'Global Warming' and the Movement of the Settlers to the Highlands of Palestine (*circa* 1200 - 1000 B.C.E.)

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ABSTRACT

Scholars *are divided as to the origins of the settlers in the highlands of Palestine, during Iron Age I. Some (e.g. Rainey) are convinced that they came from the east, while others (e.g. Dever) are of the opinion that they came from the coastal plain. Irrespective of their origins, however, in this article it is proposed that the migration to the highlands was due, at least in part, to the fact that Palestine, from the late 13th century to about 900 B.C.E., became significantly drier.*

A INTRODUCTION

The concept that climate fluctuations play a role in controlling human history may initially seem a little far-fetched. Several studies have, however, made it clear that climate fluctuations do, in fact, play a role - one which, unfortunately, has often been ignored. Climatic shifts have, for example, been shown to coincide with major breaks in the cultural evolution of the Near East. The cultural blossoming of the whole region during the Early Bronze Age (3200-2400 B.C.E.) occurred during a humid phase, characterised by a continuously high Dead Sea level, while the dry period around 2200 B.C.E., coincided with the cultural collapse that is well documented for the entire Middle East (e.g. the breakdown of the Akkadian civilization in Mesopotamia); this was followed about 300 years later by another rise in the Dead Sea level which coincided with the founding of the Middle Bronze Canaanite city-states, such as Hazor, Gezer and Megiddo.[1] It has recently been suggested by Orland *et al*,[2] based on the high-resolution geochemical analysis of a stalagmite from Soreq Cave, located in the Stalactite Cave Nature Reserve near Jerusalem, that even the decline of the Roman and Byzantine empires in the Eastern Mediterranean may have been driven by the increasingly dry weather from 100 CE to 700 C.E., with steep drops

1 Claudia Migowski, Mordechai Stein, Sushma Prasad, Jörg F. W. Negendank, & Amotz Agnon, "Holocene climate variability and cultural evolution in the Near East from the Dead Sea sedimentary record," *Quaternary Research* 66/3(2006): 427; see 2, for the role of the Dead Sea as a "rain gauge."

2 Ian J. Orland *et al.*, "Climate deterioration in the Eastern Mediterranean as revealed by ion microprobe analysis of a speleothem that grew from 2.2 to 0.9 ka in Soreq Cave, Israel," *Quaternary Research* 71/1(2009): 27-35.

in precipitation around 100 C.E. and 400 C.E. Other climate fluctuations affecting the history of Palestine are highlighted below.

Not all scholars are, however, convinced that climate fluctuations were of primary significance in the rise and fall of Near Eastern civilizations. Marfoe,[3] for example, is of the opinion that "the almost cyclical regularity of the patterns strongly suggests a complex process of socioeconomic change that cannot be explained by such facile postulations as climatic changes or 'barbarian' migrations."

It should be pointed out that it is hardly necessary to look to the past in order to appreciate the effects of climatic shifts. At present, the world is going through another cycle of "global warming" (a natural cycle which this time, unfortunately, is being exacerbated by human activity) and, already, its effects - particularly on flora and fauna - are obvious. It would thus seem quite clear that climate fluctuations do play a significant role in human history - a role which is definitely worth exploring.

In support of this proposal, use will be made of nontextual (e.g. proxy data such as pollen from five areas of the Near East, Persian Gulf sediments, barley harvest dates and an analysis of anomalies in the radiocarbon record), textual (e.g. the Ugaritic texts, Akkadian texts and Mesopotamian written documentation) and other relevant palaeoclimatic evidence (in particular, Dead Sea levels) for the warming of the Near East (*circa* 1200 - 900 B.C.E.). In addition, the benefits of this move will be spelled out. Long-term climatic fluctuations are not, in general, historically documented and "tend to go unnoticed, being beyond the temporal perspective of an individual observer" and, in any event, ancient humans took more interest in the more frequent or dramatic events (e.g. river floods and recessions or earthquakes), which have a more immediate significance to society.[4] Fortunately, modern scientific methods for the study of climate have come to our rescue and applicable methods and their results will be highlighted.

B WEATHER FLUCTUATIONS IN THE LATTER PART OF THE LATE BRONZE AGE AND THE EARLY IRON AGE

Many migrations in the Mediterranean are known to have been caused by drought and hunger: Herodotus[5] reported famine to have been the reason for the migrations of the Lydians and the Etruscans; Greek colonisation during the

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3 Leon Marfoe, "The integrative transformation: patterns of socio-political organization in southern Syria," *BASOR* 234 (1979):10.

4 Amos Frumkin & Yoel Elitzur, "Historic Dead Sea level fluctuations calibrated with geological and archaeological evidence," *Quaternary Research* 57 (2002): 334.

5 Cited by Jan Bouzek, "Climatic changes and central European prehistory," in *Climatic change in later prehistory* (ed. Anthony F. Harding, Edinburgh: Edinburgh University Press, 1982), 186.

8th century B.C.E. has been attributed - at least, in part - to famine in the over-populated Greek cities at that time; while, even in more modern times such as the 19th century, migrations in Brazil and China have been linked to droughts. If people "wanted to survive, they had to move elsewhere or to adapt their system to the changing conditions."[6]

Palestine experiences extreme climatic differences, being temperate sub-humid in the north and sub-tropical hyper-arid in the south. The mean average rainfall also differs markedly. Some places in Upper Galilee, for example, experience a mean annual rainfall of as much as 1000mm, while the southern Negev receives only 25mm and rain may be entirely absent for several consecutive years. These differences, as well as drastic fluctuations in the climate, appear to have had a tremendous impact on the ancient Israelites, since rain and drought, as well as heat and cold, play a prominent role in the Hebrew Bible[7] in a variety of texts, including poetry, proverbs, curses and blessings - the most feared evidently being hunger and famine, since these are mentioned most frequently.[8] Sufficient rainfall or the lack thereof most probably would have meant the difference between life and death, since agricultural yields depended largely on precipitation.

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6 Bouzek, "Climatic changes and central European prehistory," 186.

7 The importance of the rain, for example, to the Israelites is underlined by the number of names for rain in Hebrew (e.g. *delef*, *geshem*, *matar*, *mimtar*, *nezel*, *raviv*, *sagrir*, *seirim*). The settlers were utterly dependent on timely rains ("the early and later rain" [Deut 11:13-14]; "the rain in its season, the autumn rain and the spring rain" [Jer 5:24]). The early rains were required for germination and early seedling growth; the mid-season rains for subsequent growth - especially in those areas where the soil was shallow or coarse-textured; and the late rains for the ripening of the grain and fruit (Daniel Hillel, *The Natural History of the Bible: an environmental exploration of the Hebrew scriptures* [New York: Columbia University Press, 2006], 157). The onset of the wet season (early rain; *yoreh*), which lasts from autumn to spring, usually occurs in October or November. If it arrives too early, it is likely to be followed by a dry spell which would probably kill the young seedlings; if the *yoreh* is either too scanty or arrives too late, the dry season may arrive before the seedlings have grown and matured sufficiently. The final rain (*malkosh*) usually arrives in April, at grain-setting and -maturing time. Should the *malkosh* be too early or too late, the crop yield is likely to be limited; in addition, harvesting, threshing and preparations for summer crop-planting are likely to be hindered (Hillel, *The Natural History of the Bible,* 317, n 12). "There is no mistaking that this is a very high-risk environment" (David C. Hopkins, "Life on the land: the subsistence struggles of early Israel," *BA* 50/3 [1987]: 184).

