HARVEST DATES IN ANCIENT MESOPOTAMIA AS POSSIBLE INDICATORS OF CLIMATIC VARIATIONS

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Abstract. Butzer (1958; also, Lamb, 1968) puts forward observations to the effect that about 2500 B.C. a period of increased aridity set in in the general area of the Near East, including Mesopotamia, and that rainier conditions returned after about 850 B.C. Because in the Mediterranean type of climate (winter rains) of the Near East winter temperatures and seasonal rainfall are highly correlated in a negative sense, we expect that the above mentioned period of aridity was also a period of relative warmth, whereas the period after 850 B.C. up to Roman times, was a period of cool winters. This negative correlation is thought to be due to the fact that in the Near East rainfall is usually produced in the migratory cyclones, especially close and behind the associated cold fronts which bring in cold air as well. A failure of these cyclones to reach the region in numbers, manifests itself both in reduced rainfall and comparatively high winter temperatures. In order to check on these ideas on temperature conditions, a search was undertaken of references to barley harvest dates in the 'literature' (clay tablets) of ancient Babylonia comprising two periods: 1800–1650 B.C. (Late Old Babylonian Period = L.O.B.P.) and 600–400 B.C. (Neo-Babylonian Period = N.B.P.). It turns out that in the former, the harvest began late in March or early in April, while in the latter, it began late in April or in May, amounting to a difference of about a month or slightly more. In our own era, in what was once central and northern Babylonia, harvest begins in the second half of April or so. Thus in the L.O.B.P., harvest opened 10–20 days earlier and in the N.B.P. 10–20 days later than at present. The differences between the harvest dates of the two periods seem to be too large to be explained by changes in the barley varieties cultivated. On the other hand, the above mentioned inverse relationship between rainfall and winter temperatures supports the interpretation that the L.O.B.P. was warmer, and the N.B.P. cooler than the present era, and goes some way toward explaining the inferred differences in harvest dates.

1. Purpose of Study

The aim of this paper is to describe the results of an examination of copies of clay-tablet inscriptions from ancient Babylonia providing information on dates of barley harvest for two periods about 1200 years apart. Group 1 of the tablets dates back to 1800–1625 B.C. while Group 2 relates to 600–400 B.C. We shall refer to the earlier period as the Late Old Babylonian Period (= L.O.B.P.) and to the later one as the Neo-Babylonian...
Period (= N.B.P.). A comparison of harvest dates for the two periods and the dates for the present era offers qualitative information on the relative warmth of the three provided that there was no significant change in the maturation times of the varieties grown.

2. Background

Butzer (1958, pp. 116–118) states that in approximately 2500 B.C. a marked decline set in in precipitation in the general area of the Near East. After listing some finds concerning the Sahara, Egypt and Palestine, he quotes archaeological inferences, according to which the known Neolithic (~ 10000–3100 B.C.) and Bronze Age (~ 3100–1200 B.C.) sites1 from the Mesopotamian Steppe are in the ratio 5:1, implying that many settlements were abandoned after the middle of the third millennium B.C. due to diminished rainfall; numerous ‘tepehs’ (~ tells) were replaced by Steppe and loess deposits. He believes that moister, rainier conditions did not return before about 850 B.C. Observations of rainier conditions after the latter date seem to be limited to a report by Wright (1960, p. 91) who found late Assyrian (750–600 B.C.) potsherds in an alluvial fill in northern Mesopotamia.

The work of other investigators antedating Butzer’s studies is generally in line with the latter’s ideas. Thus Brooks (1949, p. 319) says that in 2200 B.C. there began an intense drought in western Asia. Such sites as Anau, at Persia’s northern margin, and Susa, the future administrative capital of Darius I, at the foot of the Zagros mountains, were given up. And while the aridity of the 2500–850 period does not seem to be paralleled by events in Europe (Willett, 1949, p. 48), the moister conditions attributed to the period following 850 B.C. and extending to Roman times, are notably matched. Willett states that suddenly, about 850 B.C., a great deterioration of climate took place in northern Europe exhibited by catastrophic advances of glaciers; the level of the Bodensee rose 9 m. Lamb (1968, p. 7) places the maximum rainfall about 400 B.C. and states “In Classical Greece from perhaps 800 B.C. onwards until Roman times this was apparently a favourable period with plenty of forest and presumably more rainfall than now.” A recent U.S. Committee for the Global Atmospheric Research Program (1975) report estimates (see Fig. A.10, p. 153, in the report), on the basis of tree-ring width analyses, that in the middle latitudes of the northern hemisphere (more precisely: California), the greatest cold of the period of concern to us, occurred about 600–500 B.C.

