kiel 1972). Secondly, changes in the rate of growth of cementum from season to season result in variations in the mineral density of cementum bands. Cementum deposited during periods of rapid growth is often less mineralized and therefore optically lighter than cementum deposited during periods of slower growth.

Cementum bands have been used to estimate the age at and season of death of animals from a wide range of contexts (e.g., Gordon 1988, Pike-Tay 1991) and are especially useful for estimating the season of death of mountain gazelle (*G. gazella*) (Lieberman, Deacon, and Meadow 1990, D. Lieberman 1991). Gazelle have very distinct seasonal diets that result in very clear cementum bands. During the stressful fall/winter rainy season, gazelle are primarily grazers, eating grasses and forbs that are low in nutritional quality; during the dry season they switch to being mostly browsers, eating high-quality but tough shrubs such as jujube (Baharav 1981, 1983). The differences in nutritional quality between their diets during the dry season and the wet season and the differences in bite force needed to process these diets result in clear cementum bands with different collagen orientations and relative mineral densities. Relatively hypomineralized translucent bands grow during the dry season between March/April and September at a rate of approximately 4.6 $\mu\text{m}/\text{month}$, and relatively hypermineralized opaque bands grow between October and March at approximately 2.5 $\mu\text{m}/\text{month}$ (D. Lieberman 1993).⁶

Gazelle are also useful for cementum increment analysis and for estimating the season of occupation of archaeological sites because they are by far the most common animal in Levantine archaeological sites before the Neolithic. Mountain gazelle are nonmigratory, territo-

6. As measured on the lingual surface of M_1 close to the dentine-enamel-cementum junction.

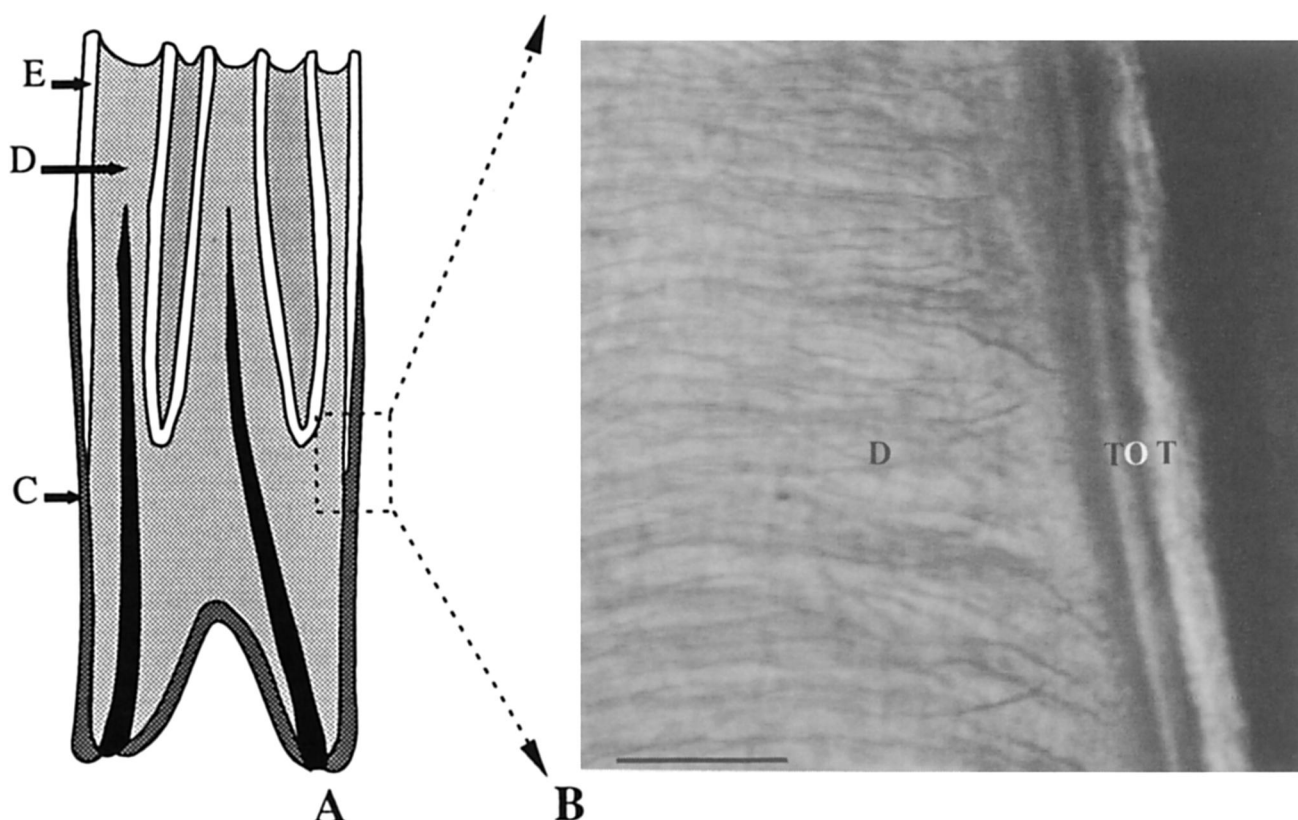


FIG. 3. Schematic cross-section of gazelle tooth (A) showing location of cementum (C), dentine (D), and enamel (E), and cross-section of gazelle tooth (B) showing cementum increments in transmitted polarized light. Translucent bands (T) grow between April and September, when gazelle eat primarily tough but nutritious shrubs; opaque bands (O) grow more slowly between October and March, when gazelle eat primarily softer but less nutritious grasses and forbs. Scale bar 50 microns.

rial, easy to hunt, and rapid breeders (Baharav 1974) and were therefore hunted throughout the year by Upper Pleistocene hunter-gatherers (D. Lieberman n.d.a). Consequently, they constitute between 50% and 90% of the fauna in most Middle Palaeolithic, Upper Palaeolithic, and Epipalaeolithic sites. Gazelle are therefore the most reliable indicator of the season of occupation of sites in the southern Levant: the presence of gazelle killed during only one season at a particular site suggests that the site was occupied during just that season. Such data, of course, need to be correlated with other archaeological indicators of seasonal activities.

Archaeological Evidence

Estimates of the season of occupation of 33 different levels from 20 southern Levantine Palaeolithic and Epipalaeolithic sites were obtained primarily from the analysis of cementum bands in gazelle and other animals (table 1).⁷ For most sites, the sample is the total number

7. Full discussion of the data is published in Lieberman (1993), and the methods of sample preparation and analysis are described in Lieberman, Deacon, and Meadow (1990), Lieberman and Meadow (1992), and Lieberman (n.d.a). Only teeth still protected by alveolar bone were analyzed, and all samples were analyzed "blind."

of available gazelle teeth still protected by mandibular or maxillary bone (because cementum is very fragile, loose teeth have a high likelihood of yielding incorrect estimates). The small sample sizes from Tabūn, el-Wad, and Kebara levels B and C reflect the fact that few specimens were saved from the original excavations (Turville-Petre 1932, Garrod and Bate 1937). Random samples were selected from Kebara Upper and Middle Palaeolithic levels, from Ain Mallaha, and from Hattoula. In all cases, samples were selected from archaeological contexts without evidence of carnivore activity.

CIRCULATING MOBILITY

Circulating mobility is inferred from the occurrence of contemporary sites in different habitats that were used on a consistent seasonal basis and contain evidence for a full range of extractive and maintenance activities (Binford 1980). The provisional estimates of seasonal occupation in table 1 indicate that most southern Levantine sites were usually inhabited for just a single season. Almost all the gazelle in the majority of sites were killed during either the spring/summer dry season or the winter rainy season. These data suggest that a strategy of circulating (residential) mobility with seasonal move-

TABLE 1
Seasonality Data from Southern Levantine Sites

Site/Level	Age (thousand years)	Environmental Zone ^a	N	Cementum Analysis ^b			Estimated Season	Source
				Mean	S.E.	Range		
Mousterian Tabūn C (and D)								
Tabūn C	80–130	M, L	10	2.3	0.20	2–3	Winter	Garrod and Bate (1937)
Tabūn D	>130	M, L	10	2.4	0.22	2–3	Winter	Garrod and Bate (1937)
Qafzeh >XV	92–115	M, H	14	5.2	0.17	3–6	Spring/Summer	Vandermeersch (1981)
Hayonim E	?	M, H	8	5.0	0.24	3–6	Spring	Bar-Yosef, personal communication
Mousterian Tabūn B								
Tabūn B	60–100	M, L	12	3.9	0.40	2–6	Multiseasonal	Garrod and Bate (1937)
Kebara X–VII	50–60	M, L	30	4.0	0.44	1–7	Multiseasonal	Bar-Yosef et al. (1992)
Qafzeh <XV	<90	M, H	13	3.8	0.53	1–6	Multiseasonal?	Vandermeersch (1981)
Upper Palaeolithic								
Kebara III–I	44–54	M, L	21	5.2	0.26	5–7	Spring	Bar-Yosef et al. (1992)
el-Wad D	33–27	M, L	12	2.0	0.30	1–3	Fall/Winter	Garrod and Bate (1937)
el-Wad C	20–25	M, L	15	5.2	0.08	5–6	Spring	Garrod and Bate (1937)
Hayonim D	27–29	M, H	12	1.9	0.18	1–3	Fall/Winter	Bar-Yosef, personal communication
Hayonim C	17–14	M, H	8	2.6	0.18	2–3	Winter	Bar-Yosef, personal communication
Nahal Ein Gev	20–25	M, L	9	2.3	0.31	1–5	Fall/Winter	Bar-Yosef (1973)
Kebaran and Geometric Kebaran								
Kebara C	?	M, L	12	2.4	0.41	1–5	Fall/Winter	Turville-Petre (1932)
Nahal Hadera	17–14	M, L	6	5.3	0.11	5–6	Spring/Summer	Saxon, Martin, and Bar-Yosef (1978)
Ohalo II	19	M/S, L	18	2.8	0.55	1–5	Winter/Spring	Nadel and Hershkovitz (1991)
Ein Gev I	16	M/S, L	14	2.7	0.19	2–3	Winter	Bar-Yosef (1970)
Urkan e-Rub	15	S, L	5	5.5	0.11	5–6	Spring	Hovers et al. (1988)
Fazael VII	?	S, L	4	6.0	0.0	6	Spring/Summer	Goring-Morris (1980)
Neve David	≈13	M, L	16	2.5	0.58	1–5	Fall/Winter	Kaufman (1986)
Tor Hamar	12.7	S, H	9	1.9	0.11	1–3	Fall/Winter	Henry and Garrard (1980)
Natufian								
Wadi Judayid	12–12.8	M/S, H	16	4.6	0.33	2–7	Multiseasonal	Henry et al. (1985)
Ain Mallaha	12	M, L	20	3.9	0.47	1–7	Multiseasonal	Perrot (1966)
el-Wad B	9.8–12	M, L	15	3.7	0.46	1–6	Multiseasonal	Garrod and Bate (1937)
Kebara B	?	M, L	12	3.3	0.54	2–7	Multiseasonal	Turville-Petre (1932)
Hayonim B	12	M, H	15	3.4	0.49	1–6	Multiseasonal	Belfer-Cohen (1988)
Hayonim Terrace	11.92	M, H	13	4.2	0.41	2–6	Multiseasonal	Henry, Leroi-Gourhan, and Davis (1981)
Hatoula 4	11	M, L	17	3.1	0.84	1–7	Multiseasonal	Ronen and Lechevallier (1991)
Salibiya I	11.5	M/S, L	6	5.4	0.10	5–6	Spring	Schuldenrein and Golberg (1981)
Rosh Horeshe	10.5–11	S, H	15	2.1	0.54	1–5	Fall/Winter	Marks and Larson (1977)
Fazael VI	?	S, L	3	6.3	0.09	6–7	Spring/Summer	Goring-Morris (1980)
Abu Salem	10	S, H	11	6.0	0.10	5–7	Spring/Summer	Marks and Scott (1976)
Pre-Pottery Neolithic A								
Jericho	?	M/S, L	12	3.1	0.68	1–7	Multiseasonal	Kenyon and Holland (1983)
Hatoula 2	10	M, L	14	3.6	0.60	1–7	Multiseasonal	Ronen and Lechevallier (1991)

^aEnvironmental zone: M, Mediterranean; S, Steppe; L, lowland (or coastal); H, highland (or inland hills).^bEstimated season of death: 1, fall; 2, fall/winter; 3, winter; 5, spring; 6, spring/summer; 7, summer.

ments from uplands to lowlands was the rule rather than the exception for Upper Pleistocene hunter-gatherers in the southern Levant. Hunter-gatherers consistently occupied sites in the lowlands (or coastal plain) during the spring and summer and in the highlands (or inland regions) during the fall and winter, and/or they occupied sites in the lowlands during the winter and spring and the highlands during the summer and fall (fig. 4a). It is the spatial and temporal distribution of plants, *not animals*, that best accounts for these seasonal patterns. Gazelle and deer, the most common prey, were available and hunted year-round in most environments. Occupation of lowland sites during the spring provided optimal access to the largest concentrations of annual plants, including cereals and pulses; occupation of highland

sites in the fall provided the best access to nuts and fruits; edible leaves, roots, and tubers are available in most seasons throughout the Mediterranean phytogeographic zone (Danin 1988, White 1977).