8 Michael Zohary, *Plants of the Bible* (Cambridge: University of Cambridge Press, 1982), 26.

There is some evidence that the Near East became increasingly and significantly drier in the latter part of the Late Bronze Age and McCarter[9] suspects that this was one of the important factors which contributed to the destabilisation of life in the lowland cities and the change of settlement patterns in Iron Age I, since it is easier for people to live in hill country villages than in cities when the weather becomes drier. According to Halpern,[10] the movement of the settlers "into a relatively uninhabited area suggests more than anything else a shift in climate and patterns of precipitation;" in addition, the effects of climatic warming on the coastal agriculture "can only have been devastating."[11] Thompson[12] is also of the opinion that drought played a significant role in the movement of the population of Palestine into the central hill country, a sentiment echoed by Matthews and Benjamin: "By 1250 B.C.E. perhaps sixty percent of the people of Syria-Palestine had died from starvation due to crop failures, which followed subtle changes in climate and the exhaustion of natural resources." [13]

Why, then, would this move have been to their advantage? Firstly the coastal ranges, even in times of drought, have more precipitation than the lowlands, courtesy of the westerly rain-bearing winds from the Mediterranean; in addition, the larger valleys of the central hills were blessed with an abundance of springs.[14] The central highlands have an asymmetrical topography: the western, windward, relatively moist slope drops gently towards the Mediterranean, while the eastern, leeward, arid slope (being in the rain shadow) drops steeply towards the Jordan Valley. As the moisture-laden air from the Mediterranean is forced to rise by the windward side of the mountain range (which rises to some 900m, about 50km from the sea, after which it levels out to form a plateau), the vapour condenses to form clouds and is then precipitated as rain (the orographic effect). The moisture-deprived air then descends the leeward side, compresses, warms up and desiccates the land. In such a situation, the streams carrying the runoff tend to flow from the plateau down the western slope towards the sea.[15]

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[9] P. Kyle McCarter, "The origins of Israelite religion," in *The rise of ancient Israel: symposium at the Smithsonian Institution, October 26, 1991,* (eds. Hershel Shanks, Washington D.C.: Biblical Archaeology Society, 1992), 130.

[10] Baruch Halpern, *The emergence of Israel in Canaan* (Chico: Scholars Press, 1983), 98.

[11] Halpern, *The emergence of Israel in Canaan*, 100.

[12] Thomas L. Thompson, *The mythic past: biblical archaeology and the myth of Israel* (New York: Basic, 1999), 155, 158-161.

[13] Victor H. Matthews & Don C. Benjamin, *Social world of ancient Israel 1250 - 587 B.C.E.,* (Peabody: Hendrickson, 1993), 2.

[14] Robert B. Coote & Keith W. Whitelam, *The emergence of early Israel in historical perspective* (Sheffield: Almond, 1987), 83; cf. Thompson, *The mythic past*, 161.

[15] Hillel, *The Natural History of the Bible,* 141, 143.

Secondly, if forest and woodland were the dominant features, the mountainous areas rather than the lowlands of ancient Western Asia would have provided some of the best grazing land in the area.[16] Thirdly, the thicker vegetation and the rocky natural defences provided by the terrain would have made it more difficult for adequate military control of the area by the city-states, giving the settlers more independence and the remote mountainous regions "would have constituted a refuge for uprooted social elements."[17] As Halpern[18] has pointed out, one of the simplest and yet most relevant facts retrieved from the Amarna archives (especially those written by the prolific Rib-Adda of Byblos),[19] is that the mountainous areas in the interior, even prior to the settlement period, "tended to be most restive, or most successful at restiveness," due to their remoteness[20] "in terms of time, access and effort, from Egyptian control," enabling the inhabitants to enjoy "a greater latitude of policy than did their counterparts on the plains." Although the Amarna materials give no hint of a movement to the hills at that stage, this area would nevertheless have been "less subject to the vicissitudes of local and international politics than were the plains."[21] Fourthly, being independent of "large-scale agriculture or vulnerable central food supplies" the settlers "would have been far more resistant to the harsh conditions of such an era." Finally, a "relatively decentralised hills population would have been better suited to survive by alternative means of food production"[22] and, in our opinion, the "roots, shoots and fruits" and the abundance of acorns naturally available in these woodlands, even during periods of drought, were probably important dietary supplements.

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16 M. B. Rowton, "The woodlands of ancient Western Asia," *JNES* 26 (1967): 277.

17 Rowton, "The woodlands of ancient Western Asia," 263.

18 Halpern, *The emergence of Israel in Canaan*, 87.

19 See Marvin L. Chaney, "Ancient Palestinian peasant movements and the formation of pre-monarchic Israel," in *Palestine in transition: the emergence of ancient Israel* (eds. David N. Freedman & David F. Graf, Sheffield: Almond, 1983), 72ff.

20 As Chaney ("Ancient Palestinian peasant movements," 49) has pointed out: "Even the language of 'official' religion at Ugarit reflected this situation." The mythic text CTA 4.7.35-37 relates that:

> Ba'al's enemies take to the woods,
> Haddu's foes to the sides of the mountain crag.

21 Halpern, *The emergence of Israel in Canaan*, 88.

22 Halpern, *The emergence of Israel in Canaan*, 101.

1 Palaeoclimatic, nontextual and textual evidence for the warming of the Near East (*circa* 1200-900 B.C.E.)

1a Palaeoclimatic evidence

A general climatic decline is known to have occurred in the northern hemisphere from about 1500 B.C.E. onwards.[23] Palaeoclimatic studies for the Late Bronze Age in Mesopotamia have been shown to correspond with the well-documented changes in weather patterns in Europe during the period 1200-900 B.C.E..[24] A striking correspondence has also been found between moisture trends in Europe and the Near East in all phases (including today) so far examined. In addition, modern meteorological data show a close correlation between the climate and weather characteristics of the eastern Mediterranean littoral and northern Iraq. It is a fair assumption that the levels of correlation in ancient times did not differ substantially from those in modern times.[25]

Following a few centuries of comparatively cool weather (*circa* 1500 - 1200 B.C.E.), favourable (on the average) for increased precipitation, historical climatology studies have strongly suggested that from about 1200 until about 900 B.C.E., Europe and, according to a few but nevertheless convincing textual and nontextual sources, the Near East became notably warmer. Near Eastern winters are the main rainfall season and there is a strong tendency for cool winters to be rainy as well (a fact reflected in a study of Jerusalem's rainfall data since the middle of the 19th century). The resultant reduced amounts of rain which tend to be produced by warmer winters were bound to have a negative effect on the local agriculture. A mere increase of 1^0C in mean winter temperatures has been estimated to reduce the annual rainfall in the area by as much as 30mm. If one presumes that the favourable climatic conditions prior to 1200 B.C.E. had boosted the population growth in settled areas to ecologically critical limits[26], then it is clear that even a seemingly small warming after 1200

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[23] John L. Bintliff, "Climatic change, archaeology and Quaternary science in the eastern Mediterranean," in *Climatic change in later prehistory* (ed. Anthony F. Harding, Edinburgh: Edinburgh University Press, 1982), 150.

[24] J. Neumann & Simo Parpola, "Climatic change and the eleventh - tenth century eclipse of Assyria and Babylonia," *JNES* 46/3 (1987): 162-163.

[25] Neumann & Parpola, "Climatic change in Assyria and Babylonia," 170.

[26] According to Israel Finkelstein, "Ethnicity and origin of the Iron I settlers in the highlands of Canaan: can the real Israel stand up?" *BA* 59/4 (1996), 208, "recent studies have shown beyond doubt that the lowlands population had never reached close to a 'carrying capacity' point, and hence there were no land-hungry demographic surpluses eager to expand into new frontiers." However, irrespective of the origins of the new settlers, a climatic shift is still of significance since it would have simultaneously affected both the settled regions and the nomadic habitats (Neumann & Parpola, "Climatic change in Assyria and Babylonia," 161). Deterioration of the climate would have led to the loss of the nomad's economic base - the pasture

B.C.E. would have been sufficient to disrupt the economies and stability of the Canaanite city-states. Dry conditions are known to produce years of crop failure, famine, and social and political unrest.[27]

1b Nontextual evidence

As an example of nontextual evidence for the eastern Mediterranean littoral, Schaeffer[28] has pointed out in *Ugaritica V* that the soil (up to two metres thick in places) found everywhere in the excavated area of Ugarit and into which the destroyed buildings marking its end (early 12th century B.C.E.) are embedded consists of fine, powdery, homogeneous particles of a light yellow, often whitish colour. In his view, this "without any doubt whatsoever indicates a period of extreme heat and dryness at the time of Ugarit's end."[29] The brown soil from both the layers below (containing the early Late Bronze [15th - 14th centuries] and the late Middle Bronze [late 17th century] ruins) and above (Late Iron Age [probably *circa* 7th - 6th century]), are non-powdery and of a colour suggesting a more rainy climate. In other words, the dry powdery layer of "Ugarit final" is sandwiched between two layers indicating a moist climate. Similar indications were also observed by Schaeffer at Enkomi, Cyprus.[30]

Other studies include estimates of the Tigris-Euphrates peak streamflow over the past 6000 years based on ten regional palaeoenvironmental "proxy" data (i.e. indirect, climatic data; e.g. pollen from five areas of the Near East, Persian Gulf sediments, barley-harvest dates, etc.) and an analysis of anomalies in the radiocarbon record in the Near East.[31] The former study indicates that a sharp increase of peak steam flow began about 1450 B.C.E., with a maximum peak dating to about 1350 - 1250 B.C.E., followed by a sharp drop reaching a minimum peak about 1150 B.C.E and then by a relatively sharp rise about 950 B.C.E.. The latter study tentatively indicates that the years 1420 - 1260 B.C.E. were a time of low solar activity which produced a relatively cold and rainy period.