Close to the time when Butzer’s study came out, an entirely independent paper was published by Jacobsen and Adams (1958). The emphasis of that paper is on changes in soil salinity (connected with irrigation, water quality and soil structure), crop types and yield. Some of the outstanding facts emerging from their study are as follows: (a) Beginning shortly after the rule of Enmetena, ensi (~ Chief Administrator) of Lagaš in southern Mesopotamia, about 2450 B.C., temple surveyors (much of the irrigated land was owned by temples) report the presence of saline soil patches. Some fields that were reported free of salt at the time, are described as having developed sporadic salinity by about 2100 B.C.; (b) Counts, by H. Helbaek, of grain impressions in excavated pottery at sites in southern Mesopotamia suggest that about 3500 B.C. wheat and barley were grown
in approximately equal amounts. A thousand years later, at Girsu, adjacent to Lagag, the less salt-tolerant wheat reduced to approximately 15% of the grain crop and by about 2100 to less than 2%; about 1700 B.C. the cultivation of wheat was given up completely; (c) Soil fertility too shows a marked decline: In Girsu, about 2400 B.C., field records report an average yield of 2500 l/ha (highly respectable even by modern U.S. and Canadian standards), in 2100 B.C., 1460 and about 1700 B.C. the recorded yield at Larsa, also in the south, shrank to an average of 900 l/ha. The southern part of Mesopotamia, which was most severely afflicted by the above processes, never really recovered. Many of the great Sumerian cities dwindled to villages or were left in ruin.

3. Temperature in Relation to Rainfall

Willett (1951, Table I) presents a qualitative relationship between temperature and precipitation for the middle and the higher middle latitudes of the northern hemisphere as from A.D. 1820. The relationship is of a prominently negative character. Striem (1974, p. 60 and Figure 5) studied in a quantitative manner the parallel relationship in the long series of observations at Jerusalem for 1861–1960. In his study, winter (December through March) temperatures were correlated with mean annual rainfall (winter rains) for \( \frac{3}{2} ^\circ \text{C} \) temperature class intervals. A marked anticorrelation is indicated. Some years earlier Gagin (1968) investigated the relationship between daily rainfall and temperature in Israel and showed, that in the mean, there is a strong association between daily rainfall and temperature, the larger amounts of rain occurring on cold days. Because of the importance of that inverse relationship to the topic of this paper, we reproduce in Figure 1 Striem’s relevant diagram.

It seems a plausible assumption that an essentially similar relationship held in ancient times as well in the general area of the Near East. In the present era, at least, rainfall in the Near East is usually associated with the passage of depressions, and especially with the passage of cold fronts; rain frequently falls in the unstable cold air just ‘behind’ the front. It is therefore reasonable to assume that the arid period 2500–850 B.C. in the Near East, must have been brought about by a failure of the migratory depressions to penetrate to the latitudes or area of concern, (for a chart of depression tracks in the general area of the Mediterranean in the current era, see Gagin and Neumann, 1974, Fig. 13.3), presumably due to a change in the general circulation of the atmosphere. Since the formation of cold fronts usually leads to the formation of depressions, the failure of penetration of depressions is tantamount to the failure of incursions of cold air (modified polar air). It is then our suggestion that the decline of rainfall in Mesopotamia in the period of about 2500–850 B.C. must have been a period of relatively warm winters. For the same reasons, the postulated higher rainfall from about 850 B.C. to Roman times, must have been, in all probability, associated with somewhat cooler winters.

The considerations set forth in the foregoing paragraph could go some length to explain the process of soil salinization in southern Mesopotamia described by Jacobsen and Adams. A rise in temperatures must have been accompanied by a rise in potential evapotranspiration and this, in turn, must have increased the demand for and application
of irrigation water. It is known (Jacobsen, 1958, p. 82), in fact, that the earlier mentioned ruler of Lagas had had a canal built from the Tigris about 2400 B.C. Given the quality of water (Jacobsen and Adams, 1958, p. 1251), irrigation 'technology', etc., the enhanced application of irrigation water must have led to an intensification of the process of soil salinization.