The pattern of seasonal site use does not mean that Upper Pleistocene hunter-gatherers used only one circulating mobility strategy. Rather, a variety of strategies were probably used, depending on local climatic factors at sites and palaeoclimatic changes. Highland sites, for example, were probably avoided in the winter because of low temperatures and unpleasant conditions, but well-sheltered sites in the upland or inland regions such as Hayonim Cave (which is located in the hills 13 km east of the coast) would have been excellent camps during the fall/winter, as was the case during the Aurigna-

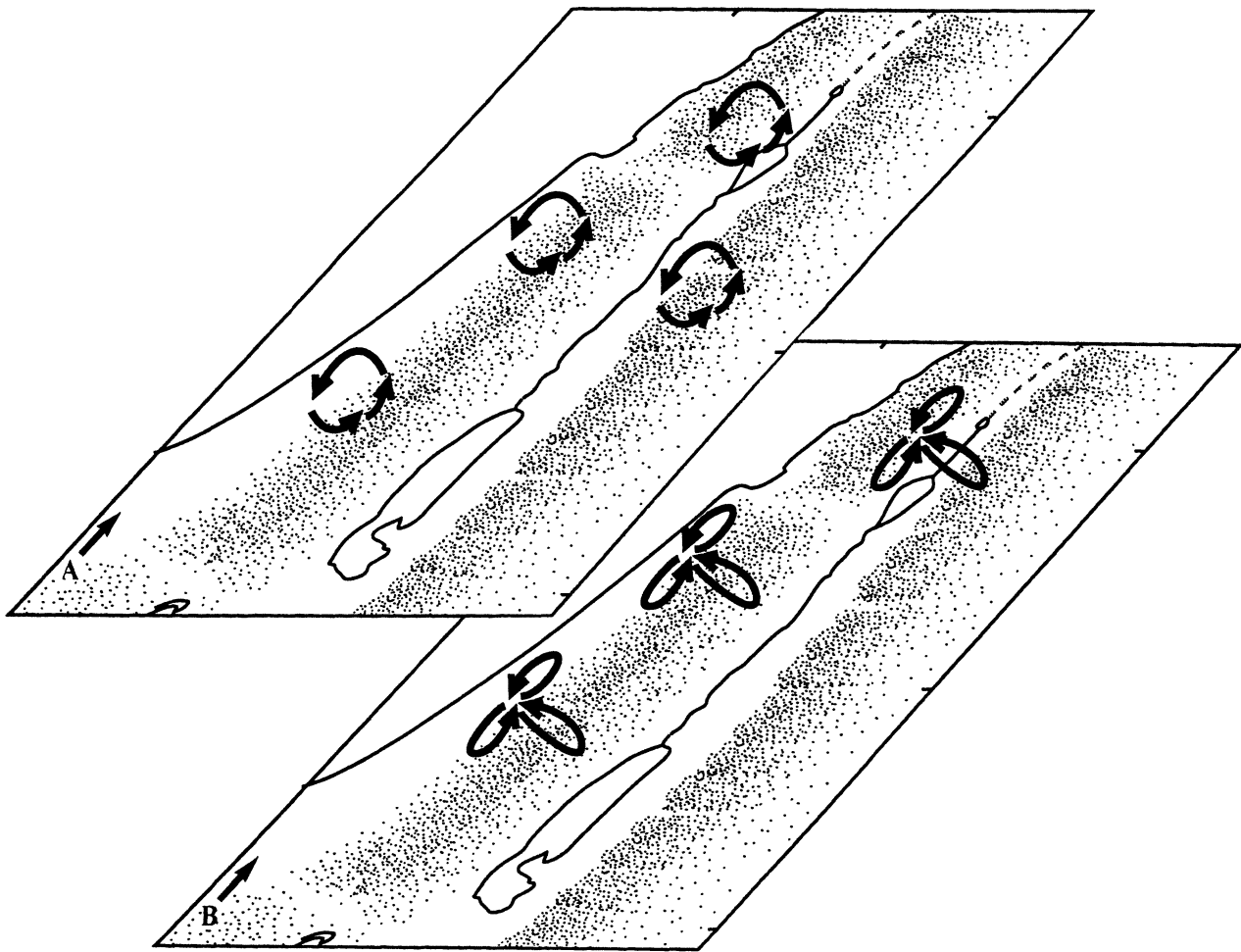


FIG. 4. Schematic view of the differences between the circulating (A) and radiating (B) mobility strategies used by hunter-gatherers in the southern Levant.

cian and the Kebaran. Hayonim Cave, which is large, dry, and faces southeast, is protected from the wind and relatively warm and was probably a good base for gathering nuts and fruits that ripen at higher elevations as the rainy season progresses. The highland Natufian site of Rosh Horeshe in the Negev was similarly sheltered and appears to have been occupied during the fall and/or winter (Marks and Larsen 1977, Goring-Morris 1987). Ecotonal lowland sites such as Kebara and el-Wad were good sites to inhabit during most seasons but were apparently occupied in different seasons at different times. The roughly contemporary Aurignacian occupations of el-Wad during the fall/winter and Kebara during the spring could reflect hunting and gathering in the lowlands during just the winter and spring or year-round seasonal movements on the coastal plain.

Patterns of seasonal movement appear to be more pronounced in the now arid peripheries of the southern Levant. This is to be expected because of more severe climatic conditions and the more marked pattern of seasonal plant food distribution in these zones (Danin 1988). In arid zones, lowland sites were probably occu-

pied in the fall/winter and almost all highland sites in the spring/summer; moreover, the larger size of most lowland sites suggests that they were occupied during periods of population aggregation and that the highlands were occupied during periods of population dispersal (Coinman, Clark, and Lindly 1986). Significantly, the same pattern seems to occur in the core Mediterranean zone during the Kebaran, which coincides with the cool and dry conditions of the Late Glacial Maximum (Bar-Yosef 1990). Severe climatic conditions and seasonal resource stress for Kebaran hunter-gatherers probably constrained their mobility strategies.

RADIATING MOBILITY

Radiating mobility is recognized by the occurrence of focal sites (base camps) that are repeatedly or continuously occupied and connected to smaller special-activity sites (fig. 4b). Radiating mobility is harder to infer than circulating mobility, but two periods contrast with the basic pattern of seasonal movements from highlands to lowlands that characterized most Upper Pleistocene

southern Levantine hunter-gatherers. Multiseasonal occupations typical of a radiating mobility strategy are found at most Natufian sites and at several sites from the Middle Palaeolithic association with the Tabūn B-type industrial variant of the Levantine Mousterian and with burials of archaic humans.⁸

Three Mousterian sites appear to have been used multiseasonally during part of the Middle Palaeolithic. This is best documented in the Kebara Mousterian levels (units VII–X), in which gazelle appear to have been hunted year-round: 52% of the gazelle were killed during the spring/summer and 48% during the fall/winter, and the relative widths of the outermost bands indicate that they were hunted throughout the wet and dry seasons. Multiseasonal hunting of gazelle in the Kebara Mousterian is documented not only in samples from the original Stekelis excavations (corresponding to units VII–X) but also in samples from a single level (unit X) of the 1987 excavation of the *décapage* which originate from a single layer (between –668 and –678 from 4 m²) and are associated with hearths and other cultural material (Bar-Yosef et al. 1992). These samples are unlikely to be the product of very temporally separated occupations or other nonanthropogenic processes, supporting the hypothesis that the multiseasonal pattern at Kebara is not the result of the mixing of very different layers that were occupied for only a single season. Further evidence comes from Tabūn B and from the *upper levels* of Qafzeh (XV–VII), where no hominid fossils were found. At Tabūn B, equal proportions of the animals were killed during the rainy and dry seasons; at Qafzeh XV–VII, 63% of the fauna analyzed were killed during the wet season and 37% during the dry season. In both these sites, the widths of the outermost cementum bands suggest culling during most seasons of the year (D. Lieberman 1993). The evidence from Tabūn B and the upper levels of Qafzeh is more problematic than that from Kebara VII–X because of small samples and the lack of detailed provenience information, but it does contrast with the clear single-seasonal pattern of Hayonim E and Tabūn C and D, in which gazelle were killed during the winter, and Qafzeh XVI–XXIII, in which gazelle and other animals were killed only during the spring/summer.

The multiseasonal occupation of Tabūn B-phase sites suggests a radiating mobility pattern in which humans repeatedly returned to the same sites (perhaps base camps) over the course of many seasons (although it is unlikely that these were sedentary sites). The contrast between the single-seasonal nature of hunting at Tabūn C, D, and Hayonim E and the evidence for multiseasonal hunting at Tabūn B, Kebara XII–VII, and Qafzeh XV–

VII are most likely the consequence of different long-term patterns of seasonal use of the environment at these sites. This is further supported by the massive ash and hearth accumulations and high artifact density at Kebara compared with Qafzeh (Bar-Yosef et al. 1992). Significantly, Marks and Freidel (1977) and Coinman, Clark, and Lindly (1986) use site distribution and artifact diversity data to argue that contemporary Mousterian occupations in the Negev and southern Jordan were also characterized by radiating mobility.⁹

The Tabūn B-phase Levantine Mousterian sites are not the only multiseasonal occupations in the southern Levant prior to the Neolithic. The Natufian is a sudden change from the pattern of circulating mobility in earlier phases of the Epipalaeolithic, the Upper Palaeolithic, and most of the Middle Palaeolithic. All but three of the ten Natufian sites analyzed have evidence for multiseasonal gazelle hunting and, hence, habitation. The high range and standard error of the estimated seasons of death and the relatively equal percentages of animals killed in the dry season and the wet season indicate that the gazelle in these sites were hunted throughout the year (D. Lieberman 1993). Not all sites classified as Natufian, however, were occupied year-round; a few sites in the Jordan Valley (Fazael VI and Salibiya I) and one Late Natufian site from the Negev (Rosh Horeshe) contain gazelle killed during only one season. (In addition, one Harifian site [Abu Salem] from the Negev appears to be a single-seasonal occupation.)

Other faunal data, especially from Hayonim and Ain Mallaha, support the hypothesis that some Natufian sites were inhabited throughout much of the year. Davis (1983) has argued that the age-profile of gazelle in the Natufian levels of Hayonim Terrace (estimated from crown heights) indicates year-round hunting; Pichon (1991) has identified winter and summer migratory birds from the Natufian levels of Hayonim Cave and Ain Mallaha; and Tchernov (1984, 1991) has noted that the presence of human commensals (*Mus musculus*, *Passer domesticus*, and *Rattus rattus*) at Ain Mallaha and Hayonim Terrace suggests relatively continuous occupation. Unfortunately, such detailed faunal analyses are not available for most other Natufian sites, but less absolute archaeological indicators of multiseasonal occupation are present at many of them, including evidence for investment in substantial permanent architecture (Perrot 1966, Cohen 1977), storage structures (Perrot 1966), increased artifact diversity and density (Binford 1978, Bar-Yosef 1983), and large cemeteries (Belfer-Cohen 1991). None are secure indicators of permanent habitation (Rafferty 1985, Edwards 1989), but their presence is significant in conjunction with a priori evidence for multiseasonal site use from cementum increment analysis, human commensals, and other faunal indicators of long-term, intensive, and relatively sedentary occupation.

Whether large multiseasonally occupied Natufian sites such as el-Wad, Nahal Oren, Hayonim Cave and

8. The term “multiseasonal occupation” refers to sites that were inhabited during more than one season of the year. Multiseasonal occupation can range from sedentism—in which a site is relatively permanently occupied—to occupation for short periods of time during different seasons over the course of several years. Without other sources of data it is difficult to distinguish between different kinds of multiseasonal occupation.

9. Coinman, Clark, and Lindly (1986), however, argue that radiating mobility persisted during the Upper Palaeolithic in the region.

Terrace, and Ain Mallaha were inhabited year-round or for some period less than 12 months a year is a moot point (see, however, Edwards 1989). There are no archaeological indicators of seasonality precise enough to identify such differences in occupational duration. Large sites such as Ain Mallaha and Hayonim Cave and Terrace were clearly base camps occupied for much of the year, but the inhabitants of these sites almost surely employed some forms of radiating (logistical) mobility. Unfortunately, logistical sites are almost impossible to detect in the archaeological record (although Salibiya I and Fazel VI are likely candidates), and it is difficult to distinguish between repeatedly occupied logistical camps and short-term residential camps. In any case, the dramatic change from a highly mobile, circulating, seasonal mobility pattern to the less seasonally mobile, radiating mobility pattern that occurred during the Early Natufian must have had important social and environmental consequences.