1c Textual evidence

The Ugaritic texts tell us[32] that a famine, described as being a "matter of life and death" in parts of Great Hatti, occurred during the reign of the Hittite king, Shuppiluliumas II, causing him to request his vassal in Ugarit to send a ship-

grounds would have been lost and, most probably, animals through illness, causing "a fall out of the nomadic cycle" (Van der Steen 1996:66).

27 Neumann & Parpola, "Climatic change and Assyria and Babylonia," 162, 169.

28 Claude F.A Schaeffer, *Ugaritica 5*. (Paris: Imprimerie Nationale, 1968), cited in Neumann & Parpola, "Climatic change and Assyria and Babylonia," 163-164.

29 Cited in Neumann & Parpola, "Climatic change and Assyria and Babylonia," 163.

30 Cited in Neumann & Parpola, "Climatic change and Assyria and Babylonia," 163.

31 Neumann & Parpola, "Climatic change and Assyria and Babylonia," 164.

32 Albert Leonard, "Archaeological sources for the history of Palestine: the Late Bronze Age," *BA* 52/1 (1989): 30.

ment of 2000 measures of grain to Cilicia. This protracted drought is, in fact, one of the two main reasons for the destruction of the Hittite empire at the end of the 13th century B.C.E., during the reign of Shuppiluliumas II (*circa* 1210-1190 B.C.E.), the last Hittite king - the other reason being the dissension at the periphery of the empire and the ever-increasing pressures from the Sea Peoples and other outside elements such as the Phrygians.[33] Pagan, the ruler of Alashiya/Cyprus, also requested food supplies from Ugarit. In a semi-arid region such as Syria, where summer, "if not actually a season of sterility ... is nevertheless a season of tension," the timely arrival of the spring rains (the "later rains"/"latter rains" of the Hebrew Bible; Deut 11:14) is of paramount importance to the success of the coming season's crop. It is, thus, not surprising that the Ba'al texts have, as a predominant theme, "the tension between fertility and sterility" and describe the main antagonist of the fertility god, Ba'al, as Mot (the power of death, drought and sterility).[34] The Canaanites, like their neighbours in Egypt and Mesopotamia, "were incapable of intellectual or speculative detachment [and] were emotionally involved" (our insertion – MleR and IR) with the recurrent cycle of nature.[35]

Against the background of a dramatic climate shift, the sources referring to Canaan during the 13th - 12th centuries B.C.E. are also better understood. In a letter found at Aphek, the Ugaritic commissioner makes an otherwise surprising request to the Egyptian prefect of Canaan to restore his consignment of 15 metric tons of wheat to him; after all, international commerce during the Late Bronze Age was largely concerned with luxury goods (i.e. the wheat transaction must therefore have been due to somewhat unusual circumstances.[36] Large quantities of grain are mentioned in the ostraca from Lachish and Tel Sera' (*circa* the time of Ramesses III) and Na'aman[37] has suggested that this "may well reflect an Egyptian effort to store grain in the face of the long drought and famine" in that period.

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33 Aharon Kempinski, "Hittites in the Bible: what does archaeology say?" *BAR* 5/4 (1979): 39.

34 John Gray, *The legacy of Canaan: the Ras Shamra texts and their relevance to the Old Testament*, 2nd Ed. (Leiden: EJ Brill, 1965), 12.

35 Gray, *The legacy of Canaan*, 13.

36 Nadav Na'aman, "The 'Conquest of Canaan' in the Book of Joshua and in history," in *From nomadism to Monarchy: archaeological and historical aspects of early Israel* (eds. Israel Finkelstein, I & Nadav Na'aman, Jerusalem: Israel Exploration Society, 1994), 244.

37 Na'aman, "The 'Conquest of Canaan' in the Book of Joshua," 244.

We know from Akkadian texts that a famine, at the beginning of the 11th century B.C.E., caused Aramaeans to move to Mesopotamia and it may well have forced others to move south.[38]

Mediterranean documentation[39] from the period 1200 to 900 B.C.E., when supplemented by secondary sources such as omens, poetic narratives and incidental historical references in later texts, contain numerous references to negative developments (more or less evenly distributed over the whole period) which are likely to have resulted from unusually arid conditions (crop failures, famines, high grain prices, massive nomad incursions). At the same time, allusions to good crops, favourable grain prices, and the like, are almost totally lacking. By comparison, texts from a well-documented sub-period of seventy years (735 - 665 B.C.E.), have few references to drought, crop failures and famines, speaking instead of abundant rains, heavy snow, excessive floods, high water levels, good crops and favourable grain rates.[40] Although the textual evidence has many limitations - these sources can hardly be considered to be meteorological records and they are dated only approximately - it generally agrees with the nontextual evidence that the period 1200 - 900 B.C.E. was relatively dry, while that after 900 B.C.E. was comparatively moist.[41]

What the factors were that led to a warm period from 1200 to 900 B.C.E. in parts of Europe and the Near East remain uncertain. While Neumann and Parpola[42] reject volcanism as the cause, they have suggested that it may have been due to an increase in the solar output, at least in the visible portion of the spectrum. The use of advanced models of the general circulation of the atmosphere shows that an increase of even 1% in the solar constant - provided the change is sustained - leads to noteworthy changes in temperature and precipitation. Modern technology has shown that the solar constant is not as "constant" as once thought. Small changes in the constant have been measured using satellites flying "above" the atmosphere. Although the changes are far below 1%, it should be borne in mind that the period of observation involved is far too short to be able to make any extrapolations for the years 1200 - 900 B.C.E..

2 The Dead Sea as a sensitive recorder of Near Eastern climate variability

The surface of the Dead Sea receives less than 100mm/annum and, being a terminal lake which drains one of the largest hydrological systems in the Near East, its level depends primarily on the precipitation received in its northern

38 Gösta W. Ahlström, "The bull figurine from Dhahrat et-Tawileh," *BASOR* 280 (1990): 77-78.
39 Neumann & Parpola, "Climatic change in Assyria and Babylonia," 171-172.
40 Neumann & Parpola, "Climatic change in Assyria and Babylonia," 175.
41 Neumann & Parpola, "Climatic change in Assyria and Babylonia," 177.
42 Neumann & Parpola, "Climatic change in Assyria and Babylonia," 169-170, n 38.

headwaters. This area experiences a Mediterranean climate (i.e. the winters are wet, while the summers are dry) and most of the precipitation received originates in the North Atlantic, with the Mediterranean Sea acting as a secondary moisture source. Thus, according to Migowski et al, "the Dead Sea can be viewed as a large rain gauge for the Near East region and in turn a sensitive recorder of Near East climate variability."[43]

In response to climatic shifts, the level of the Dead Sea has fluctuated throughout history. During the period 1997-2005, for example, its level has dropped by 6mm, from 412m below mean sea level (m bmsl) to 418 m bmsl,[44] while its shores have retreated by about 1m/year (mainly due to human interference, but also, presumably, because of global warming). The Dead Sea has two sub-basins; the northern basin (*circa* 300m deep) is separated from the shallow southern basin by a sill at about 400m bmsl. Extreme arid events causing the water level in the northern basin to drop significantly below the sill would, ultimately, cause the southern basin to dry out. In order to flood the southern basin (where evaporation is more rapid) and raise the level of the lake significantly, a substantial increase in precipitation in the drainage area is required - substantially more than the amount simply required to raise the lake level above the sill.[45]

Migowski *et al.*[46] have reconstructed a comprehensive record of lake level changes based on the detailed lithological and mineralogical information derived from three, well-dated sediment cores recovered from the fast retreating modern shores of the northern basin of Dead Sea; this information was then stratigraphically and lithologically correlated and compared with the exposed sections in modern near-shore gullies. The results obtained suggest that, during the period 8000 to 1350 B.C.E., there were two major wet phases (*circa* 8000-6600 and 3600-1500 B.C.E.), a long dry phase (*circa* 6200-3600 B.C.E.) and multiple abrupt arid phases (*circa* 6600, 6200, 2200, 1500 B.C.E.) in the eastern Mediterranean palaeoclimate. As pointed out earlier, these events appear to coincide with major breaks in the cultural evolution of the Near East, suggesting that there is a sensitive relationship between society and environment.