If our ideas concerning the relative warmth of the period 2500–850 B.C. and the relative coolness of the few centuries following the latter date are correct, then the changes must have manifested themselves in, e.g., a shift in the dates of the cereal harvest. As barley was by far the most important grain crop of ancient Mesopotamia, we have decided to make a check of inscriptions recording dates of barley harvest. Other investigators had looked before us for such dates but their study involved far more limited material than ours. Thus, e.g., Meissner (1920, p. 186) suggested on the basis of the Babylonian dates of two tablets from King Samsuiluna's time (reigned 1749–1712 B.C.) that the harvest must have been early and that, apparently, the climate was warmer then. He emphasized, though, that the great fluctuations from year to year in the positions of months of the Babylonian calendar relative to the solar year, render his inference subject to uncertainties. Subsequently, the great algebraist van der Waerden
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(1945–48, pp. 422–423) studied the so-called Venus Tablets of King Ammisaduqa (reigned 1646–1626 B.C.) and he, too, suggested, on the basis of his tentative determination of the Julian equivalents of some harvest dates taken from a paper by Fotheringham (1928), that the climate of the time must have been comparatively warm. It has been shown, however, recently, (see D. Pingree in Reiner, 1975, pp. 22–23) that the ‘records’ in the preserved copies of the Venus Tablets had been considerably tampered with and mixed up, at least those sections of the ‘record’ that relate to the period onward from the 9th regnal year of Ammisaduqa. Van der Waerden decided to adopt dates for this king’s rule that are approximately 76 years more recent than the dates now considered to be the best available estimates, so that for that reason alone, his correlation of the Babylonian and Julian dates cannot be accepted.

We shall now proceed to consider the implications of the tablets but because of the difficulties in identifying Babylonian dates of the L.O.B.P. in terms of the solar calendar, the case of the tablets for the N.B.P. will be considered first.

4. Neo-Babylonian Period

We are aware of about 90 tablets offering an indirect indication of the time of barley harvest during the N.B.P. or to be more specific, during the period 600–400 B.C. The tablets (Thureau-Dangin, 1927, p. 193; Fotheringham, 1928, p. 73) are listed in Table I stating their reference or museum numbers, provenance (names of sites are meant to include the neighborhood as well) and references to literature where copies of the texts can be located. In many cases, translations, mainly into German, are available. References to translations (and transliterations), insofar as they have been published, can be found in Borger (1967, 1975).

Schematically, the texts of these tablets run as follows: X lends Y so much silver, or barley, or other goods, or X leases his field and irrigation canals to Y, in return for which Y commits himself to ‘pay’ in barley in month II\(^2\) or month III; the rate of interest is specified and/or Y commits himself to donate a gift; names of witnesses, name of ruling king, his regnal year, date of signing the deal and, often, the place where the deal was transacted, are recorded. On the basis of a knowledge of the ways and customs of the time, Assyriologists (see, e.g. Ebeling in Ebeling and Meissner, 132, p. 21, entry ‘Ackerbau’) interpret the month of repayment in barley as the month of barley harvest. We note in Table I that in the majority of cases this month is month II and, not infrequently, month III (58 vs. 35 tablets).

The correspondence between the Babylonian and Julian (or Gregorian) calendars is known as from 626 B.C. onward so that an estimate can be made of the positions of the Babylonian months in each of the solar years. In Figure 2 we show the distribution of the Babylonian date II.1 in terms of the Julian calendar for the 220 years 626–407 B.C. inclusive, covering closely the period involved in Table I. The diagram was prepared from the ‘chronological’ tables of Parker and Dubberstein (1946, pp. 25–32). It is seen that in the N.B.P. the date II.1 fell between April 4 and May 25, with most of the cases falling between April 22 and May 22; the date III.1 would of course occur 30 days later. In
TABLE I: List of tablets offering (indirect) information on month of barley harvest during the period 600–400 B.C. ('Neo-Babylonian Period')

<table>
<thead>
<tr>
<th>Name of king ruling over Babylonia</th>
<th>Number of tablets</th>
<th>Reference numbers of tablets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Years of reign, B.C.</td>
<td>Month II</td>
</tr>
<tr>
<td>Sīnšarrīškun</td>
<td>629–612</td>
<td>1</td>
</tr>
<tr>
<td>Nebuchadnezzar II</td>
<td>604–562</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Evil-Merodach</td>
<td>561–560</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Nabonidus</td>
<td>555–539</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>Cyrus II</td>
<td>538–530</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Cambyses II</td>
<td>529–522</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Darius I</td>
<td>521–486</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Artaxerxes I</td>
<td>464–424</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darius II</td>
<td>423–405</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes.