Discussion: The Consequences of Radiating Mobility

Southern Levantine hunter-gatherers migrated between highlands and lowlands on a seasonal basis during most of the Middle Palaeolithic, the entire Upper Palaeolithic, and most of the Epipalaeolithic. As discussed above, such a strategy of seasonal circulating mobility is typical of recent hunter-gatherers in a variety of temperate and tropical environments who organize their land-use patterns along transects that include several habitats, thereby maximizing their access to a variety of resources from several ecological zones (Fowler 1971, Yellen 1976, Heffley 1981, Butzer 1982, Binford 1991). The indications of multiseasonal site use during both the Natufian and the Tabūn B phase of the Levantine Mousterian are therefore particularly interesting because they are characteristic of radiating rather than circulating mobility strategies and more focused on a core camp or region. The Tabūn B-phase levels of Kebara, Tabūn, and Qafzeh were probably not relatively permanently occupied sedentary sites like the Natufian base camps, but the patterns of both periods contrast with the seasonal habitat use that was probably a stable strategy for most southern Levantine hunter-gatherers.

As Binford (1980) has argued, hunter-gatherers with radiating mobility strategies (collectors) are different in several important ways from hunter-gatherers with circulating strategies (foragers). Whereas foragers acquire resources through daily opportunistic hunting and gathering, collectors generally employ logistical strategies that are often associated with increased social complexity (Testart 1982). The Natufians and the Tabūn B-phase hunter-gatherers probably employed radiating mobility strategies for different reasons, but the consequences of their reduced mobility were probably similar and profound. In an environment like the southern Levant, it is likely that collectors with radiating mobility strategies incurred higher daily energetic costs than for-

agers with circulating mobility strategies because of two synergistic factors: (1) resource depletion and (2) seasonal variations in resource distribution.

Constant gathering and hunting of resources in any locale by humans leads to resource depletion as the density of edible plants and animals gradually diminishes around a camp in proportion to its duration of occupation (Hamilton and Watt 1970). This reduction occurs through several processes. Most important, hunter-gatherers or farmers living in a camp alter the natural distribution of plants and animals by foraging and hunting (Linares 1976, Hames and Vickers 1983, Tchernov 1991). Local biodiversity can also be affected by field burning and the tendency of many species to avoid humans. Some of the ecological changes associated with prolonged site occupation can help agriculturalists by promoting the growth of cultivated crops and by protecting livestock through diminished predator density (Gregg 1988), but the effects are more serious for hunter-gatherers, who depend on high local biodiversity. The ultimate consequence of radiating mobility or sedentism is the expenditure of more time and energy to satisfy hunter-gatherer resource needs (Vickers 1983, Halstead and O'Shea 1989, Speth and Scott 1989). Vickers (1983) found that after prolonged occupation of a village Siona-Secoya hunters spent 12% more time and traveled 18% longer on hunting trips that yielded only 56% of the returns of trips when the village was first settled. Hunter-gatherers employing a circulating mobility strategy are expected to move to a new camp when the energetic rate of return of gathering and hunting falls below the average rate of return for their habitat (Charnov 1976, Winterhalder 1981). The San, for example, tend to move camp when they need to spend more than three to six hours a day in search of food (Lee 1972, Silberbauer 1981).

Seasonal fluctuations in resource density can compound the problems caused by resource depletion for hunter-gatherers with radiating mobility strategies, particularly in a markedly seasonal environment such as the southern Levant. In some habitats, seasonal changes in resource availability can enhance the variety and abundance of foods, reducing the need for mobility. This enhancement has been documented for a variety of marine environments (Yesner 1980) and is often associated with sedentism. In most habitats, however, seasonal variations in the availability of edible resources can cause an even more rapid decrease in the availability of foods. During periods of resource stress (such as the rainy winter in the Levant), the rate of resource depletion by hunter-gatherers will increase because of the reduced number of available resources. Hunter-gatherers during such periods are forced to concentrate on fewer resources and hence deplete them more rapidly.

Radiating mobility must have caused similar problems for both the Natufians and the archaic humans living in the southern Levant during the Upper Pleistocene because the amount of time and/or energy spent foraging per capita is expected to increase with length of residence. Ethnographic evidence indicates that

hunter-gatherers almost always increase their reliance on high-quality resources (e.g., meat) to cope with the energetic costs of remaining in the same locale over a long period of time. In addition, they often broaden their resource base, store food, trade food, and sometimes grow food. Archaeological data from the southern Levant suggest that both Natufians and archaic humans specialized in high-quality resources. However, while the Natufians employed all the strategies listed above (eventually including food production), there is currently no evidence that archaic humans during the Mousterian employed any strategies other than resource specialization.

Hunter-gatherers are essentially resource specialists, relying on foods that are high in proteins, fats, and carbohydrates, such as meat, and energy-rich fruits and cereals that are low in fiber and cellulose (Foley 1987). An increase in resource specialization is an important predicted consequence of reduced mobility for hunter-gatherers because prolonged residence in the same location increases the relative benefits of acquiring high-quality foods that yield a greater caloric return for the time invested. Such resources tend to be distributed in dispersed patches and may favor logistical mobility (Kelly 1983).

Meat is one of the most important high-quality but sparsely distributed hunter-gatherer resources. Medium-to-large-sized mammals are socially more important than plants or small mammals, but acquiring them is less cost-effective in relatively undepleted habitats. When plentiful plant food is available, medium-to-large-sized animals usually yield a lower caloric return per *total* time invested (Lee 1979, Winterhalder 1981; see, however, Hawkes, Hill, and O'Connell 1982). Hunted meat is thus a relatively minor component of most hunter-gatherer diets, constituting roughly 10–30% (Hayden 1981*b*) of daily calories in nonarctic habitats.¹⁰ Increased dependence on hunting is a likely consequence of a relatively less mobile resource acquisition strategy such as radiating mobility because the decrease in plant foods near base camps makes hunting a better solution to the problem of providing daily food than the longer foraging trips required to compensate for local resource depletion. Since long trips have an intrinsic cost in time and energy, it is better to maximize return on the investment by specializing in resources such as medium-to-large-sized mammals because the energetic return per unit of effort declines more rapidly for small items than for large ones. The Yanomamo, for example, hunt three times more frequently in hunting trips that are 1.5 times longer after they have been living in a camp for an extended period of time (Saffirio and Scaglione 1982).

Hunters and foragers can remain in the same location for long periods by expending more time and energy to satisfy their resource needs. This is most effectively accomplished by increasing the relative proportion of

hunting. Szuter and Bayham (1989) argue that increased sedentism among the Hohokam in the American Southwest resulted in the need to hunt more and larger animals. Their study of Ventana Cave shows that the proportion of large animals increases over time with greater sedentism, as does the relative frequency of hunting equipment such as projectile points and bifaces. However, hunting trips become more energetically costly because the yields of hunting trips are expected to decrease with the age of a settlement. Vickers (1983) documented that hunting yields among the Siona-Secoya in Ecuador averaged 25 kg/hunt during the first few months at a new settlement but dropped to 15 kg/hunt during the next two years despite a concomitant increase in the amount of time spent on each hunt. It therefore becomes optimal to specialize in larger animals because the rate of return per unit of time or energy expended needs to be relatively high to make the trip worthwhile (Pulliam 1987). Traveling many hours makes less sense for a few tubers or rabbits than for a large deer or antelope.

The Natufian provides dramatic evidence for highly specialized gazelle hunting. Gazelle are by far the predominant species hunted by the Natufians, making up between 60% and 90% of the bones at most sites, often in spite of local environmental conditions (Bar-Yosef 1983, Henry 1989, Tchernov 1991). Most faunal measures demonstrate that the intensity of gazelle hunting is much higher in the Natufian than during previous periods (Legge 1972, Davis 1983, Henry 1989) and may even have resulted in a body-size decrease in local populations (Cope 1991). Unfortunately, it is difficult to make any assessments of hunting frequency during the Middle Palaeolithic on the basis of the fauna because complete and analyzed assemblages are available only from Kebara and Qafzeh.¹¹ Increased levels of hunting in multiseasonal Middle Palaeolithic sites are, however, suggested by the relative frequency of pointed artifacts (Shea 1991). Analysis of Levallois points tentatively suggests that the occupants of the multiseasonal levels of Kebara XII–XI and Tabūn B hunted more often than the occupants of the single-seasonal levels from Qafzeh XXIV–XVII and Tabūn C (Lieberman and Shea n.d.). Points account for 21.6% of the worn artifacts from Kebara XII–XI and 2.4% of Tabūn B; in contrast, points make up only 3.8% of the artifacts from Qafzeh XXIV–XVII and 8% from Tabūn C. Although points are approximately six times more common in Kebara XII–XI than in Qafzeh XXIV–XVII, the two assemblages have the same percentage of impact wear from use as projectiles (31.1% and 33.3%, respectively). Different Middle Palaeolithic hominids therefore used points in similar ways for hunting but differed from each other in the frequency with which points were made, used, and discarded at sites. Clearly, estimating levels of hunting

11. Only a small fraction of the fauna from Tabūn and Skhūl was saved, making these samples useless for such analyses. New information should soon be available from Hayonim (Bar-Yosef, personal communication) and Amud (Hovers, personal communication).

10. With the exception of specialized arctic hunter-gatherers, who have few available plant sources for much of the year.

from the frequencies of points is questionable and needs to be tested with more complete faunal samples (currently unavailable). However, recent isotope analyses (Bocherens et al. 1991) suggest that Neanderthals in Europe had very high levels of meat in their diet in comparison with modern humans, which further supports the hypothesis that they were more reliant on hunting.

Hunter-gatherers with radiating mobility strategies probably also increased their reliance on certain high-quality plants. There is little evidence for plant use in the southern Levant, particularly during the Middle Palaeolithic, but the dramatic increase in cereal exploitation during the Natufian is most likely the result of a greater reliance on specialized plant resources. Cereals existed in Levant long before the Natufian (Tsukada, cited in van Zeist and Bottema 1982; Baruch and Bottema 1991) and were collected at least by the early Epipalaeolithic, during the Kebaran (Kislev, Nadel, and Carmi n.d.). A significant increase in cereal harvesting during the Natufian is documented by charred grains (Zohary and Hopf 1988), numerous sickle blades, many of which have wear traces from cutting cereals or grasses (Unger-Hamilton 1989), and the elaboration and proliferation of ground stone tools (K. Wright 1991). Evidence for increased Natufian consumption of cereals is also suggested by isotopic analyses (Sillen and Lee-Thorp 1991) and by the high incidence of dental caries typical of populations that eat large amounts of starches or sugars (P. Smith 1991).

While both the Natufians and archaic humans increased their reliance on specialized resources as a result of their radiating mobility strategies, the Natufians also responded to resource depletion in other ways, including acquiring more low-quality resources (resource generalization), adopting trade and storage, and perhaps even producing food. The most visible of these is resource generalization.¹²

Increased consumption of lower-quality, more widely distributed resources is a frequent consequence of resource depletion caused by long-term human settlement in one location. Hunter-gatherers sometimes compensate for changes in resource availability around human habitations by consuming a wider range of plants and animals that are present near sites (Tchernov 1991). As high-quality resources become depleted near sites and require more time and energy to acquire, nearby low-quality resources that entail more processing or foraging time become more attractive. There is considerable ethnographic evidence for such a response to environmental deterioration (Hayden 1981*b*). For example, acorns, which are high in secondary compounds and require considerable processing, are gathered and eaten by both hunter-gatherers and farmers during stressful seasons when few other foods are available (Renfrew 1976). In addition, intensive hunting and gathering and other

forms of habitat disturbance (e.g., gardening) around a site sometimes cause changes in the local ecology that favor the abundance of smaller animals, leading to garden-hunting (Linares 1976). The number of small animals around human habitations can increase as the population of larger prey species becomes depleted and predator density decreases (Speth and Scott 1989, Tchernov 1991). Hames and Vickers (1982), for example, show that animals less than 5 kg (such as tortoises and squirrels) become more common around semipermanent villages in the Amazon as a function of age of settlement while animals greater than 5 kg become less common. Often these animals provide a rich and plentiful source of nutrition for sedentary or semisedentary farmers and can be easily hunted (often by children) through trapping or other such means. Therefore, while one expects humans to be specialists when foraging or hunting far from home, sedentary humans are eventually forced to become generalists when hunting and gathering near home (Pulliam 1981).

Evidence for broad-spectrum hunting is difficult to document in the Middle Palaeolithic because of the lack of plant remains and complete faunal samples from many sites and because published analyses of the fauna from Kebara, Qafzeh, and Hayonim (Haas 1972, Bouchud 1974, Tchernov 1981) are concerned mainly with biostratigraphy. However, Tchernov (1991) cites ample evidence for a sudden and dramatic increase in resource generalization during the Natufian. Faunal remains from recently excavated sites that were wet-sieved—Hayonim (Bar-Yosef and Tchernov 1966), Abu Hureyra (Moore 1991), and Hayonim Terrace (Henry et al. 1981)—contain numerous small animals such as hares, fox, birds, tortoises, fish, lizards, and snakes (Henry 1989, Pichon 1991). These animals are sometimes present in site levels from earlier periods (Edwards 1989), but they are much more abundant in Natufian base camps in the core Mediterranean zone relative to the percentage of other small nonprey species such as small rodents (Tchernov 1991).