Although the period from about 1500 to 1200 B.C.E. was comparatively cool, favouring (on average) increased precipitation,[47] of significance here is the abrupt climatic deterioration around 1500 B.C.E., when the lake level was at approximately 417m bmsl and then dropped about 35m in the following less

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43 Migowski *et al.*, "Holocene climate variability," 421.

44 Amos Frumkin & Yoel Elitzur, "Historic Dead Sea level fluctuations calibrated with geological and archaeological evidence," *Quaternary Research* 57 (2002): 335; also Migowski *et al.*, "Holocene climate variability," 421.

45 Migowski *et al.*, "Holocene climate variability," 422.

46 Migowski *et al.*, "Holocene climate variability," 422-426.

47 Neumann & Parpola, "Climatic change in Assyria and Babylonia," 162.

than 200 years. This rapid climate deterioration occurred around the same time as the fall of the Canaanite city-states (1300-1200 B.C.E.), although warfare is the generally accepted reason for their demise.[48]

On the basis of all lines of evidence (previously published geological and archaeological evidence, as well as the imprecise biblical indicators) of Dead Sea levels, Frumkin and Elitzur[49] have reconstructed the history of lake-level fluctuations during the Iron Age. Geological evidence indicates that the Dead Sea level was above 390m bmsl during the period between about 1500 and 1200 B.C.E. and that, between about 1200 and 500 B.C.E., the level fell off to below 390m bmsl (i.e. slightly above the floor of the southern basin but, nevertheless, close to the threshold level of the sill). It is not, however, clear whether the southern basin was completely dry.[50]

Three archaeological Iron Age sites, which were flooded during periods of high water level and which reappeared when the level dropped, are significant. The first, Mesad Gozal, is in the southern basin near to Mount Sedom (Jebel Usdum). The pottery found there was dated to between about 1100 and 900 B.C.E.,[51] while the floor level of the building is at 388m bmsl. Since it is presumed to have been a fortress (probably Edomite and destroyed during David's reign; cf. 2 Sam 8:12-14; 1 Kgs 11:15-16; 1 Chr 18:12-13), the Dead Sea level was obviously lower than that and, in all likelihood, probably considerably lower. The other two sites, Rujm el-Bahr and Khirbet Mazin (possibly, biblical Midin; Jos 15:61), are located on the shores of the northern basin and would seem to have been used as docks for boats; both were dated, by Bar-Adon,[52] to about 800 to 600 B.C.E.. The effective water level for the anchoring of boats at the former is 400m bmsl and at the latter it is 395m bmsl, suggesting that the Dead Sea fluctuated about 5m (from 400-395m bmsl), during that two-century period. In other words, the southern basin may have been shallowly filled by the Dead Sea from about 1100 to 900 B.C.E. and may have been dry, or almost dry, from about 800 to 600 B.C.E.; however, the evidence is inconclusive.

The Hebrew Bible mentions "the Valley of Salt" (*gai ha-melah*) five times as the battlefield where thousands of Edomites were defeated, first by king David (*circa* 1004-965 B.C.E.; 2 Sam 8:13; 1 Chr 18:12; Ps 59:17) and then by king Amaziah (*circa* 798-769 B.C.E.; 2 Kgs 14:7; 2 Chr 25:11). The word *gai*, in biblical Hebrew, is used for a narrow ravine (as in Jos 8:11) or a wide plain (as in Deut 34:6). Presumably, here the context implies the latter. Frumkin and

48 Migowski *et al.*, "Holocene climate variability," 422-426.
49 Frumkin & Elitzur, "Historic Dead Sea level fluctuations," 334-342.
50 Frumkin & Elitzur, "Historic Dead Sea level fluctuations," 338.
51 Yohanan Aharoni, "Mesal Gozal," *IEJ* 14 (1964): 113.
52 Pesach Bar-Adon, "Excavations in the Judean Desert," in *'Atiqot 9* (Jerusalem, Israel Antiquities Authority and Israel Exploration Society 1989) [in Hebrew], as cited in Frumkin & Elitzur, "Historic Dead Sea level fluctuations," 338.

Elitzur[53] thus conclude that the battlefield was probably the dry southern basin (or, at least, a significant part of it), since it is associated with Edom and there is no other "geographical feature that fits this term." In other words, during the period 1200 and 700 B.C.E. (or, at least, during the period when this biblical record was written and edited, since there is no "updating comment;" cf "the Valley of Siddim [that is, the Salt Sea];" Gen 14:3), the level of the Dead Sea had dropped below 400m bmsl.

C THE WOODLANDS OF THE HILL COUNTRY OF PALESTINE

Despite all the excavations that have been carried out in the highlands of Palestine, archaeologists have rarely recorded evidence useful for reconstructing the ancient environment.[54] As a consequence, the real picture of the landscape during the Bronze and the Iron Ages remains unknown. However, an approximate idea can be derived from inferences drawn from a variety of sources such as phytogeography, texts (particularly the Hebrew Bible and the Amarna Letters) and settlement patterns.

Phytogeographers have demonstrated that the elevated areas of Western Asia, although bare and eroded today, were forested during prehistoric times. However, until fairly recently, it was thought that the expansion of urban civilization which took place throughout much of Western Asia at the beginning of the Bronze Age, with its concomitant sharp and enduring increase in the demand for timber, would have destroyed these forests and woodlands. Rowton,[55] using cuneiform sources (*circa* 90% of which are from the period 1250-550 B.C.E.) and the, less reliable, ancient "tree-toponyms" (the epithets used for mountains derived from their most conspicuous timber, that are found in historical, literary, religious and lexical sources; e.g. the alternative names for Mt. Hermon and Mt Lebanon were Cedar Mountain and Cypress Mountain, respectively), has shown this view to be mistaken.[56] The continued existence of forests does not necessarily depend on climate. Even in times of drought, provided there is sufficient minimum precipitation and soil in which to grow, forests are able to endure. The most common soil in the hill country of Palestine is the fertile, shallow (often less than 50cm deep), red to brownish-red *terra rossa* which has a clay content usually above 50%.[57] Although it is able to hold moisture well, it has poor resistance to erosion, especially on slopes where the forest canopy has been denuded. Soil erosion, in turn, prevents the regrowth of the forest. Lower precipitation only means fewer kinds of trees, not necessarily fewer trees. Trees such as the oak and the terebinth, both known from biblical

53 Frumkin & Elitzur, "Historic Dead Sea level fluctuations," 341.
54 Lawrence E. Stager, "The archaeology of the family in ancient Israel." *BASOR* 260 (1985): 4.
55 Rowton, M B. "The woodlands of ancient Western Asia," 261-277.
56 Rowton, "The woodlands of ancient Western Asia," 261, 262, 267, 276.
57 Stager, "The archaeology of the family in ancient Israel," 4.

sources,[58] are able to survive these conditions. In addition, their root systems are particularly suitable for the prevention of soil erosion. The amount of soil available depends on the presence of not only trees but also on the degree of bush cover present to prevent soil erosion.[59]

Reference to forests in cuneiform sources is comparatively rare. The Amarna correspondence, for example, makes no mention of forests, although many of the events and towns are located in forest country. This, however, does not imply that forests did not exist. After all, as Rowton[60] has pointed out, "why waste precious tablet space" on something that was common knowledge? Nevertheless, there are sufficient ancient sources from Egypt mentioning forests in the Lebanon and the adjacent parts of Syria and Palestine, usually concerning the provenance of timber during the course of military expeditions,[61] to suggest that throughout the Bronze Age and for several centuries thereafter the mountainous areas were considered to be the domain of the forest. Even as late as at the beginning of the 19th century, the process of deforestation and erosion was not yet complete. In other words, this process is a relatively slow one.