(i) The years of reign of Sīnšarrīškun were taken from von Soden, 1967, p. 254. The years of reign of other rulers mentioned in this paper are found in a table prepared by J. A. Brinkman, see, pp. 335–347 in Oppenheim, 1964.

(ii) Copies of the tablets listed above can be found in the following references:

- BE 8 Clay, 1908
- BE 9 Hilprecht and Clay, 1898
- BE 10 Clay, 1904
- BIN I Keiser, 1918
- Camb. Strassmaier, 1890b
- Cyrus Strassmaier, 1890a
- Dar. Strassmaier, 1893, 1897
- Evetts Evetts, 1892
- NIPPUR Strassmaier, 1889b
- NIPPUR Nabuch. Strassmaier, 1889a
- VS 3 Ungnad, 1907, and San Nicolò and Ungnad, 1935
terms of the solar, Gregorian calendar, the dates would be 4–5 days earlier in the year. In any case, the inference is that during the N.B.P. the barley harvest must have taken place mainly in May, with late April the earliest date (where we disregard the small number of cases where month II began in the first three weeks of April) and, apparently, not infrequently the harvest opened late in May. In our era, in the general area of Baghdad, the barley harvest begins 10–15 April (J. F. Webster, formerly of the Agricultural Directorate in Baghdad, quoted by Fotheringham, 1928, p. 73) and, even, as late as April’s end (Adams, 1965, p. 16: “Harvesting of an early ripened barley (begins) at the end of the month (April”) ). Considering that the sites figuring in Table I are between 40 and 150 km south of Baghdad, the corresponding opening days of the barley harvest should be between 1 and 5 days earlier. The aforementioned differences in opening dates are based on statements (J. F. Webster in Fotheringham, 1928, p. 73) that the harvest in the Baghdad area begins about 15 days later than in the Basra area, the latter being situated 440 km SE of Baghdad; latitudewise they are 3° apart (1° latitude = 110 km). Without ignoring these minor differences, the conclusion still is that during the N.B.P. the barley harvest must have started at least 10 to 20 days later than at present. The cause of this difference may be meteorological, that is, it is possible that the climate was cooler. However, it is also possible that the barley cultivated during the N.B.P. was of a late-maturing type. We shall return to that problem in Section 6.

Although in Table I the number of tablets suggesting month II as the harvest month is appreciably larger than the number suggesting month III, the excess is not at all uniformly distributed over the period. It is an intriguing problem if any significance, meteorological or other, is to be attached to the fact that in the earlier phase of the era.
under examination, the frequency of month III dates is about as large as that of month II dates. The apparent increase in frequency of late, month III, harvest dates would be in line with the finding mentioned in Section 2 that in the middle latitudes the greatest cold of the period under review occurred between 600 and 500 B.C.

5. Late Old Babylonian Period

The tablets dating back to the L.O.B.P. that relate to barley harvest can be conveniently classified into two groups. Group A comprises tablets which are in the nature of 'receipts' for harvest work done on a certain day; Group B encompasses tablets which confirm an advance 'payment' (sometimes in kind) in return for which the person(s) commit(s) himself (themselves) to do harvest work when the time comes.

In looking at Group A tablets, we have to bear in mind: (i) In the cases where we have more than one tablet for the same season and place, the tablet bearing the earliest date is of most interest though there is no guarantee that the harvest did not begin some days earlier. Weitemeyer (1962, p. 62) points out that the harvest of any one field appears to have lasted up to a fortnight, while the harvest of any given 'neighborhood' seems to have extended over a month or so. (ii) The opening day of the harvest tends to lag with latitude. As was mentioned in the last-but-one paragraph of the previous Section, the first day of the harvest of the Baghdad area is usually about 15 days later than that of the Basra area. (iii) For comparison's sake with the N.B.P., it is desirable to have data for the same places for both periods.

In Table II we list data available to us from the L.O.B.P. comprising the cases where at least the month of harvest work is preserved on the tablets (22 in number). In some cases the provenance of the tablets is not known but it is probably correct to say that most of them relate to what may be called central and northern Babylonia where we mean Babylonia north of Nippur (32° 05'N, 45° 12'E). A majority of these tablets comes from Sippar (33° 05'N, 44° 20'E), a site about 70 km NNW of Babylon and 140 km NW of Nippur: Sippar, Babylon and Nippur figure prominently in Table I for the N.B.P. The expected 'natural' difference between the harvest opening dates of Sippar in the north and Nippur in the south could be, based on the current difference of 15 days between Baghdad and Basra, about 4 days.