Plant food remains are much less abundant from sites, but the enormous diversity of plant types from the Epipalaeolithic levels at Abu Hureyra (Hillman et al. 1989), Wadi Hammeh 27 (Edwards 1991), and other sites (Valla, Plisson, and Buxo i Capdevilla 1989) indicates that the Natufians foraged in a wide array of habitats. Many of these plant foods, which include pulses such as lentils and peas, would have been very laborious and time-consuming to collect because of the low seed/plant ratio and are thus indicative of resource generalization (Ladzinsky 1989).

Hunter-gatherers also cope with seasonal shortfalls in food availability through storage and trade (Testart 1982, Rowley-Conwy and Zvelebil 1989). They provide food for storage by a variety of means, including boiling, steaming, roasting, and drying (Hayden 1981*b*, Soffer 1985) and use a variety of storage facilities such as baskets, skins, and pits (Testart 1982). California Indians, for example, roasted acorns and stored them in baskets (Kroeber 1925); the Ainu stored dried salmon and deer

12. Also known as the broad-spectrum revolution (Flannery 1969), this change may have begun in the early Epipalaeolithic, 10,000 years before the Natufian.

in special houses for consumption during the winter (Watanabe 1972). However, with the exception of lined pits and storage houses, most storage technologies are hard to find in archaeological sites. Evidence for storage during the Middle Palaeolithic is absent, but there are a few possible pits from several Natufian sites, including Ain Mallaha (Perrot 1966), Hayonim Terrace (Valla et al. 1989), Wadi Hammeh 27 (Edwards 1991), and perhaps el-Wad (Garrod and Bate 1937). Exchange of food is common between hunter-gatherers and either agriculturalists or pastoralists (e.g., Denbow 1984, Laden 1992) but has rarely been documented between hunter-gatherer groups. This absence may be due to hunter-gatherers' general self-sufficiency, but it may reflect more the marginalization of recent hunter-gatherers (Schrire 1984, Headland and Reid 1989). Kroeber (1925) documented numerous examples of trade between hunter-gatherer tribes in California, such as between the Hupa and the Yurok of northern California, who regularly exchanged dried sea foods (e.g., fish, mussels, and seaweed) for canoes. In addition, Australian Aborigines traded a wide variety of undomesticated plants (Yen 1989). While there is no evidence for trade during the Middle Palaeolithic, there is ample evidence for shell bead trade during the Natufian, which may be related to food exchange. During the Late Natufian, shells from very distant locations (up to 400 km) appear in several sites (Goring-Morris 1987, D. Bar-Yosef 1991, Reese 1991).

Last, but not least, hunters and gatherers can produce food to cope with predicted seasonal resource shortages. Agriculture is not an exclusive practice of sedentary agriculturalists (Eder 1984); there are many examples of nonsedentary farmers or semisedentary "hunter-gatherers" occasionally cultivating food (Griffin 1989, Silberbauer 1981, Hill and Hurtado 1989, Preucel 1989, Laden 1992). Although, as we have seen, evidence for cultivation first appears immediately after the Natufian, it would be a mistake to rule out the possibility of some form of incipient agriculture at the end of the Epipalaeolithic by sedentary hunter-gatherers (Cauvin 1978, Unger-Hamilton 1989). Hunter-gatherers such as the Efe can often promote or enhance the growth of edible plants near their habitations through seed dispersal (Laden 1992). To date there is no substantial evidence for incipient cultivation of cereals during the Natufian, but traces of "plant husbandry" would be difficult to verify (Hillman, Colledge, and Harris 1989). Dogs, however, were first domesticated during the Natufian (Davis and Valla 1978).

Conclusion

Paradoxically, the circulating mobility strategy used by hunter-gatherers for at least 100,000 years in the southern Levant may require less daily mobility than sedentism and other radiating mobility strategies. Frequent residential mobility allows hunter-gatherers to acquire sufficient quantities of high-quality resources from undepleted environments in relatively little time. Even in

harsh habitats such as the Kalahari Desert, mobile hunter-gatherers work only a few hours a day to satisfy their needs (Lee 1979, Hayden 1981*b*). Sedentism or reduced mobility, in contrast, requires more time and energy because of the effects of long-term habitation and hunting and gathering on the local ecology. Over time, radiating mobility strategies are unstable or energetically costly for hunter-gatherers in environments like the southern Levant. However, while the immediate consequences of radiating mobility were probably somewhat similar for archaic humans and Natufians, its causes and ultimate consequences were clearly very different.

Any explanation of the Natufians' shift from circulating to radiating mobility must take into account several interrelated factors including climatic change, increased population pressure and territoriality, and increased social complexity. Henry (1989) and McCorriston and Hole (1989) suggest that greater availability of cereals in Holocene conditions was an incentive for sedentism. Increased territoriality triggered by climatic changes may also have been important. Although the regional palaeoclimatic sequence needs resolution (Baruch and Bottema 1991), deep-sea core data and changes in the distribution of sites between the Geometric Kebaran and the Natufian suggest that rapid global cooling dramatically reduced the territory available for hunter-gatherers around 13,000 B.P., forcing the early Natufians back into the core Mediterranean forest zone of the southern Levant (Bar-Yosef and Belfer-Cohen 1992).¹³ Such a rapid reduction in the size of the Mediterranean zone, combined with possible increases in population size over the course of the Epipalaeolithic, would have led to increased population densities during the Early Natufian. The greater competition for resources fostered by this density can be expected to have resulted in territoriality and reduced mobility which facilitate the monitoring and defense of key resources but reduce residential mobility (Dyson-Hudson and Smith 1978). In other words, radiating mobility may be energetically less efficient than circulating mobility with low population densities but necessary in conditions of high intergroup competition.

Reduced mobility among hunter-gatherers is associated with the increased social complexity and intensity (Testart 1982, Price and Brown 1985) that are manifested during the Natufian by new forms of symbolic representation (Belfer-Cohen 1991), new technologies (K. Wright 1991), larger and more differentiated settlements (Valla 1991), increased trade (D. Bar-Yosef 1991), and perhaps social ranking (G. Wright 1978). Such cultural complexity was no doubt an important precondition for the origins of agriculture at the end of the Natufian (Bender 1975), but it is not clear whether the cultural elaboration that distinguishes the Natufian from the Geometric

13. Mushabian hunter-gatherers, however, persisted in the more arid zones of the southern Levant during this time (Goring-Morris 1987, Henry 1989).

Kebaran was a cause or a result of changes in mobility and resource acquisition strategies. Sedentism and population pressure are closely correlated with socioeconomic complexity in the ethnographic record, and this complexity may sometimes be archaeologically visible (Price and Brown 1985, Keeley 1988). Testing these hypotheses will require better data on environmental changes in the southern Levant at the end of the Epipalaeolithic and on group sizes and social territories (Perlès and Phillips 1991).

It is far harder to explain why the archaic human occupants of Tabūn B-phase sites such as Kebara XII–VII adopted some form of a radiating mobility strategy that resulted in the multiseasonal pattern of gazelle hunting reported here. One possibility is climatic change. The stadial conditions of oxygen-isotope stage 4 and early stage 3 (when archaic humans inhabited the region) might have resulted in richer Mediterranean vegetation (Horowitz 1988) that reduced the cost of radiating mobility. However, the core region of the southern Levant—in which Kebara, Qafzeh, and Tabūn Caves are situated—was always part of the Mediterranean phyto-geographic zone, and microfaunal and macrofaunal data show that these sites were probably always situated on or near ecotones between more forested zones and more open areas (Tchernov 1988). In contrast, the more arid regions of the southern Levant, such as the Negev and the eastern edge of the Transjordanian Plateau, were probably more directly affected by climatic change during stages 4 and 5. These regions, which are now either desertic or marginal steppic vegetational zones, received more rainfall and supported Mediterranean vegetation only during the last interglacial and the middle phases of stage 3 (Marks 1981, van Zeist and Bottema 1982, Goldberg 1986, Henry 1987a, Goodfriend and Magaritz 1988, Clark and Lindly 1989). Climatically induced changes in mobility patterns were probably more marked in such arid zones than around Kebara and Qafzeh.

It is tempting to hypothesize a relationship between different mobility patterns and hominid/cultural variability. For example, it is possible that archaic humans used the environment differently from their early modern counterparts because of behavioral differences related to linguistic and/or cognitive capacities. Such differences have yet to be demonstrated or disproved (Arensburg et al. 1990, P. Lieberman 1991), but long-distance seasonal migrations between habitats clearly require complex social and cognitive skills such as information sharing and alliance networks to monitor and regulate access to resources (Gamble 1986, Whallon 1989). Differences in mobility strategies could also be related to demographics. Radiating mobility strategies were perhaps favored by intense territorial competition created by high population densities (Zubrow 1989). Alternatively, the different mobility patterns associated with Tabūn B and Tabūn C phases of the Levantine Mousterian may simply reflect cultural contrasts that are reflected in their different flint-knapping traditions

(Meignen and Bar-Yosef 1988). These and other hypotheses require more data to be tested.

Whatever their causes, the radiating mobility strategies of hunter-gatherers during the Natufian and the Tabūn B phase of the Levantine Mousterian ultimately had radically different consequences. Both the Natufians and the Tabūn B-phase Mousterians were almost surely faced with seasonal shortages of food that were exacerbated by the depletion of edible resources around their habitations by long-term hunting and gathering, but they responded in different ways. The Tabūn B Mousterians, like the Natufians, were high-quality resource specialists and may have relied on hunting to a greater extent than most hunter-gatherers in similar environments, but there is no indication that they adopted such other strategies for coping with the increased energetic costs of resource depletion as resource generalization, storage, trade, and food production. Rather, they compensated by working harder. High workloads—a possible result of radiating mobility—may be reflected in archaic human skeletal morphology. In comparison with their early modern counterparts, Levantine archaic humans are skeletally much more robust, which suggests that they placed more strain on their bones. Levantine archaic humans, for example, have thicker and more laterally expanded midshaft femoral cross-sections, thicker humeral diaphyses, broader scapuli, and more laterally curved radii (Smith, Bloom, and Berkowitz 1984, Trinkaus 1992). Perhaps the differences in energetic expenditure between archaic and modern humans resulted in the disappearance of Neanderthals in Western Europe around 35,000–30,000 years ago, when they may have been in direct competition. In contrast to archaic humans, the Natufians compensated for or counteracted the effects of resource depletion by specializing in a few key, high-quality resources (gazelle and cereals), by broadening their resource base to include more small animals and diverse plant foods, by practicing logistical mobility, by storing food, and perhaps by exchange and some crop cultivation. The environmental and social factors that led to the sudden adoption of a relatively sedentary, radiating mobility strategy by the Natufians, in turn, had significant environmental and social effects. Ultimately, their adoption of a less mobile subsistence and its environmental consequences set in motion an irreversible dynamic that led to increasing reliance on food production and the origin of agriculture.

Comments

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Lieberman's research can be considered a breakthrough, enabling us to verify the season and duration of occupa-

tion at various prehistoric sites and therefore to test the validity of assumptions based on conventional archaeological data concerning the ways of life of prehistoric human groups in the southern Levant. It is rather intriguing that, although separated by more than 50,000 years, the Mousterian and the Natufian have many similarities (Belfer-Cohen and Hovers 1992, Gilead 1989). Unfortunately, we are still groping in the dark as to what motivated archaic *Homo* and modern Natufian alike towards a "sedentary" way of life.

While applauding the research, I have reservations concerning some of the archaeological data presented. First, that the Natufian produced "the first art from the region" is an obvious misstatement. Artistic manifestations are known from preceding Upper Palaeolithic and Epi-Paleolithic cultures in the region (Bar-Yosef and Belfer-Cohen 1989, Hovers 1990). The difference, of course, lies in the intensity of Natufian artistic production, its variety, and its great abundance.

As for the Mousterian data, some of them are simply wrong. As is stated in the text, no hominid fossils have been recovered from the upper levels (XV–VII) of Qafzeh, nor is there, as yet, a detailed lithic study of the whole Mousterian sequence in the cave (the information concerning lithics cited is based on the study of the worn artifacts only). None of the upper levels in Qafzeh has been dated, and the dates obtained for the lower levels (XXIV–XII) are not ordered sequentially from bottom to top. Thus there would seem to be no basis for classifying the upper levels of Qafzeh as Mousterian (Tabūn B), associated with archaic *Homo*. I also have a problem with accepting the whole Middle Paleolithic sequence at Kebara (XII–VII) as representing a multiseasonal occupation on the basis of a sample taken from one layer only, layer X; the sequence is more than 4 m thick.