Rowton has shown that the forests in the mountainous areas and urban settlement in the lowlands were able to coexist over prolonged periods of time[62] and that remnants of forest in almost all the regions mentioned in this connection have survived into recent times.[63] For example, substantial forest can be shown to have existed, right down to the Hellenistic period, in the comparatively small mountain range which extends southwards from the mouth of the Orontes into the Upper Galilee, despite the number of towns in the immediate proximity (e.g. Sidon, Tyre, Byblos, Ugarit, Alalakh, Hazor, etc). Even to-

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58 There appears to be some uncertainty as to which words should be translated "oak" and which "terebinth" (E. W. G. Masterman, "Oak," n. p. Cited 20 April 2008. Online: http://www.internationalstandardbible.com/O/oak.html). In recent revisions of English versions of the Hebrew Bible, "terebinth" has been increasingly added in the margin. All the Hebrew words which are used for these trees are closely allied (*'elah* [e.g. "the oak;" Gen 35:4; Judg 6:11,19; 2 Sam 18:9-10] *'allah* [apparently a slight variant for *'elah*; Josh 24:26]/*'elim* [perhaps the plural of *'elah*; e.g. Is 1:29]/*'elon* [e.g. "the oak of Moreh;" Gen 12:6; margin notes "or terebinth"]/*'allon* ["Allon-bacuth;" Gen 35:8; margin notes "the Oak of weeping;" compare Gen 35:4]). Masterman has suggested that these words "may originally have had simply the meaning of 'tree' but it is clear that, when the Old Testament was written, they indicated some special kind of tree." He has suggested further, that the words *'elah*, *'allah* and *'elim* refer to the terebinth and that *'elon* and *'allon* are most probably correctly translated "oak" - an opinion wholeheartedly supported by Zohary, *Plants of the Bible,* 111.

59 Rowton, "The woodlands of ancient Western Asia," 265-266, 274.

60 Rowton, "The woodlands of ancient Western Asia," 275.

61 Rowton, "The woodlands of ancient Western Asia," 262.

62 Rowton, "The woodlands of ancient Western Asia," 263-265.

63 Rowton, "The woodlands of ancient Western Asia," 265-274.

day, in the northern part of the Lebanon, the process of deforestation is still far from complete.[64] Less than a century ago, remnants of oak and pine forest existed in the Jerusalem-Hebron-Jaffa region, while substantial woodland (although the total area is far from large) has survived in the Ajlun (ancient Gilead[65]). The Hebrew Bible tells us that Gilead was a forested region (2 Sam 18:8) and that ancient Bashan which lay between Gilead and Mt. Hermon was an oak woodland (Isa 2:13; 33:9; Ezek 27:6; Zech 11:2).

It seems fair to assume that a significant amount of forest would have survived in the hill country of Palestine, right up until to the end of the Bronze Age, and even later. Although the central range and northern slopes had experienced extensive deforestation during the Middle Bronze period, the survey of the territory of Ephraim undertaken by Finkelstein[66] has demonstrated that during the Late Bronze period the arboreal vegetation had partially renewed itself on the slopes, especially in those areas not used intensively by pastoral groups. This survey, as well as those undertaken in Manasseh, Benjamin, and Judah, all indicate that the earliest settlers in the hill country of Palestine were not faced with densely wooded areas, since they inhabited the desert fringe, the small intermontane valleys of the northern central range and the Bethel plateau,[67] while the densely wooded areas were located further to the west, on the slopes and in the foothills. It was only later when the population densities in many parts had increased (particularly, those areas without much bottomland) - and, presumably, as the drought progressed - that the settlement spread to the more wooded western slopes. These more densely wooded areas would, however, have been in a transitional stage. The forest would have already thinned out and these areas would have consisted of a mixture of trees, bush and pasture, in other words, "woodland,"[68] and would have contained some of the best grazing land in Palestine.

New strategies would have been required as the Iron I settler population grew, in order to increase agricultural productivity in the limited environment of the hill country. No doubt, this caused extensive deforestation (perhaps, as succinctly described in Josh 17:16-18). According to Stager,[69] at least as early as 1200 B.C.E., the population densities in some areas were sufficiently great to begin the process of converting hillsides into agricultural terraces and he is of the opinion[70] that: "Of all the technologies and techniques available to the Iron Age settlers, none served them better than agricultural terracing, which helped

64 Rowton, "The woodlands of ancient Western Asia," 265.

65 Rowton, "The woodlands of ancient Western Asia," 266.

66 Finkelstein, "*The archaeology of the Israelite Settlement,*" (Jerusalem: Israel Exploration Society, 1988), 200.

67 Finkelstein, "*The archaeology of the Israelite Settlement,*" 198.

68 Rowton, "The woodlands of ancient Western Asia," 277.

69 Stager, "The archaeology of the family in ancient Israel," 4.

70 Stager, "The archaeology of the family in ancient Israel," 5.

to open up the highland frontier to the Iron Age farmers." The best-dated examples of Iron Age I terraces come from just outside the village of 'Ai; the slopes below Khirbet Raddana were also terraced in the 12th - 11th centuries B.C.E..[71]

D EDIBLE WILD PLANTS AND PLANT PRODUCTS OF THE PALESTINIAN HIGHLANDS

Although farming resulted in an increasing dependence on a much smaller repertoire of "domesticated" wild plants, the knowledge of edible wild plants has not disappeared from the collective memory of humanity. Millions of people, in fact, especially those in developing countries, still rely on edible wild plants as a food source, particularly during periods of food crisis.[72] Many are also used for medicinal purposes - an interesting topic in itself. However, this discussion will be limited to wild plants as a source of food.

We know little regarding the full spectrum of plants eaten by the settlers in the hill country of Palestine. The analysis and interpretation of assemblages of plant remains recovered from a particular archaeological site is, unfortunately, rare. However, several new methods are now available which could be used to fill in the gaps. In addition, too little attention appears to have been paid to ceramic artifacts used in processing plant foods and for other subsistence-related activities. The ceramic matrices of potsherds, for example, may be able to yield information about vessel usage.[73]

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71 Lawrence E. Stager, "The archaeology of the east slope of Jerusalem and the terraces of Kidron," *JNES* 41/2 (1982): 116.

72 In 1896, for example, during the drought in KwaZulu-Natal, which was accompanied by locust swarms, crop failure and tsetse flies, the people were able to survive on wild plants such as the smooth sow thistle (*Sonchus oleraceus*), cooked as a green vegetable (cf. Jenny Viall, "Wild about weeds," *The Cape Argus* [17 March 1995]:11). Even today, those of us in South Africa who are close to the soil, know and eat such "weeds" as *veldkool* (*Trachyandra hispida* and *ciliata*), the cowpea (*Vigna unguiculata* subsp. *unguiculata*) and those loosely grouped together under the term *imfino*/*morogo* (e.g. *Chenopodium album* [fat hen] and *Amaranthus thunbergii).* The latter is known to be highly nutritious, having a protein content of up to 36%, as well as being rich in vitamins A and C (cf. M.E Madisa & M.E. Tshamekang, "Conservation and utilization of indigenous vegetables in Botswana," in *Traditional African vegetables: proceedings of the IPGRI International Workshop on Genetic Resources of Traditional Vegetables in Africa: conservation and use, 29-31 August 1995* [ed. L. Guarino, Nairobi, Kenya, ICRAF, 1997], 150.

73 H. Edward Hill, & John Evans, "Crops of the Pacific: new evidence from the chemical analysis of organic residues in pottery," in *Foraging and farming: the evolution of plant exploitation* (eds. David R. Harris, Gordon C. Hillman, London: Unwin Hyman, 1989), 419.