The greatest difficulty is presented by attempts at the identification of L.O.B.P. dates in terms of the solar calendar. As is known, the Babylonian calendar was lunisolar. Keeping the 12-lunar-month year of 354 days in line with the solar year, intercalary months were inserted. Unfortunately, no list of intercalation is available for the period of concern here. Moreover, according to all indications, the intercalation was effected in a haphazard manner. At least one case is known (Edzard, 1957, p. 28) where a total of three intercalary months were added within a period of two years. At times, the insertion was done by a last-minute 'command decision'. On one occasion the great law-giver king Hammurapi announces: "The year has a leap-month. The next month should therefore be registered as a second month VI". 4 (For a new translation of this short tablet, see Frankena, 1966, p. 11, item 14.)
TABLE II: List of tablets stating date of day(s) of harvest work performed during the Late Old Babylonian Period, about 1800–1625 B.C.

<table>
<thead>
<tr>
<th>Reference number</th>
<th>Museum number</th>
<th>Name of king</th>
<th>Years of reign B.C.</th>
<th>Regnal year</th>
<th>Babylon Mo. Day</th>
<th>Site</th>
<th>Literature reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(A) Central and northern Babylonia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BM 81895</td>
<td>Vs 9 25</td>
<td>Hammurapi</td>
<td>1792–1750</td>
<td>8</td>
<td>II 2 (?)</td>
<td>SIPPAR</td>
<td>W, p. 58</td>
</tr>
<tr>
<td>BM 82003</td>
<td></td>
<td>Hammurapi</td>
<td>31 (?)</td>
<td>I</td>
<td>12</td>
<td>?</td>
<td>KU, p. 109</td>
</tr>
<tr>
<td>BM 82018</td>
<td></td>
<td>Hammurapi</td>
<td>31 (?)</td>
<td>I</td>
<td>10</td>
<td>SIPPAR</td>
<td>W, p. 56</td>
</tr>
<tr>
<td>BM 81953</td>
<td></td>
<td>Hammurapi</td>
<td>35</td>
<td>I</td>
<td>19</td>
<td>SIPPAR</td>
<td>W, p. 58</td>
</tr>
<tr>
<td>TCL XI 164</td>
<td></td>
<td>Hammurapi</td>
<td>38</td>
<td>XII</td>
<td></td>
<td>SIPPAR</td>
<td>L, p. 38</td>
</tr>
<tr>
<td>BRM III 182</td>
<td>V s 9 25</td>
<td>Samsuiluna</td>
<td>1749–1712</td>
<td>4</td>
<td>I</td>
<td>?</td>
<td>KU, p. 177</td>
</tr>
<tr>
<td>Pinches, Berens</td>
<td>Coll. 96 (19b)Samsuiluna</td>
<td>6</td>
<td>28</td>
<td>?</td>
<td></td>
<td>KsU</td>
<td>p. 178</td>
</tr>
<tr>
<td>BM 81934</td>
<td></td>
<td>Samsuiluna</td>
<td>7</td>
<td>7</td>
<td>SIPPAR</td>
<td>W</td>
<td>p. 54</td>
</tr>
<tr>
<td>BM 22658</td>
<td></td>
<td>Samsuiluna</td>
<td>8</td>
<td>15</td>
<td>SIPPAR</td>
<td>W</td>
<td>p. 54</td>
</tr>
<tr>
<td>Leiden 955</td>
<td>V s 7 57</td>
<td>Ammiditana</td>
<td>1683–1647</td>
<td>30</td>
<td>I 13</td>
<td>DILBAT</td>
<td>KU, p. 89</td>
</tr>
<tr>
<td>BRM III 188</td>
<td>V s 7 57</td>
<td>Ammišaduqa</td>
<td>1646–1626</td>
<td>?</td>
<td>II 5</td>
<td>?</td>
<td>KsU, pp. 179–180</td>
</tr>
<tr>
<td>CT VI 23b</td>
<td></td>
<td>Ammišaduqa</td>
<td>?</td>
<td>I 3</td>
<td>SIPPAR</td>
<td>W</td>
<td>p. 57</td>
</tr>
<tr>
<td>BM 82013</td>
<td></td>
<td>Ammišaduqa</td>
<td>?</td>
<td>I 14</td>
<td>SIPPAR</td>
<td>W</td>
<td>p. 57</td>
</tr>
<tr>
<td>BM 22667</td>
<td></td>
<td>Ammišaduqa</td>
<td>?</td>
<td>I 3</td>
<td>SIPPAR</td>
<td>W</td>
<td>p. 57</td>
</tr>
<tr>
<td></td>
<td>(B) Tablets for which there are other tablets for an earlier day of the season at the same place</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCL I 123</td>
<td>BM 22768</td>
<td>Samsuiluna</td>
<td>8</td>
<td>I</td>
<td>25</td>
<td>SIPPAR</td>
<td>W, p. 54</td>
</tr>
<tr>
<td>TCL I 124</td>
<td>BM 22664</td>
<td>Samsuiluna</td>
<td>8</td>
<td>I</td>
<td>2</td>
<td>SIPPAR</td>
<td>W, p. 55</td>
</tr>
<tr>
<td>BM 22679</td>
<td></td>
<td>Samsuiluna</td>
<td>8</td>
<td>II</td>
<td>6</td>
<td>SIPPAR</td>
<td>W, p. 55</td>
</tr>
</tbody>
</table>