Lieberman writes that archaic *Homo* coped with the increased energy costs of resource depletion stemming from their radiating-mobility strategies by working harder. Indeed, "high workloads—a possible result of radiating mobility—may be reflected in archaic human skeletal morphology. In comparison with their early modern counterparts, Levantine archaic humans are skeletally much more robust." Thus, "perhaps the differences in energetic expenditure between archaic and modern humans resulted in the disappearance of Neanderthals in Western Europe . . . when they may have been in direct competition." It is rather ironic that not so long ago the demise of the Neanderthals was explained in terms of their laziness and easy way of living, as it was thought that there can be no progress of any kind without struggle (and hard work). Humans, it was thought, evolved amidst the struggle with adverse conditions, whereas the ancestors of the gorilla and the chimpanzee gave up the struggle for mental supremacy because they were satisfied with their circumstances (Elliot Smith, as cited in Lewin 1987). Thus Henry Fairfield Osborn saw in "the Neanderthal Man a splendid example of arrested or even retrogressive development." The reason? "Game was very plentiful, the rivers of

France and England abounded with hippopotami which afforded an easy source of food supply, and in the forests and plains roamed many types of elephants and rhinoceroses" (p. 35). Later it was assumed that radiating (logistic) mobility strategies are complex and, as opposed to circulating (residential) mobility strategies, require in-depth planning (Binford 1980). Modern humans were considered to have practiced the former, being "collectors," while the Neanderthals were merely scavengers or "foragers," wandering hither and thither (Binford 1985 and in Fishman 1992). Perhaps this was the reason for their robust skeletal morphology (Trinkaus 1992)? Poor Neanderthals—"Heads I win, tails you lose"! It seems that in our eagerness to understand processes in the past, we are prone to trip over our own old notions while marshaling new ones.

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Establishing the seasonality of the occupations of prehistoric foragers is an important aspect of reconstructing their settlement/procurement and provisioning strategies. All too often, however, such evidence is scarce, circumstantial, and imprecise. Cementum-increment analysis, as undertaken by Lieberman, provides an important new and accurate means of determining the season of death for human prey species and thus the seasonality of an occupation. The results of this study relative to the Natufian occupations are not surprising, though they are important in other ways, but Lieberman's findings in the analysis of teeth from Levantine Mousterian deposits assist in filling a crucial gap in our understanding of the cultural ecology of these Middle Paleolithic hominids.

Several lines of evidence, both biological (human commensals, migratory birds, age-sex profiles of gazelle) and cultural (site areas, artifact densities, architecture, burials, etc.), have prompted proposals that Natufian base camps or hamlets were occupied year-round (Bar-Yosef 1981, Henry 1981, 1991, Tchernov 1992). Primarily on the basis of the apparent absence of architecture and other features in sites outside of the core Mediterranean zone, it has been argued that the occupation of these sites was more ephemeral (Byrd 1989, Olszewski 1991, Edwards 1989). What is overlooked in these arguments, however, is that of the more than 50 Natufian sites known in the Levant, no more than 10 can be said to have been extensively excavated, and these are concentrated in the Mediterranean woodlands of the Carmel and Western Galilee of northern Israel and the upper Jordan Valley. While features, architecture, and burials are undoubtedly important indicators of sedentism, their apparent absence from sites that have not undergone extensive excavation is not very meaningful. For these reasons, such characteristics as site area, thickness of cultural deposit, artifact density, tool-kit diversity,

and tool:debitage ratio may be less sensitive to sample bias and more accurate measures of residential mobility levels.

The test excavations undertaken at the Early Natufian hamlet of Wadi Judayid in the modern arid zone of southern Jordan, for example, failed to identify structures or prominent features, but the .6-m-thick cultural deposit yielded a remarkably high artifact density of 1,437 specimens/m³. This exceeds that computed for other occupations with evidence for architecture, including hamlets such as Wadi Hammeh, Hayonim Terrace, and Rosh Zin. Lieberman's results are significant here in that they are in concert with the proposal that Wadi Judayid was a permanent or semipermanent occupation.

In pushing back from terminal Pleistocene times, Lieberman's cementum-increment findings for Epipaleolithic and Upper Paleolithic samples is in general agreement with other lines of evidence. That is, he sees a transhumant strategy that followed one of two seasonal schedules: (1) occupation of the lowlands during the spring and summer and the highlands during the fall and winter and (2) occupation of the lowlands during the winter and spring and the highlands during the summer and fall. Here I think it is important to distinguish between absolute elevations and the relative elevations found within the range of a prehistoric settlement system. In southern Jordan, for example, absolute elevations range from near or below sea level in the Rift Valley to above 1,600 m on the Jordanian Plateau. During the Epipaleolithic, foraging groups followed two distinctive schedules in their transhumant strategy for exploiting this elevationally diverse region. Madamaghan (Mushabian complex) and perhaps even earlier Qalkhan groups appear to have established winter camps at elevations of ca. 900–1,000 m, as is supported by Lieberman's findings for his Tor Hamar sample. Phytolith analyses (A. Rosen, personal communication, 1992) are also consistent with the winter occupation of the site. In the summer, these largely steppe/desert-adapted groups appear to have moved to lower elevations, where they were likely to have become tethered to springs in the Rift Valley and along the Red Sea coast. In the same region, Early, Middle, and Late/Final Hamran (Geometric Kebaran, Kebaran complexes) groups also inhabited winter camps at elevations of ca. 800 m (Henry 1987), but unlike the scheduled movements of Madamaghan and Qalkhan groups, those of the Hamran took them upslope for the summer-fall occupation of the piedmont and uplands of the Jordanian Plateau.

Determination of the seasonality of Levantine Mousterian occupations contributes important new information for reconstructing settlement/procurement patterns, but these seasonal data need to be complemented with evidence on the intensity and organization of residential behaviors within the full range of the settlement/procurement system in question. Lieberman's suspected correlations between settlement/procurement patterns and hominid taxa are in fact refuted by other lines of evidence. Both inter- and intrasite data

from early Levantine Mousterian (D-type) occupations in the Negev indicate a radiating pattern some 90,000 years b.p. (Munday 1979; Marks 1988, 1989), and in southern Jordan a strategy of transhumance has been identified for late Levantine Mousterian sites (both dated to ca. 70,000 b.p.) in which settlement/procurement and provisioning patterns varied seasonally and elevationally (Henry 1992, 1993). Lower-elevation, long-term winter occupations were supported logistically through a radiating pattern, whereas high-elevation, ephemeral, warm-season camps were provisioned opportunistically through a circulating pattern.

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Attempts to document and model hunter-gatherer settlement patterns have long been an integral aspect of prehistoric research in the Levant. Most studies have concentrated on site distributions, areal extent of occupations, artifact densities, and variability in assemblage configurations. Rare are the cases in which biological data, including faunal information, have been applied to these problems, particularly with regard to the earlier periods, and it is for this reason that Lieberman's paper is such a welcome and valuable contribution.

Because I am in general agreement with Lieberman's conclusions, I will restrict my comments to two points which call for elaboration. First, his work has an important implication for the Middle Paleolithic. It has often been argued (e.g., Binford 1989, Chase and Dibble 1987a) that Middle Paleolithic hominids, particularly those considered archaic humans (Neandertals), were behaviorally and organizationally different from those of the Upper Paleolithic. However, a strategy based on the reduced mobility of a logistically organized system would require a high degree of planning and tactical depth (Binford 1989) as well as highly developed social, cognitive, and communicative skills. In other words, the bearers of the Mousterian culture were much more human than some would lead us to believe. I find it of great interest that it is the Neandertals who are associated with multi-seasonal occupations rather than modern *Homo sapiens*.

Second, Lieberman seems to view logistical (radiating) and residential (circulating) mobility strategies as mutually exclusive. Thus he does not consider the possibility that, as is noted by Binford (1980:19) himself, a group of hunter-gatherers may shift between the two. This, in fact, seems to be the case for the Kebaran and the Geometric Kebaran (Kaufman 1992). During periods of aggregation (probably fall/winter) these groups were logistically organized, while during periods of dispersal (probably spring/summer) their strategy was based on a higher degree of residential mobility. It seems plausible that a similar combination of circulating and radiating strategies may have been operating during the Middle Paleolithic.

Studies of this kind have vast potential for clarifying

prehistoric hunter-gatherer adaptations. I hope that additional researches of this caliber will soon be undertaken.

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The movements of people through a prehistoric annual round of activities can, in theory, be tracked by the seasonality of sites within an archaeological region. Available indicators of site seasonality may be at a coarser resolution than the movements themselves, and archaeological reconstructions are therefore inherently simplified. It may be appropriate, then, that Lieberman considers mobility in terms of a simple dichotomous typology, which is otherwise problematic. However, seasonality can be difficult to interpret even roughly because cultural practices such as food storage and taphonomic factors such as carnivore activity may blur or distort the picture. Seasonality determination by measuring the differential growth in dental cementum is, according to Lieberman, relatively immune to these skewing factors. Mandibles and maxillae, as low-meat or -fat carcass components, would be less likely to be stored, and the cementum itself is protected within the alveolar bone from some post-depositional alterations. It is an exciting technique that may well find many applications in areas with well-defined seasonal change.

Lieberman has selected the southern Levant as a discrete study area within which sites assigned to the same cultural tradition are assumed to have coherence for the explanation of adaptive strategies. In this example, the pattern of seasonality of sites belonging to single cultural traditions profiles the aggregate annual rounds and, by extension, describes the mobility pattern. I would have welcomed a more explicit discussion of how Lieberman defined this internally heterogeneous region and, particularly, whether the same region is a suitable frame of reference for the varying cultural traditions and hominid taxa represented across the lengthy sequence he presents. Such discussion might also have illuminated any influences of long-term environmental variation on the seasonal behaviour of the inhabitants. Clearly, while the seasonality of sites or of components within sites may be determined with some confidence using dental cementum, it is more difficult to extend the results obtained to infer a mobility strategy.

Using these new seasonality data, Lieberman suggests that prehistoric hunter-gatherers in the Levant adopted, on two distinct occasions, a strategy of radiating or logistical mobility which centered on base camps occupied year-round or nearly so. This is a remarkable finding because, as Lieberman notes, ethnographically described hunter-gatherers tend to be fairly mobile, following a strategy of circulating or residential mobility. Northwest Coast and Columbia-Fraser plateau groups are usually considered exceptional cases in which relative sedentism is possible not because they lived in a "Garden

of Eden" (Yesner 1987) but because of the spatial and temporal structure of the resource base (e.g., Schalk 1977, Renouf 1990). However, these diverse groups did not share an annual round, nor did they usually occupy an all-season base camp or village. Instead, the winter community disaggregated to special-purpose camps during most of the year (Mitchell and Donald 1988:309). Hence, many of these archetypically sedentary hunting-gathering cultures appear to have been more mobile, as defined by site seasonality, than those of the Levantine Tabūn B and Natufian cultural traditions interpreted by Lieberman.

It is welcome that the existence of prehistoric hunter-gatherers with no close ethnographic analogues is considered. Lieberman notes a lack of sufficient environmental data, but I hope that at some point it will become possible to give a more precise explanation for each instance of the adoption of radiating mobility, especially as it is said to be an unstable strategy because it causes local resource depletion. In the Tabūn B case this is mitigated by greater intensity of hunting effort, while the Natufians compensate with a broader range of behaviours, including diversification. The longevity of these traditions demonstrates that radiating mobility together with other subsistence strategies can help form a long-term, stable adaptation.

The subsistence complex in the Levant included, at different times, a combination of various strategies of mobility, food storage, diversification, intensification, and trade. The interrelationships among these, which approximate to Halstead and O'Shea's (1989) basic cultural responses to risk and uncertainty, are complex and poorly understood. For example, Lieberman's argument is that radiating mobility leads to local resource depletion, which provokes various adaptive responses. In contrast, Soffer (1989:729) reverses Lieberman's sequence of events in finding that Natufian reliance on stored foods, particularly those with a long shelf-life such as grains, led to decreased mobility and ultimately to sedentism and agriculture. I question the analytical decoupling of either mobility or storage without greater attention to untangling the rest of the bundle of subsistence behaviour. A more balanced ecological framework allows the possibility that the adoption of radiating mobility not only had "important social and environmental consequences" but was itself a consequence of social and environmental change.

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Advances in interpretation of prehistoric seasonality such as the examination of variation in cementum bands are a good addition to our repertoire. Lieberman's table outlining the estimated seasons of use for several Middle Paleolithic and Natufian sites is the most valuable aspect of his article. I am, however, less than convinced that radiating settlement patterns and the conse-

quences suggested by Lieberman can be inferred from the data presented. Cementum analysis divides the year only into fall/winter and spring/summer, requiring supplementary data for more precise seasonality. Additionally, some of the interpretive arguments are problematic.