1 Tentative identification of some of the foodstuffs consumed by the settlers

"The importance of wild foods even in the diets of the most sedentary and agriculturally intensive villages of the ancient Near East should probably receive more attention, especially from archaeologists."[74] Several new techniques have recently become available, such as phytolith analysis, isoenzyme analysis and anatomical micromorphology.[75] In addition, radiocarbon-dating by accelerator mass spectrometry now allows extremely small samples (< 5mg) to be dated accurately. It is worth pointing out that the Tell es-Safi/Gath Archaeological Project has recently set up two laboratories: one in the actual excavation area and a second at the nearby field camp, enabling organic and inorganic samples from the trenches to be identified and analysed, as they are excavated.[76] The laboratories are equipped with instruments for infrared spectroscopy, optical microscopy, UV-VIS spectroscopy, flotation, and phytolith concentration. A radiocarbon-dating expert is also included in the team to ensure the quality of the samples, enabling a change of excavation tactics within minutes or, at most, hours thus allowing a better allocation of resources. Infrared spectroscopy has, for example, shown that most of the floors at Gath were made of crushed chalk, rather than plaster.[77]

One of the newer methods is the chemical analysis of organic residues recoverable from excavated pieces of pottery (ceramics, having a rough surface, tend to retain food particles even after washing), a method first demonstrated by Evans and Biek in 1976.[78] Hill and Evans[79] have, for example, used this method to identify Pacific food plants from potsherds, dating to as early as 50 ce (uncalibrated radiocarbon date) and they have no doubt that the method would be useful for even earlier samples. Residues from potsherds appear to suffer little denaturation during deposition (charring, for example, produces a protective layer of heavily charred material, which protects the plant tissues below from further degradation as well as from decomposition by microorganisms).[80]

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74 David C. Hopkins, *The Highlands of Canaan: agricultural life in the early Iron Age*, (Sheffield: Almond, 1985), 114-115.

75 David R. Harris & Gordon C. Hillman, "Introduction", in *Foraging and farming: the evolution of plant exploitation* (eds. David R. Harris, Gordon C. Hillman, London: Unwin Hyman, 1989), 1-2.

76 Aren Maeir, & Steve Weiner, "Archaeological field labs: getting results in real time." *BAR* 35/1 (2009): 35-36.

77 Maeir & Weiner, "Archaeological field labs," 36.

78 Hill & Evans, "Crops of the Pacific," 419.

79 Hill & Evans, "Crops of the Pacific," 421-424.

80 The residues are examined under a scanning electron microscope for any recognizable tissues, especially plant tissues, which could be histologically identified.

Another new development in bioarchaeological methods is DNA-based analysis, which is better known from studies of human origins.[81] The method has, however, been successfully used to track the spread of early agricultural crops and for comparisons between cultivars and their wild progenitors. In our opinion, the method would be ideal for the identification of the foods consumed by particular groups of people during particular eras. In morphological terms, the two principal materials of archaeobotany are seeds and pollen and the most commonly encountered preservation categories are charring/carbonization, dessication, mineralization and waterlogging. In each case, wheat DNA, for example, has been successfully identified in specimens of between 1000 and 3300 years old.[82] Desiccation, which would be expected to occur in the dry environment of Southwest Asia, is one of the most favourable preservation conditions, since biochemical transformation is severely restricted. Although charring is the more ubiquitous process accounting for most archaeobotanical samples, several researchers have, surprisingly enough, shown that charred/carbonised grains retain a sufficient range of biomolecules for the analysis. Bioarchaeological specimens are dated radiometrically, the DNA is amplified and sequenced and the results could then be compared with DNA sequences from likely food sources from a particular area.[83]

Coprolite (Greek: *kopros*, "dung" and *lithos*, "stone") analysis is potentially one of the most precise methods available to archaeologists for reconstructing the diets of ancient peoples (it has been used, for example, to identify the seeds of wild, i.e. uncultivated plants) and it also may be able to shed light on the diet of the settlers in the highlands of Palestine.[84] Arid climates are par-

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The residues are then examined using infrared spectroscopy for any organic compounds. Should the latter be present, the material is extracted using a wide variety of solvents (from the most non-polar to the most polar; depending on the solvent used, various types of compounds such as triglycerides, waxes, tree resins, phospholipids, sugars, amino acids, etc can be isolated). Each extract is then subjected to a battery of tests including gas/liquid chromatography, high performance liquid chromatography, ultraviolet spectroscopy and electrophoresis. All identification peaks from the resultant spectra are then compared to the diagnostic peaks from "standard" spectra, obtained by the analysis of modern food plants using comparable analytical methods (Hill & Evans, "Crops of the Pacific," 419-420; see also Dvory Namdar, "Residue analysis: scraping the bottom of the *pithos*," *BAR* 35/1 (2009): 30, 32-33.).

81 Martin Jones, Terry Brown & Robin Allaby, "Tracking early crops and early farmers: the potential of biomolecular archaeology," in David R. Harris ed., *The origins and spread of agriculture and pastoralism in Eurasia* (London: UCL, 1996), 96-99.

82 Jones *et al*., "Tracking early crops and early farmers," 98.

83 Jones et al, "Tracking early crops and early farmers," 98-99.

84 Robert F. Heizer, & Lewis K. Napton, "Biological and cultural evidence from prehistoric human coprolites." *Science* 165/3893 (1969): 563-564.

ticularly suitable for the preservation of organic materials in human excrement, since bacterial decay is wholly or, at least partially, inhibited.[85]

2 Potential food sources

The field crops of the ancient Israelites, according to the Hebrew Bible, were wheat, emmer, barley and sorghum, with wheat and barley being the most important (wheat and barley are, in fact, mentioned first among the "seven species" with which the Land of Israel is said to have been blessed, the others being fruits - grapes, figs, pomegranates, olives and dates [the "honey" of Deut 8:8]). The biblical vegetable garden was, however, sadly lacking in variety, the main crops being leeks, onions, garlic, lentils, chick-peas and broad beans. Presumably, the settlers would have relied on wild plants[86] (*esev ha-sadeh*, i.e. "the plants of the field;" Gen 3:18; 2 Kgs 4:38-41 [the 'death in the pot' in v 40 was possibly the result of the accidental gathering of wild watermelon-gourds - *Citrullus colocynthis* - which are known to be poisonous]) as dietary supplements, just as many peasant women do today.[87]

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[85] As early as 1936, Volney Jones, *Univ. Kentucky Rep. Archaeol. Anthropol.* 3 (1936):147 (cited by Heizer & Napton, "Biological and cultural evidence," 564) was able to identify seeds of marsh elder (*Iva*), sunflower (*Helianthus*) and chenopods, as well as pieces of acorn and hickory nuts, in coprolites from a dry rock-shelter in Kentucky, whilst in the same year TB Margath identified seeds of sumac (*Rhus*) and acorns from the faecal material in the intestinal tract of a desiccated human body discovered in a bluff rock-shelter in Arkansas. Since then, newer techniques yielding adequately controlled data have been developed. Unfortunately, coprolite analysis is rarely done with this aim in mind; most coprolite analyses have been done in order to identify the possible presence of pathogens/parasites, or to generate other biomedical information.

[86] The Hebrew Bible makes it very clear that plants were extremely important in the daily existence of the people of ancient Israel and mention is made of 110 plants. According to Zohary, *Plants of the Bible,* 28: "The Bible is perhaps the most pervaded with nature of all scriptures or ritual-historical works." In addition, there are many biblical allusions, parables and metaphors confirming just how vitally important plants were (e.g. agricultural metaphors [e.g. Isa 9:3; 16:9-10; Jer 4:3], parables of plants and people [e.g. Judg 9:8-15; Ezek 17:1-10], climatic conditions [e.g. Deut 11:13-14; Isa 21:1], pastoral and agricultural activities of the Israelites [e.g. Isa 40:11; Jer 23:1-4; Lev 25:2-6]), the Song of Songs (Cant 1:1ff; "an ode to the love of nature and to love in nature;" Hillel, *The natural history of the Bible,* 257) and the song of the vineyard (Isa 5:1-2), while trees and fruits of various kinds were often used "as symbols of beauty and bounty" (Ps 92:12; Zohary, *The Plants of the Bible,* 48). Even biblical places were often named after plants (e.g. Rimmon [Jos 15:32; "pomegranate"]; Betonim [(Josh 13:26; "pistachios"]; Entappuah [Josh 17:7; "spring of the apricot"]; cf. Oded Borowski, "Agriculture in Iron Age Israel," [PhD Diss, University of Michigan, 1979], 19-20).