Notes.
(i) Items 3 and 4 in (A): Years of the king's reign when the tablets were made out, are uncertain. See W, p. 57 and pp. 62–63.
(ii) Item 7: see also W, p. 61: work finished II. 11.
(iii) Item 12: Delitzsch (1909, preface) states that the provenance of this tablet is Dèlam/Muhattat (modern names). According to Ebeling and Meissner (1938, p. 218), these sites correspond to ancient Dilbat and neighborhood.
(iv) Literature reference abbreviations are as follows:

KU = Kohler and Ungnad, 1911
KsU = Koschaker and Ungnad, 1923
L = Lautner, 1936
W = Weitemeyer, 1962
We know that the O.B. kingdom and its cities had the avowed intention of keeping the two calendars in step — evidence the introduction of intercalary months. While in some years the two may have been considerably apart, on the whole, the O.B. calendar must have been in line with the sun. Assuming that we have a good number of tablets spread over a large number of years, the correspondence between the two calendars must have remained sustained. That is to say, despite our inability to turn the O.B. dates into their Gregorian equivalents, the O.B. calendar should be on the average, at least approximately comparable with the N.B. calendar, especially for the years before 381 B.C. when the Babylonian calendar became at long last regulated. The foregoing statement assumes, however, that the positions of the months bearing the same name underwent no change from the L.O.B.P. to the N.B.P. relative to the solar year, see next paragraph.

It is a notable feature of Table II that the great majority of harvest dates fall in month I and are thus, roughly, one month and over earlier than the dates in Table I. If (i) following Landsberger (1949, p. 250) we equate the average Julian April 1 with the Babylonian 1.1 for the N.B.P., as he did on the basis of the known correspondence between the Babylonian and Julian chronologies for the era, bearing in mind that the pertinent solar, Gregorian, dates must have been March 26 or 27; (ii) equate the Gregorian March 21 with I.15 for the L.O.B.P., on the basis of a certain Babylonian astronomical series (Landsberger, 1949, p. 250; Thureau-Dangin, 1927, p. 196),5 then the inferred differences between the harvest dates of the two periods become even larger: For the N.B.P., the beginning of month II, the early harvest month (as was seen in Table I, not infrequently the harvest took place in month III), is equivalent to the third decade of April or the early part of May whereas if we represent the dates in Table II by I.15, and, if we assume, as was mentioned above, that the middle of month I fell on or close to March 21 (Gregorian), then the latter must have occurred a month, and even a week in excess of a month earlier than the harvest dates for the N.B.P. Thus, if we assume that in the L.O.B.P. the position of the Babylonian months fell earlier in the solar years, then the discrepancy in the harvest dates of the two period is accentuated. The only way to bring the harvest dates of the two periods closer would be by assuming that in the L.O.B.P. the shift in the position of the Babylonian months was in the opposite direction and amounted to a very considerable dislocation. There is no support for such an assumption: The existing evidence is in favor of the earlier mentioned 'sliding'.

The above noted difference in harvest dates may have been due to a change in the barley varieties cultivated, meaning that the N.B.P. may have grown a late-maturing barley variety. This problem will be considered in the next Section.