The Middle Paleolithic is the weakest case. Lieberman correlates Tabūn B assemblages from Kebara XII–VII, Tabūn B, and Qafzeh XV–VII with a radiating settlement pattern. These sites are spatially close—easily within a day's walk of one another. If we disregard the problems of archaeological contemporaneity, then it is quite likely that the “multiseasonal” attribution based solely on cementum analysis is a result of hominids' circulating among these sites. It is not repeated visiting of a site that constitutes radiating mobility but residence over several contiguous seasons. Although Lieberman suggests that the 10-cm-thick level of Kebara X does not represent the mixing of different single-season occupations, cave deposits are almost always palimpsests. Without information on deposition rates, Kebara X cannot be used to differentiate between one contiguous-season occupation and several short-term ones. If, as Lieberman says, it is hard to differentiate between “repeatedly occupied logistical camps and short-term residential camps” within the 2,000-year Natufian temporal span, how much less the chance of achieving this for the tens of thousands of years represented by Tabūn B occupations! Thus, the differences in settlement pattern between Tabūn C/D and Tabūn B hominids can be explained as the result of different types of circulating systems—diachronic changes partially associated with changes in climate.

Since faunal assemblages represent the sole remaining subsistence evidence and are not exclusive to Tabūn B industries, the postulated hunting specialization of Tabūn B hominids is based on the frequency of lithic points. It is no surprise that Tabūn B assemblages have more Levallois points than Tabūn C assemblages; radial preparation in Tabūn C is unlikely to yield abundant points. However, others (Jelinek et al. 1973:179) have also proposed an association of Tabūn B with hunting, suggesting that Tabūn B at Tabūn is a “specialized butchering station” where hominids used a chimney structure as a game trap. Such a natural feature lends itself to repeated use over many different seasons, articulating with Lieberman's radiating model only if Tabūn B represents task sites rather than base camps. If high frequencies of points are representative of hunting specialization in a radiating system, then what do high frequencies of Levallois points in the circulating system of Tabūn D mean?

The Natufian is arguably a better case for a radiating system, since there are several data sets beyond cementum analysis that support some degree of contiguous-season occupation at some Natufian sites. Nevertheless, this pattern appears to be characteristic of only a handful of Natufian populations (six known sites with dwellings) and only in certain areas of the Mediterranean zone (Olszewski 1991). It seems terminologically contradictory

to characterize Natufian populations as both resource specialists and resource generalists. I would suggest that they were generalists, especially in the Mediterranean zone. All of the Mediterranean-zone sites listed are multiseasonal (Salibiya I is misidentified as Mediterranean). This zone has a wide variety of food resources, and the evidence for intensive use of cereals there is extremely equivocal (Olszewski 1993). Only in the Irano-Turanian steppe, where less diversity of resources necessitates concentrating more heavily on the available few, might resource specialization be characteristic.

There are three remaining points: First, although most of the sites used by Lieberman are from the Mediterranean zone, he makes little use of the distinction between steppe and Mediterranean zones during the Natufian. The resulting interpretation is thus one of homogeneous cultural adaptation, almost certainly an oversimplification. Second, Lieberman suggests that radiating settlement patterns result in higher population densities. In the Middle Paleolithic, given the vast span of time over which these deposits accumulated, it is virtually impossible to estimate population size, much less population density. To suggest that Tabūn B hominids were more territorial because of higher population density is wishful thinking. Territoriality is difficult to substantiate even in the archaeologically well-known and relatively short-lived Natufian (Olszewski 1991). Third, Lieberman's interpretations might have been more satisfying if he had concentrated on one period rather than skimming over two such disparate ones. If both Tabūn B hominids and Natufians are examples of a radiating settlement pattern, then I wonder if this concept has much heuristic value.

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Seasonality and mobility are critical variables for placing archaeological sites in a meaningful context. All too often, discussion of these topics is superficial. Lieberman's work is therefore a very welcome contribution to a crucial area of archaeological research.

Lieberman combines precise seasonality data from a large number of sites to identify seasonal occupation of most Middle Palaeolithic through Epipalaeolithic sites, multiseasonal or year-round occupation of some “heartland” Natufian sites, and multiseasonal occupation of sites associated with Tabūn B Mousterian lithic industries.

The first of these observations is not surprising, though it is important to have it documented. Most traditional models of Palaeolithic and Epipalaeolithic settlement have assumed some form of seasonal round (often modeled on various modern hunter-gatherer groups). The significance of Lieberman's work is that a model of seasonal mobility is supported by *empirical* evidence. It would be useful to detail the pattern of seasonal movements in different times and regions. The contrasting

patterns of highland/lowland migration that Lieberman suggests could be productively examined for their specific determinants and for interactions with environmental changes and shifting cultural adaptations. In addition, Lieberman's data suggest that, despite the year-round availability of gazelles, hunting *is* somewhat seasonal, and therefore even a year-round site might not show all seasons of teeth. None of the seasonal sites of table 1 has a pure-summer or a pure-fall pattern. Either gazelle hunting was limited during the mid- to late summer and early to midfall or sites limited to these seasons have not been found. Thus, while the argument for seasonal mobility is convincing, interpretation of the cementum data must take seasonal fluctuations in hunting practices into account (e.g., Speth 1987).

The occupation at many times of the year (perhaps year-round) of Natufian sites in the Mediterranean zone again provides strong empirical support for a view that has been widely argued on other grounds. Lieberman also shows that some Natufian settlements probably *were* seasonal, particularly at lower elevations. Some of these may represent mobile adaptations in arid regions (see, e.g., Bar-Yosef and Belfer-Cohen 1992), though others could be part of a seasonal radiation from the sites in the Mediterranean zone.

The association of multiseasonal occupation with Tabūn B lithic industries is intriguing and unexpected (though see Bar-Yosef et al. 1992). Whatever its interpretation, the *contrast* in pattern between the Tabūn B deposits and other Mousterian and Upper Palaeolithic assemblages demands explanation. Lieberman's interpretation of the Tabūn B-associated assemblages raises several significant issues:

1. The assumption of an association of hominid varieties (early modern versus archaic) with particular lithic industries remains undemonstrated. Functional or directly mobility-related causes for the lithic contrast remain possibilities; different populations need not be involved.

2. As Binford (1980) emphasizes, logistical and residential mobility are elements of contrasting strategies, not mutually exclusive settlement patterns. Nor are radiating and circulating settlement the end points of a simple linear continuum (Kelly 1992). While Lieberman acknowledges the variability of strategies subsumed under the radiating/circulating contrast, the emphasis on these two categories discourages examination of multiple kinds of patterning. For instance, as Bar-Yosef et al. (1992:545) observe, not even the fine chronological control at Kebara permits distinguishing between multiseasonal settlement ("radiating mobility") and multiyear reoccupation during varying seasons (a palimpsest of "circulating mobilities"). The repeated seasonally diverse reuse of a locale would be an interesting aspect of settlement in its own right but differs from the multiseasonal occupation suggested by the term "radiating mobility." The sites could represent frequently visited (multiseasonal) special-function sites rather than the central "base camps" of a settlement system. The significance of the Tabūn B pattern may not lie along a

unidimensional contrast of circulating and radiating mobility.

3. Several analytical issues may cloud the interpretation of the seasonality data. First, not surprisingly, the seasonal ranges represented in the different assemblages are strongly correlated with sample size (Pearson's $r = 0.63$, $n = 34$, $p \ll 0.001$; similar values may be derived from rank-order correlation). Thus, the wide range of seasons represented at the Tabūn B, Natufian, and early Neolithic sites is not independent of the large sample sizes for some of these sites (Lieberman [n.d.c] has noted this problem elsewhere). A briefly occupied year-round site might have fewer preserved teeth and hence a narrower range of cementum seasons than an annually reused but largely seasonal site. The range of seasons, corrected for sample size, can be examined in a variety of ways (see, e.g., Kintigh 1984). Inspection of table 1 supports Lieberman's view that the patterning differentiates some of the Tabūn B, Natufian, and early Neolithic assemblages even when sample size is taken into account, but a systematic treatment of the sample-size issue would be helpful.

Second, although the use of numerical codes (1–7) to subdivide the seasonality data represents an important advance, the calculation of descriptive statistics with these data is potentially misleading. To give an extreme example, a late-summer-to-early-fall site should have just fall (code 1) and summer (code 7) teeth. However, descriptive statistics would be meaningless: the mean value would fall around 4 (between winter and spring), and the variance would be high, as on a multiseasonal site. A more appropriate approach would be to treat the seasonal codes as categorical variables. An indication of central tendency would be the mode, and a quantitative measure of multiseasonal use could be provided by a diversity statistic such as the Shannon index or the combination of measures of the richness (number of seasonal categories) and the evenness of their distribution (see Kintigh 1984). Bar charts of the seasonal frequencies at each site would be even more informative. These analytical suggestions are, however, unlikely to alter the patterning observed by Lieberman. Thus, we may quibble with the interpretation or details of the analysis; the importance of the contrast in patterning is not diminished.

The overall significance of the paper remains in its solid empirical demonstration of the multiseasonal use of some of the Natufian settlements, the seasonal use of many Middle and Upper Paleolithic sites, and the intriguing contrast of the three Tabūn B occupations. We can anticipate additional exciting results as Lieberman expands and refines this work.

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Lieberman has presented us with an intriguing set of data on site seasonality during the Upper Pleistocene,

but the manner in which it is presented makes it difficult for the reader to evaluate. The data in table 1 form the basis of the archaeological argument, but they would appear to be fundamentally flawed on two counts. First, Lieberman has taken a series of arbitrary category values and assigned them to seasons. He has then calculated means, standard errors, and ranges for each analytical unit. As these data are not continuous or interval or even ranked, arithmetic operations performed on them can produce spurious results. For example, if we have a site with equal numbers of fall- (1) and summer- (7) killed animals, the mean value is 4 or winter/spring. Similarly, if we have equal numbers of fall/winter (2) and spring/summer (6), the mean is also 4. A cross-tabulation of season by analytical unit would have allowed the reader to examine the distribution of season of death directly. Furthermore, if site occupation is year-round but varies in intensity through the year, we would expect small samples to indicate only seasonal occupation while larger samples from the same unit might indicate multiseasonal occupation. We have seven seasonal categories possible in these data, but four units have sample sizes under seven, making them seasonal almost by definition. If we were to rank these data by sample size, I believe we would see at least some correlation between number of seasons recorded and sample size. Deviation from or adherence to such a model might in itself provide some interesting insight into the seasonality problem.

Finally, I do not see the necessary linkage between seasonality and the radiating/circulating model. Evidence of multiseasonal occupation is not necessarily evidence of continuous occupation, although the Kebara data are interesting. If this line of argument is to be pursued, consideration should be given to the nature of the site (cave/rockshelter/open) and an analysis made of site type and seasonality. Lieberman is to be congratulated on having assembled these valuable data, but they now warrant a more critical analysis.

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This paper addresses two later Pleistocene human evolutionary transitions in the Levant: the Middle Paleolithic late-archaic-to-early-modern-human transition and the Upper-Paleolithic Kebaran-to-Natufian one. My comments here focus on the former only. In addition, within the Middle Paleolithic transition two issues are critical to the conclusions of this paper: the ability to delimit season(s) of occupation on the basis of the dental histology of the available faunal remains and the confidence with which one can assign the faunal assemblages to late archaic versus early modern humans. It is the latter issue which appears to me to have the more serious problems and is therefore the focus of these comments. Lieberman has indeed addressed what may be one of the more important bio-behavioral contrasts between late

archaic and early modern humans in the Near East, differential mobility (Trinkaus 1984, 1992, 1993; see also Tchernov 1984). The issue remains whether his data are sufficient to shed significant light on this topic.

In his table 1, Lieberman provides contrasting seasonality inferences for seven site-level complexes from four sites. For only two of these, Kebara XII–VII and Qafzeh below XV, do we have diagnostic late archaic versus early modern human remains clearly associated with the levels in question (Kebara, late archaic [Smith and Arensburg 1977, Bar-Yosef and Vandermeersch 1991], and Qafzeh, early modern [Vandermeersch 1981]). For all of the others the morphological attributes of the fossils are uncertain or misinterpreted, the stratigraphic associations of diagnostic fossils are debatable, and/or there are no associated human remains.

For Hayonim E, only an inventory of the Middle Paleolithic remains has been published (Arensburg et al. 1990). None of the highly fragmentary remains appear to preserve anatomical regions that are likely to be diagnostic as to their late archaic versus early modern human affinities.

For the upper terrace levels at Qafzeh (XV to VII), there are only a crushed fetal skull (Qafzeh 13) and an isolated incisor (Qafzeh 18) (Vandermeersch 1981). These remains do not permit a secure attribution of the upper terrace levels at Qafzeh to either of these Middle Paleolithic human groups.