[87] Michael Zohary, *Plants of the Bible*. (Cambridge: University of Cambridge Press, 1982), 41, 72-73; Daniel Hillel, *The natural history of the Bible: an environmental*

There are 2682 different plant species within the boundaries of Israel[88] and the flora would appear to be substantially the same today, as it was in the past, as witnessed by the lists of plants encountered in excavations at archaeological sites - the only change being in the proportions of plant populations. Human and animal activities such as the gathering of fruits and plants "did not change the vegetation and natural conditions," in the way that they do today. The proportions of those populations sensitive to certain environmental stresses have decreased, while those of resistant plants, have increased. In other words, irrespective of whether woodlands were replaced by herbaceous vegetation, or vice versa, "very few plant species are known to have become extinct during the Holocene."[89]

As Hopkins[90] has pointed out: "The vegetation of Highland Canaan would surely have provided ample opportunity and even incentive for the collection and use of wild produce." There is, unfortunately, only occasional evidence for the use of wild plants as contributors of calories and vitamins to the diet of the settlers. Pollen analysis has, for example, attested to traces of *Malva* (mallow) species in Beersheba.[91] The leaves of *Malva* species are still used today in soups and salads in rural Palestine.[92] *Malva sylvestris*, for example, is called *khubeiza* (bread) in the Arab villages of Palestine.[93] Presumably, the trees of the woodlands were used in construction (e.g. wooden beams to support ceilings,[94] to supply fuel for cooking, heating, the firing of pottery, in metalworking and in the manufacture of lime. Rosen[95] has suggested that "the use of the Rothem bush as firewood, even away from its natural habitat, may have had a cultural significance." This tall shrub (*Retama raetam*; white broom; the "broom" of 1 Kgs 19:4 and Job 30:3-4; Hebrew: *rothem*) is found in the desert areas of Palestine and is largely confined to the sandy soils of the

exploration of the Hebrew scriptures, (New York: Columbia University Press, 2006), 301, n 20.

88 Avinoam Danin, "Man and the natural environment," in *The archaeology of society in the Holy Land,* (ed. Thomas E. Levy, London: Leicester University Press, 1995): 24.

89 Avinoam Danin, "Man and the natural environment," 37; see also David C. Hopkins, "Life on the land: the subsistence struggles of early Israel," *BA* 50/3 (1987): 180.

90 Hopkins, *The Highlands of Canaan*, 115.

91 Baruch Rosen, "Subsistence economy in Iron Age I," in *From nomadism to Monarchy: archaeological and historical aspects of early Israel* (eds. Israel Finkelstein, I & Nadav Na'aman, Jerusalem: Israel Exploration Society, 1994), 342.

92 Zohary, *Plants of the Bible*, 99.

93 Hillel, *The natural history of the Bible,* 301, n 20.

94 Stager, "The archaeology of the family in ancient Israel," 15-16.

95 Rosen, "Subsistence economy in Iron Age I," 342-343.

coastal plains and the wadi beds and stony hills of the central and southern Negev. Its roots are excellent heating and cooking fuels.[96]

The gathering, processing and consuming of edible wild plants are still important activities in the hill country of Palestine, as has been shown recently by Ali-Shtayeh et al.[97] Fifteen small communities in five districts, in the Northern West Bank in the Palestinian Authority, were selected for this study. These communities are located mainly within homogenous mountainous, rural areas which rely on rain-fed farming for crops such as barley, wheat and fruit trees (olives, grapes, almonds, figs, etc); they also keep flocks of sheep, goats and cattle, as well as poultry. The most widely used plant parts of the 100 species gathered and consumed are leaves (24%) and stems (21%); some are eaten raw in salads (e.g. *Origanum syriacum*[98] and *Foeniculum vulgare*) while others are cooked, using local traditional recipes (e.g. *Rumex acetosa* and *Malva sylvestris* are fried in olive oil and *Gundelia tournefortii* is especially favoured as an ingredient for omelettes).[99] The most popular food botanical families are As-

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[96] Zohary, *Plants of the Bible,* 34, 144.

[97] Mohammed S. Ali-Shtayeh *et al*., "Traditional knowledge of wild edible plants used in Palestine (Northern West Bank): a comparative study," *Journal of Ethnobiology and Ethnomedicine* (2008): 13.

[98] It should be noted that Ali-Shtayeh *et al.* ("Traditional knowledge of wild edible plants," 13, refer to this plant as *Majorana syrica*. From a Taxonomic point of view, however, its correct name is *Origanum syriacum* (*International PlantNames Index* 1996).

[99] Other wild plant species in the "most often used" category (in all five areas) are the leaves of *Arum palaestinum* (which are boiled in several changes of water to remove toxic substances, before frying in olive oil and then garnishing with lemon), *Cylclamen persicum, Salvia fruticosa*, *Matricaria aurea*, *Micromeria fruticosa* and *Trigonella foenum-graecum* (Ali-Shatyeh *et al.,* "Traditional knowledge of wild edible plants," 13). Some have a long history in traditional culture and are considered holy plants. *Origanum syriacum* (Syrian hyssop; Hebrew: *ezov*), for example, is mentioned in the Hebrew Bible in Exodus 12:22, where it is used as a brush to sprinkle blood on the doorposts and lintels (others references include 1 Kgs 4:23 and Ps 51:7). It was also used in the ritual for cleansing from leprosy (Lev 14:4-7,49-51), the ritual of the Red Heifer (Num 19) and is referred to in the Psalms (e.g. Ps 51). It is worth noting that Robert Hawley, "Hyssop in the Ugaritic incantation RS 92.2014," *Journal of Ancient Near Eastern Religions* 4/1 (2004): 29-70, has recently suggested, using epigraphic, etymological and literary factors, as well as contextual analogies drawn from the mechanics of Ugaritian magic in theory and practice, that the word *uzb* in the Ugaritic incantation RS 92.2014 should be interpreted as Syrian hyssop (*Origanum syriacum*).

Others are thought of as sacred/blessed and are mentioned in the legends concerning holy people (e.g. *Salvia fruticosa* and the Virgin Mary; the plant is, in fact, called *Mariamieh* after her; it is also recognised by Palestinian Muslims in Northern Israel for its ritual importance in funerals and cemeteries), while some are even mentioned in local folkloric songs and proverbs. Both *Origanum syriacum* and *Salvia fructicosa* teraceae, Fabaceae (as vegetables) and Lamiaceae (especially as herbal teas and seasoning).[100]

Until the full spectrum of plants eaten by the hill country settlers has been determined, however, any further comments remain pure speculation. Nevertheless, to illustrate just how valuable wild plants and their products could have been, one example will suffice: oaks and acorns. The dominant constituent of the arboreal vegetation of the hill country of Palestine is the evergreen oak (*Quercus calliprinos*; Hebrew: *'elon/'allon*).[101]

Wherever oaks are to be found, acorns have been used as food for thousands of years. Evergreen holm oaks (*Quercus ilex*) fruit from the age of 10-12 years, may remain productive for 300 years and produce 600-700kg of sweet acorns per hectare annually.[102] Oaks are particularly suited to the vagaries of the Mediterranean climate and are able to withstand frequent droughts and soils prone to erosion when denuded of cover. They also enrich the pasture in their immediate vicinity and improve the soil structure, since their root systems bring subsoil nutrients closer to the surface. In addition, oak groves are fairly resistant to defoliating parasites and diseases.

Not only are acorns an excellent food source, during times of drought, for both humans and domestic animals, birds and wildlife,[103] they also yield an oil which is comparable in quality and flavour to olive oil and they were once a staple food in Europe, Asia, North Africa, the Middle East and North America.

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have, in fact, been recognised as valuable edible wild plants and have been proclaimed protected shrubs by the Ministry of Planning and International Cooperation in the West Bank in 1996.

[100] Ali-Shtayeh *et al.*, "Traditional knowledge of wild edible plants," n.p.

[101] Zohary, *Plants of the Bible,* 28.

[102] Richard J. Harrison, "Arboriculture in South Western Europe: *dehesas* as managed woodlands," in *Foraging and farming: the evolution of plant exploitation* (eds. David R. Harris, Gordon C. Hillman, London: Unwin Hyman, 1989), 364-365.

[103] Analysis of 11 species of Californian acorns has shown that they contain an average of 4.0% protein, 9.0% fat and 52.5% carbohydrate; they are also a good source of some vitamins, especially A and C, essential amino acids, and trace elements. Some acorns (e.g. those from *Quercus ilex* var *ballota*) may be eaten raw without further treatment; others require to be leached with water (preferably hot) to remove the bitter tannins. Leaching is able to reduce the tannin level from 9.0 % to just below 0.2%, without the loss of essential amino acids; hot water does, however, remove some of the desirable fats (cf. David A. Bainbridge, "Use of acorns for food in California: past, present, future" (presented at the Symposium on Multiple-use Management of California's Hardwoods, November 12-14. San Luis Obispo, California, 1986). *http://www.ecocomposite.org/native/UseOfAcornsForFoodIn California.doc* Bainbridge.

Acorn flour can be used to make quite palatable breads,[104] while the nuts may be used as substitutes for chick-peas and roasted acorns have been used to make a coffee-like substitute (cf. the *Eichel Kaffee* used during World War II). Acorn oil is prepared by boiling, crushing or pressing - some varieties of oak contain more than 30% oil - and has been used as a cooking oil in Algeria and Morocco. The residue (although not as good as whole acorns), as well as oak leaves can be used as an animal feed; they are relished, for example, by cattle and sheep. Some bitter acorns and leaves can, however, cause tannin-poisoning in livestock if used as the primary source of food. Oaks are associated with succulent edible fungi and oak woodlands provide a home for wild animals (also sources of food) such as deer, rabbits and doves.[105]

E CONCLUSION

It was proposed at the outset, that one of the motivating factors for the movement of people to the central highlands was a fairly dramatic climatic shift. Evidence was presented which would seem to confirm that this was indeed the case; a climatic shift, which began at the end the Late Bronze Age and lasted throughout Iron Age I, occurred in Palestine (as well as much of the ancient Near East). Following a few centuries of comparatively cool weather from about 1500 to 1200 B.C.E., favourable (on the average) for increased precipitation, historical climatology studies, as well as nontextual and textual evidence, have strongly suggested that from about 1200 to about 900 B.C.E., the Near East became notably warmer and increasingly and significantly drier. Such a situation would have contributed to the destabilisation of life in the lowland city-states and the change in settlement patterns in Iron Age I. Even if the settlers did not originate from the coastal plain, but as Rainey (2008) believes, from east of the Jordan, a prolonged period of aridity is still likely to have caused the movement of people (e.g. local pastoral nomads or people from Transjordan) to the cooler and wetter hill country of Palestine.

The benefits of such a move include the increased precipitation in the coastal ranges when compared to the lowlands, even during times of drought, the abundance of springs in the larger valleys, as well as the provision of some of the best grazing land in the area. In addition, the thicker vegetation and the natural rock defences provided by the terrain would have provided the settlers

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[104] Even today, acorn flour is used for making a variety of breads and porridges in such diverse places as North America and Southern Africa, based on Native American or traditional South African recipes (see the following websites: *http://www.jackmnt.com/acornbread.html*; *http://www.celtnet.org.uk/recipes/ancient/fetch-recipe.php?rid=acorn-hazelnut-pap* or *http://www.celtnet.org.uk/recipes/miscellaneous/fetch-recipe.php?rid=misc-acorn-pan-bread*).

[105] Harrison, "Arboriculture in South Western Europe: *dehesas* as managed woodlands," 365-366; cf. Bainbridge, "Use of acorns for food in California," n.p.

with added protection from the city-states should this have been necessary. The settlers would no longer have been dependent on the large-scale agriculture and vulnerable central food supplies of the lowlands and they would have been able to provide their own via alternative means of food production. The hill country woodlands would also have been an excellent source of edible wild plants and acorns.

As Finkelstein and Silberman[106] have pointed out: "In the Middle East, people have always had the know-how to rapidly change from village life to animal husbandry - or back from pastoralism to settled agriculture - according to evolving political, economic, or even climate conditions." The central hill country had only been very sparsely settled during the Late Bronze Age - a situation which changed dramatically in Iron IA, due to the appearance of hundreds of new, small sedentary sites. It should be pointed out, however, that although the central hill country has now been extensively surveyed, the coastal area of Palestine has not been surveyed to the same extent; it is thus "simply not possible to make comparisons between some, often very important subregions."[107]

The prophetic denunciations and Deuteronomistic reforms directed at syncretistic cults - including those devoted to Ba'al and Asherah - would seem to suggest that Canaanite religion persisted and was a component of Israelite life, at least until the end of the Iron Age. Susan Ackerman, in *Under every green tree: popular religion in sixth-century Judah* (1992) has, in fact, clearly demonstrated that even as late as the end of the 7th century and during the first part of the 6th century B.C.E., Judahites of all classes of society were worshipping not only Yahweh, but other deities such as Asherah. In addition, they were worshipping Yahweh in a number of ways that were condemned by the "theologians" who wrote the Hebrew Bible. In her words: "Yahwism was characterised by a diversity which extends far beyond the parameters seemingly established by the biblical text."[108]

The persistence of the fertility cult is unsurprising, especially during a period of climatic warming. The Ugaritic texts (in particular, the Ba'al cycle) make it clear that this religion had to do with the necessities of life, the crops and food on which survival depended. Ba'al's antagonist is Mot (the divine personification of death, drought and sterility, whose home appropriately is the underworld). The Ba'al texts describe, in broad terms, the tension between fer-

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[106] Israel Finkelstein & Neil A. Silberman, *The Bible unearthed: archaeology's new vision of ancient Israel and the origin of its sacred texts*, (New York: Free, 2001), 117.
[107] Keith W. Whitelam, *The invention of ancient Israel: the silencing of Palestinian history*. (New York: Routledge, 1996), 183.
[108] Susan Ackerman, *Under every green tree: popular religion in sixth-century Judah*. (Atlanta: Scholars Press, 1992), 215.

tility and sterility and thus reflect the climatic conditions. The summer in Syria and Palestine, "if not actually a season of sterility, ... is nevertheless a season of tension."[109] If the spring rain (the "latter rains" of the Hebrew Bible) is either too scanty or arrives too late, the dry season may arrive before the seedlings have grown and matured sufficiently. Should the final rain be too early or too late, the crop yield is likely to be limited.

What would have been more surprising is if the settlers had not worshipped fertility gods/goddesses, since they depended on agriculture for survival. Although the number and types of figurines declined in the early Iron Age, when compared to their ubiquity in the Late Bronze Age, it is worth noting that mould-made figurines began to reappear at Israelite sites, especially in Judah, with increasing frequency during the 9th century, reaching a peak during the late 8th and 7th centuries, followed by a decline in the 6th century B.C.E..[110] It is quite possible that, as the period of aridity progressed, the Israelites would have felt an increasing need to enlist the aid of the fertility goddess. If these pillar-based figurines were indeed fertility figurines, then their appearance may be linked - as a kind of "after the fact" reaction - to the climatic shift between about 1200 and 900 B.C.E.. Initially, the effects of the notable warming in Palestine would probably not have been viewed as either serious or of possible long term duration - the climate in Palestine being notorious for its vicissitudes - so the necessity for "Mother goddess" figurines would not have been considered a matter of urgency. However, as the period of warming and diminished precipitation proceeded, the old Canaanite practice is likely to have been resuscitated. The fact that it lasted well after the climate had begun to ameliorate is unsurprising; these figurines were obviously "working," after all. Trade had picked up and there was more opportunity to obtain fertility figurines or, at least, more time create them. And, perhaps, it may be suggested that, with today's global warming, it may be worth investing in a few "Mother goddess" figurines, ourselves!

A sensitive relationship exists between society and environment. How human populations thrive or suffer depends on the social impact of local habitats and a climate deterioration undoubtedly would have had a significant effect. Until recently, the importance of the influence of the physical environment, including the role of climate fluctuations, on the history of a given region has been largely ignored. No doubt, this aspect will be increasingly recognised in the future. The effects of climate shifts should not, however, be viewed in

[109] Gray, *The legacy of Canaan*, 12.
[110] Ziony Zevit, *The religions of ancient Israel: a synthesis of parallactic approaches*. (London: Continuum, 2001), 271.

isolation; climate should always "be viewed in light of and in conjunction with many other factors."[111]

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[111] Robert Coote & Keith Whitelam, *The emergence of early Israel in historical perspective*. (Sheffield: Almond, 1987), 54.

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