Tabūn and its fossils are more complicated. Most important, the Tabūn 1 (C1) late archaic skeleton (the numbering follows McCown and Keith [1939], followed parenthetically by the numbering in Howell and Fritz [1975]), as Lieberman notes, has no secure stratigraphic provenience other than to the Middle Paleolithic of Tabūn Cave. However, if one combines Garrod and Bate's (1937) comments with the observations of Jelinek (1992) based on his reexcavation of the site, it is apparent that the partial skeleton could derive from Tabūn layers B, C, or D. However, the Tabūn 2 (C4) distal right radius and the Tabūn 3 (C5) right hamate are virtually perfect mirror images of the same left bones of the Tabūn 1 partial skeleton and almost certainly derive from that skeleton (Trinkaus, personal observation). Given that these specimens (Tabūn 2 and 3) appear to be securely attributed to Tabūn layer C, they may provide the needed evidence to assign the Tabūn 1 skeleton to layer C. Nevertheless, it is probably best not to use the Tabūn 1 skeleton to assign any one of the Tabūn Middle Paleolithic layers to either late archaic or early modern humans.

The only human remains securely attributed to Tabūn layer B are several series of isolated teeth (Series 1 [B1], the Series 2 I₂ [B3], Series 3 [B4], and the Series 4 dm²s [B5] [McCown and Keith 1939]); none of these is diagnostic as to late archaic versus early modern humans. In addition, there are no hominids securely attributed to Tabūn D, even though the Tabūn 1 partial skeleton might derive from that level (Jelinek 1992); in either case, there are simply no potentially early modern remains which could be attributed to layer D.

There are two additional specimens which appear to be securely attributed to Tabūn layer C: the Tabūn 1 (C3) right femoral diaphysis and the Tabūn 2 (C2) mandible. The former is clearly a late archaic human, with an antero-posteriorly flattened, nonpilastric diaphysis very similar in morphology to the Tabūn 1 right femur. Its pilastric index (92.1) is low even for a Near Eastern archaic human, being 1.02 S.D. below a Near Eastern Middle Paleolithic archaic human mean (102.6 ± 10.3 , $N = 5$) but 2.78 S.D. below a Qafzeh-Skhul mean (124.6 ± 11.7 , $N = 8$) (McCown and Keith 1939; Trinkaus 1976, 1983; Vandermeersch 1981). The Tabūn 2 mandible is a large and massive bone. It has one feature which is reminiscent of early modern humans, a relatively prominent mental eminence. However, that mental eminence does not protrude beyond the procumbent incisors on the specimen, and similarly developed mental eminences are present on at least four European Neandertals (La Ferrassie 1, Guattari 3, La Quina 9, and Vin-dija 231 [Martin 1926, Sergi 1956, Heim 1976, Wolpoff et al. 1981]). Furthermore, anterior-to-posterior dental dimensions and wear align the specimen with late archaic humans. Similar to Near Eastern late archaic humans, Tabūn 2 exhibits anterior teeth which are large relative to cheek teeth; its index of summed anterior dental breadths to the square root of the summed post-canine tooth areas (111.7) is trivially above a Near Eastern late archaic mean (110.5 ± 2.5 , $N = 4$; 107.3, 109.0, 111.8, 113.7) but 4.56 S.D. above that of a Qafzeh-Skhul early modern human sample (97.1 ± 3.2 , $N = 4$; 91.9, 97.1, 99.2, 100.0) (Trinkaus 1983, Tillier 1991). If these dental dimensions are combined with an occlusal wear scale to provide an indication of relative anterior-to-posterior dental attrition (fig. 1), Tabūn 2 falls on the late archaic human line and is clearly separate from the lower early modern human line. The Tabūn 2 mandible, therefore, is best seen either as a late archaic human or as insufficiently complete to be assigned to either sample; it cannot provide evidence of early modern humans in Tabūn layer C.

Therefore, assuming that the Tabūn 1 femur is from layer C, that the Tabūn 2 radius and the Tabūn 3 hamate derive from the Tabūn 1 skeleton and from layer C, and that the Tabūn 2 mandible from layer C is more likely to represent a late archaic than an early modern human, it appears most probable that the Tabūn layer C faunal assemblage was accumulated by late archaic rather than by early modern humans.

Given these considerations, it is possible to reconstitute the Middle Paleolithic portion of Lieberman's table 1, indicating the more probable seasonal site use patterns for Middle Paleolithic late archaic versus early modern humans in the Levant (my table 1). The result is *one* early modern human "spring/summer" site use (Qafzeh below XV), *one* late archaic human "multiseasonal" site use (Kebara), *one* probable late archaic human "winter" site use (Tabūn C), and *four* site-level complexes for which we do not know who was responsible for the faunal accumulations.

Consequently, even though Lieberman's data and con-

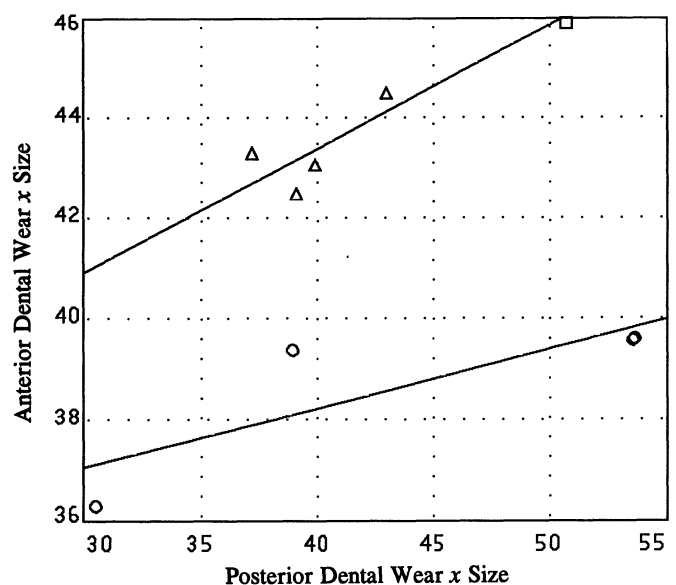


FIG. 1. Bivariate plot of mandibular anterior dental attrition and size versus posterior dental attrition and size. ○, early modern; △, late archaic; □, Tabūn 2. The values consist of the summed scores for each tooth within the anterior or posterior dental arcades; for the anterior teeth, the score equals the product of the Molnar (1971) wear value and the labiolingual diameter of the tooth, whereas for the posterior teeth it is the product of the wear value and the square root of the "area" (product of the buccolingual and mesiodistal crown diameters) of the tooth. For the posterior teeth, the values are based on the three molars; for the anterior teeth, they include only I_1 and C_1 , so as to permit the inclusion of the Skhul 4 mandible (use of I_1 to C_1 or I_2 and C_1 produces very similar results [Trinkaus 1992]). The least-squares regression lines through the two samples are based only on the specimens clearly assigned to late archaic (Amud 1, Kebara 2, Tabūn 1 [C1], and Shanidar 2) versus early modern (Qafzeh 7 and 9, Skhul 4 and 5) human samples.

TABLE 1
Revised Attributions of Late Archaic versus Early Modern Human Groups to Levantine Middle Paleolithic Level Complexes

Site/Level	Hominid Group	Season(s) ^a
Hayonim E	???	Spring
Kebara XII–VII	late archaic	Multiseasonal
Qafzeh XV–VII	???	Multiseasonal
Qafzeh below XV	early modern	Spring/Summer
Tabūn B	???	Multiseasonal
Tabūn C	late archaic?	Winter
Tabūn D	???	Winter

^aFrom Lieberman's table 1.

siderations appear to shed additional light on the nature of the cultural transition from the Levantine Upper Paleolithic through the Kebaran to the Natufian, they are adequate only to *hypothesize a possible* contrast in residential mobility patterns for the two groups of Levantine Middle Paleolithic hominids. They certainly are insufficient to shed significant light on this latter question.

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Lieberman makes an important contribution to the understanding of seasonality patterns in the prehistoric Near East. The data he is able to offer through analysis of cementum bands in gazelles shed new light on a question that is difficult to approach through other, more classical means of investigation. Fish vertebrae (another tool for exploring the same problem) are seldom well preserved in sites and even when present do not usually provide samples large enough to rely on (see Lernau in Lechevallier and Ronen 1985:102 and Valla et al. 1986, but cf. Desse in Bouchud 1987:155 for a case study of an extensive sample from Mallaha). In any case, gazelle hunting being ubiquitous in Levantine sites, Lieberman's method allows a much wider range of interpretation, both diachronic and synchronic. One may wonder if this method is 100% reliable as seems to be assumed here. Being unable to discuss this specific point, I shall address only the interpretation of the results, concentrating on the Natufian, which is my field of expertise.

If I understand him correctly, Lieberman assumes that there is a strong opposition between circulating and radiating hunter-gatherer strategies, which he combines with ways of using highlands and lowlands. Unfortunately, this model finds very limited support in the archaeological record for Israel north of the Negev. Basically, with the exception of the Judean desert rockshelters, there are almost no highland sites during the Pleistocene in Central Palestine or the Galilee after the Acheulean period. Qafzeh Cave opens at 220 m, and Hayonim Cave (here considered an upland site) lies at 250 m in a position very similar to that of the Carmel sites, which are typically situated at the articulation between the coastal plain and the mountains. In fact, most sites appear to be on the edge of the highlands. A new pattern of occupation emerged in the Early Natufian, especially in the coastal plain, but it did not affect the highlands, which yield virtually no sites representing the Geometric Kebaran or the Natufian.

Quoting a tentative explanation by Bar-Yosef and Belfer-Cohen for the disappearance of the Geometric Kebaran from the Negev, Lieberman assumes "a rapid global cooling around 13,000 B.P. forcing the early Natufians back into the core Mediterranean forest zone of the southern Levant," but then he seems to contradict himself in assuming relatively favourable climatic conditions during the early part of the Natufian on the basis

of the Hula pollen diagram, which shows a continuous increase of arboreal pollens for the period. Clearly, one has to choose between contradictory reconstructions. In any case, whatever the reconstruction, it seems to me doubtful that cultural evolution simply reflects climatic variations: large mammals are known to be relatively insensitive to such variations, and man, thanks to his social organization, is even more so.

Turning to the problem of food, Lieberman describes the Natufian people as coping with resource depletion due to sedentism by increased hunting of gazelles, intensive pursuit of small game, increased gathering of all kinds of plant foods and especially cereals (eventually leading to their cultivation), storage, and trade. Most of this is assumed rather than observed. Our knowledge of the Geometric Kebaran diet is so limited that comparisons with it are not possible. Turning to the Kebaran, a millennium earlier, the increase in gazelle hunting is not especially "dramatic" (Valla 1987: table 3). As for cereal consumption, strontium-calcium analysis suggests a limited increase during the Early Natufian—indeed, at Kebara Cave similar results were obtained for human bones from the two periods—but a clear decrease during the Late and Final Natufian (Sillen and Lee-Thorp 1991: fig. 1). Storage was probably practiced, but the evidence is very limited, and we have no idea of its scale. Finally, assuming that an exchange of food took place on the basis of the exchange of a few decorative marine shells obviously laden with symbolic meaning may be risky.

In my view (Valla n.d.), the pattern of mobility adopted by Early Natufian people in the Carmel and Galilee areas resulted from the combination of a lengthening of the aggregation period and a tendency to aggregate again and again in the same place, eventually resulting in apparent sedentism, the mobile part of the community dispersing seasonally while other members remained on the spot. This practice allowed unprecedented development in social life and secondarily produced a more "radiating" pattern of mobility than was probably the case in the Geometric Kebaran and earlier. This practice may have proved attractive to groups outside the Carmel and Galilee areas but was apparently difficult to adopt in less favourable environments. Its influence reached its maximum extent during the Late Natufian, when people in relatively poor areas combined radiating movements during aggregations with circulating mobility during dispersal periods, as seems to be documented in the Negev. Later, during the Final Natufian, the system lost some of its efficiency in the Carmel-Galilee area, and the Natufian culture exhibits a tendency to lose coherence through centrifugal movements, each province showing increased originality. In a way, Natufian "sedentism" served as a preadaptation to agricultural practices, but there is no indication whatsoever that people actually cultivated plants at that time. To my mind, a reconstruction of this kind better fits the data and avoids creating an artificial problem by proposing a way to bridge the opposition between circulating and radiating mobility.

Reply

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My primary goal in this paper was to present new data on seasonality from the Levant that are important for interpreting two of the most important behavioral transitions that occurred before the Neolithic, the origin of modern humans and the origin of agriculture. I also suggested some hypotheses about how hunter-gatherer mobility might have evolved during the Upper Pleistocene, but I was explicit that these were simply hypotheses based on limited information that merited further discussion and testing. Comments should either provide alternative hypotheses to explain the data, point out other data that relate to the hypotheses proposed herein, or suggest further sources of information that are necessary to test the hypotheses. I am pleased that the commentators have touched on all these points in a thoughtful way. In particular, I am encouraged by the recognition that data on the season of death of animals from cementum histology can supply vital and reliable information on seasonality that has been generally unavailable for most Palaeolithic sites. As several commentators point out, the seasonality estimates presented here agree with other published data and will be useful to other archaeologists. I hope that cementum analysis will continue to be used to examine issues of human seasonal behavior both in the Levant and elsewhere.

I am interested (but not surprised) that most of the critical attention is focused on the seasonality data relating to the origin of modern humans. The commentators' concerns are entirely justified in that we have much less information about the Middle Palaeolithic than about the end of the Epipalaeolithic, but some of the comments primarily reflect the sensitive nature of any theory concerning the origins of modern humans. I avoided discussion of whether Neanderthals contributed to the modern human gene pool because I have no new information on this complicated subject. I did *not*, however, avoid the question of behavioral differences between archaic and early modern humans—an issue that makes many palaeoanthropologists uncomfortable. The association of mobility strategies with hominids is dangerous because of the lack of provenience information of many fossils, but it is additionally complicated by the inability of many anthropologists to agree on hominid taxonomy. This is typified by the conflicting attributions of the Tabūn 1 and 2 hominids (Arensburg 1991, Day 1986, Trinkaus's comments above). Most biological anthropologists, however, do agree that there are at least two taxa in the Middle East (that may or not be conspecific) and that their morphological contrasts imply behavioral differences. Some archaeologists (e.g., Clark and Lindly 1989) have stressed certain superficial similarities in the Middle Palaeolithic archaeological record associated with these hominids, but it is incumbent

upon us to look for meaningful differences in the behavioral processes that formed the evidence. Obviously, some differences must exist. I readily accept that my hypothesis that archaic humans (such as Neanderthals) used the environment differently from modern humans may be incorrect, and I look forward to future data that help to resolve the issue. But the fact remains that a transition to circulating mobility occurred at some point in human evolution and that it was probably an important transition with significant consequences. Similar debates (many published in *CURRENT ANTHROPOLOGY*) rage over other major transitions such as the origins of language, symbolic art, or burials (e.g., Chase and Dibble 1987, Gargett 1989, Lindly and Clark 1990, Graves 1991, Belfer-Cohen and Hovers 1992, P. Lieberman 1992). Attaching values to these differences is an impediment to research. Modern humans may have used the Levantine environment more efficiently than archaic humans through circulating mobility, but Belfer-Cohen and Kaufman point out that the radiating mobility of archaic humans may actually have been cognitively more complex.

As is noted by many of the commentators, the association of archaic and early modern humans with the Levantine Mousterian industrial variants is an issue that needs to be resolved but may always be problematic. Contrary to what is suggested, I do not suppose that one can associate archaic humans with the upper layers of Qafzeh, with Hayonim E, or with Tabūn D, and I agree with Trinkaus that the Tabūn 1 female may be from Tabūn C. But if one looks at just those sites with well-described industries associated with hominids, a relatively clear pattern is suggested. Archaic humans have been found with more recent Tabūn B-type industries at Kebara and Amud, and early modern humans have been found with older Tabūn C-type industries at Qafzeh and Skhūl. Unfortunately, we do not yet have seasonality information for Skhūl and Amud, and no hominids are associated with the Tabūn D industrial variant. For these reasons, I concentrated on comparisons of sites with Tabūn B and Tabūn C industries.

Almost all the commentators argue that radiating mobility and circulating mobility are points on a continuum, and I agree that there is no reason to assume that hunter-gatherers with a circulating mobility strategy could not or did not also employ radiating/logistical strategies. Henry, for example, suggests that Tabūn D-type hunter-gatherers in the Negev employed radiating mobility at lowland winter camps and circulating mobility at highland summer camps, and Kaufman and Valla suggest that the Kebaran and Geometric Kebaran may have been a transition between circulating and radiating mobility. These points are well taken—particularly given the very limited data available on the Tabūn D phase of the Mousterian and the Kebaran and Geometric Kebaran—and they relate to Mackie's concern with what sorts of settlement systems we can infer from the archaeological record. In my opinion, we are limited to inferring mobility strategies from estimates of the season of animals' deaths and a variety of indica-

tors of occupational intensity at a small number of roughly contemporaneous sites in different habitats. With so few data, it is dangerous to assume (as does Olszewski) that hominids were migrating between any two known sites (e.g., from Qafzeh to Kebara, which are actually quite distant). Rather, we can only examine how specific sites in different habitats were used to infer seasonal movements from habitat to habitat within a single culture-stratigraphic unit. In contrasting radiating and circulating mobility, I primarily tried to stress the dichotomy between intensive, long-term use of a single site/habitat and short-term, highly seasonal site/habitat use.

Some of the discussion of radiating mobility may be related to confusion about the concept of multiseasonal occupation. As I said, these are simply occupations of a site for more than one season within the same limited culture-stratigraphic unit. They do not necessarily have to be continuous (as is the case with sedentism). Multiseasonal site use by hunter-gatherers is as rare in the Levantine Palaeolithic as it is in the ethnographic record (a point reiterated by Mackie), but I certainly do not wish to imply that the evidence for multiseasonal occupation in the Middle Palaeolithic suggests a form of sedentism. The strongest evidence for multiseasonal occupation comes from Kebara X. All the Kebara data allow us to say is that over a limited range of time archaic humans were living in Kebara during all the seasons of the year and that this pattern is completely unlike the pattern of gazelle killing at the site for the Upper Palaeolithic and the Kebaran. There are only two possible explanations for the seasonality pattern at Kebara and other Tabūn B-type sites: either the occupants were relatively sedentary (which is unlikely) or they were repeatedly returning to the site during every season (which is more likely). Both may be characteristic of a radiating mobility strategy in which the use of the site was more regionalized, intensive, and focused than during most of the Palaeolithic and Epipalaeolithic. This ties in with the evidence (noted by Olszewski) that hunter-gatherers at Tabūn B-type sites were making more pointed artifacts and were probably hunting more than those at Tabūn C-type sites (Lieberman and Shea n.d.).

It is extremely difficult to understand the causes of changes in mobility strategies, although I agree with Mackie's suggestion that environmental factors are the most likely candidates. I strongly disagree with Olszewski's complaint that the temporal scale covered in this study is too great for the distinction between radiating and circulating mobility to have any heuristic value. Hunter-gatherers in the Levant faced similar resource acquisition problems throughout the Upper Pleistocene because of the generally stable nature of the region's geography, climate, and resources. Moreover, a systemic approach to understanding hunter-gatherer mobility strategies is necessary if we are to study change in the Palaeolithic archaeological record. Chang (1962), Mortensen (1972), Binford (1980), Kelly (1992), and numerous others have gone a long way towards providing a useful and coherent framework for relating hunter-gatherer settlement systems with aspects of their envi-

ronment and culture. I also take issue with Olszewski's argument that hunter-gatherers (in this case the Natufians) cannot be both resource generalists and specialists (for a discussion of these strategies see Foley 1987:199–210). She accepts that the Natufians were generalists, but there is no reason that hunter-gatherers cannot combine a variety of strategies for acquiring resources (just as they can combine mobility strategies). The evidence for intensive, multiseasonal gazelle hunting in the Natufian is perhaps the best example of the resource specialization (Tchernov 1991) that may be associated with radiating mobility.

Whether the multiseasonal occupation of sites in the Middle Palaeolithic or the Natufian was intensive enough to deplete resources to the extent that a major cultural response was required remains to be tested with more faunal data, but I acknowledge some of Rocek's and Sheppard's comments about the limited use of statistics in table 1 (sample modes are published in Lieberman 1993a). I included some basic descriptive statistics because they might be useful to investigators, but I tried to refrain from presenting analyses of significance in order to avoid implying that one could probabilistically evaluate the season of occupation of sites from cementum data alone. While estimates of an animal's season of death can be accurate to within a few months (Lieberman n.d.b), estimates of a site's season of occupation are bound to be much less accurate because of our lack of understanding of site formation processes. For this reason, the range and distribution of estimates of season of death are probably the most useful indicators of seasonal site occupation. However, the relationship between sample size and the range of seasonal deaths is not as problematic as Rocek and Sheppard suggest. In fact, a regression (fig. 5) of sample size and range of estimates of season of death (taking into account that I divided the rainy and dry seasons into numerical categories by not coding any season as 4) clearly indicates that there is no statistically significant relationship between these two variables ($r^2 = 0.19$, $n = 34$). In this study, sample size and the range of estimates of season of death are statistically independent.

Finally, I agree wholeheartedly with Mackie, Rocek, and Valla that we need more environmental data to understand the complex relationship between subsistence behaviors such as mobility and the environment. I therefore avoided offering any specific hypotheses about why hunter-gatherers switched from circulating to radiating mobility in the Natufian and during the Middle Palaeolithic and concentrated instead on examining the consequences of radiating mobility. As Valla points out, climatic reconstructions of the early Holocene are somewhat in conflict, limiting our ability to propose any hypotheses about the causes of changes in mobility practices. Oxygen-isotope data from deep-sea cores (Nesteroff et al. 1983, Bar-Yosef and Belfer-Cohen 1989) indicate a period of global cooling during the early Natufian, but lake-core pollen data from the Hula Basin suggest an increase in arboreal pollen that is normally associated with warming (Baruch and Bottema 1991). Therefore, in order to resolve the issue of why the Natufians became

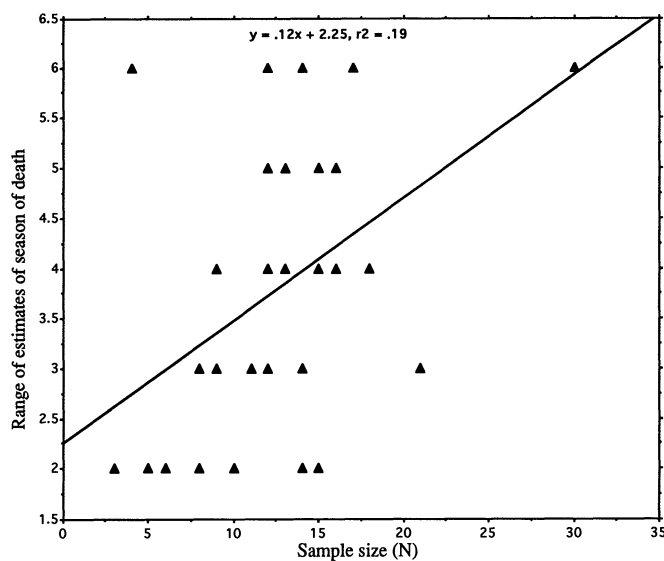


FIG. 5. Regression of sample sizes and ranges of estimates of season of death from table 1.

sedentary we need significantly more data about the Kebaran and Geometric Kebaran, more data on seasonality from sites throughout the region (including sources other than cementum analysis), a greater understanding of site formation processes, and better archaeological information on important behaviors such as storage and trade that are significant components of hunter-gatherer resource acquisition strategies. We are even farther away from understanding the behavioral differences between archaic and early modern humans. I hope that these issues will continue to be addressed in future research and discussions of the evolution of hunter-gatherer mobility.

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Calendar

1994

- January* 5–8. Society for Historical Archaeology and Advisory Council on Underwater Archaeology, Annual Meeting, Vancouver, B.C., Canada. Plenary theme: Science and Technology in an Interpretation and Presentation of the Historic Past. Write: Program Chair, Department of Archaeology, Simon Fraser University, Burnaby, B.C., Canada V5A 1S6.
- March* 21–24. International Conference on Ethnic Traditional Culture and Folk Knowledge, Moscow, Russia. Write: Organizing Committee, International Conference, Institute of Ethnology and Anthropology, Leninsky Prospect 32A, Moscow 117334, Russia.
- April* 5–11. William Robertson Smith Congress, Aberdeen, Scotland, U.K. Theme: Smith's life, times, and work as a Semitist, theologian, encyclopaedist, and librarian and the various academic fields that recognise his influence. Write: William Johnston, Department of Hebrew and Semitic Languages, University of Aberdeen, King's College, Old Aberdeen AB9 2UB, Scotland, U.K.
- April* 27–30. Southern Anthropological Society, Annual Meeting, Atlanta, Ga., U.S.A. Key symposium: Anthropological Contributions to Conflict Resolution. Write: Alvin W. Wolfe, Department of Anthropology, University of South Florida, Tampa, Fla. 33620, U.S.A., or Honggang Yang, Conflict Resolution Program, Carter Center of Emory University, One Copenhill, Atlanta, Ga. 30307, U.S.A.
- July* 4–9. Threatened Peoples and Environments in the Americas: 48th International Congress of Americanists, Stockholm, Sweden. Write: Institute of Latin America Studies, S-106 91 Stockholm, Sweden.
- September*. Texts and Images of People, Politics, and Power: Representing the Bushman People of Southern Africa, Symposium and Exhibitions, Johannesburg, South Africa. Write: T. A. Dowson and J. D. Lewis-Williams, Rock Art Research Unit, Department of Archaeology, University of the Witwatersrand, Johannesburg 2050, South Africa.
- November*. The Pleistocene/Holocene Boundary and Human Occupations in South America, International Symposium, Mendoza, Argentina. Write: Marcelo Zárate, International Symposium The Pleistocene/Holocene Boundary, Centro de Geología de Costas y del Cuaternario, UNMP, Casilla de Correo 722-Correo Central, 7600 Mar del Plata, Argentina.