Before passing on to the problem of possible changes in the barley varieties cultivated, we must return to the case of Group B tablets. As stated in the opening paragraph of this Section, Group B tablets represent a legal obligation to do harvest work against an advance payment. Stol (1976, pp. 101–102) has published a list of 68 such tablets for the L.O.B.P. With the exception of 6, all these tablets were made out in month XII or before. The near-absence of such tablets dated after month XII is suggestive that the harvest must have taken place in month I or so, in close agreement with the implications of Group A tablets, see Table II.
6. Discussion

Helbaek (1960, p. 110) states that "... in the area south of Baghdad, no traces of two-row barley could be identified for any time prior to the Islamic conquest (7th century after Christ), whereas good morphological evidence abounded for six-row barley", and "From the beginning in Mesopotamia the six-row barley is exclusively the lax-eared nodding variety". Despite this uniformity in variety we must bear in mind that some of this very same six-row lax-eared nodding variety is of the early-maturing type and some of the late-maturing type. The latter has the advantage of producing greater yield and, therefore, it would appear natural to try to explain the late date of harvest in the N.B.P. as due to a change-over to the cultivation of the late-maturing type. Certainly, a cooler (and rainier?) climate would be an incentive to such a transition.

As to the possibility that the late date of harvest during the N.B.P. may have been due to a change to a late-maturing type of barley, it seems appropriate to make the following two points: (i) There is no other evidence for or against the above raised possibility of change-over. We understand (Y. Arnon) that palaeobotanic research of the kind carried out by Helbaek would not be able to distinguish between the grains of the early and of the late-maturing barley; our own intensive literature search could not produce, as was stated above, any support, for or against the matter. (ii) As was stated earlier (last-but-one paragraph, Section 4), in the general area of Baghdad to-day, the barley-harvest opening date varies over a period of about three weeks: from April 10–15 to early May. The varieties grown include the two-, four- and six-row barley (Y. Arnon; see also J. F. Webster quoted by Fotheringham, 1928, p. 73). Presumably, the dates indicated include variations due to both fluctuations in weather from year to year and differences in ripening dates. Now the discrepancies in the harvest dates of the L.O.B.P. and those of the N.B.P. amount to 3–8 weeks. These discrepancies seem to be too large to be explained solely by differences in maturing dates in an otherwise homogeneous climate.

If then we base our estimates on present-day conditions in southern Iraq, we think that the case for cooler winters during the N.B.P. as compared both with the L.O.B.P. and the present is rather strong. With the barley-harvest opening during the L.O.B.P. being about 10–20 days earlier and in the N.B.P. about 10–20 and more days later than in our era, the temperature conditions of southern Iraq in the current era appear to be midway between those of the L.O.B.P. and those of the N.B.P.

Finally, we wish to point out that the temperature conditions in Mesopotamia during 1800–1650 B.C. (warm) and 600–400 B.C. (cool), as compared with the present and as inferred by us from an analysis of ancient barley-harvest dates, seem to parallel the conditions thought to have obtained in the middle latitudes (northern hemisphere), or, more precisely, in California, at those times. The U.S. Committee for the Global Atmospheric Research Program (1975, see, especially, Figure A.10, p. 153; also, see Figure A.2, p. 130) Report referred to at the end of Section 2 above, suggests that the period 2500–1300 B.C. was warm, whereas the period 1300–300 B.C. was cool relative to the present. The periods examined by us in respect of Mesopotamia fall inside the periods just mentioned and the temperature conditions inferred by us are in qualitative
agreement with the conditions inferred for the middle latitudes. It is particularly noteworthy that the greatest cold of the middle latitudes occurred about 600–500 B.C. that, is, in the period designated by us as N.B.P. for which the tablets supply a comparatively late date in the year for the barley harvest.

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Notes

1 Dates for the Neolithic and the Bronze Age in Mesopotamia were taken from Hallo and Simpson, 1971, see p. 10, p. 27 and p. 123.
2 Five of the 'regular' and two of the leap months of the Babylonian calendar figure in this paper. Their Babylonian names are as follows: Month I = ṅisannum, month II = aīrūm, month III = simannum, month VI = ullūm, month XII = addarum; the two leap months to be mentioned are: second month VI = VI₂ = diri-ullūm and XII₂ = diri-addarum.
3 The case of April 5 occurred in 607 B.C. (Parker and Dubberstein, 1942, p. 25) during the reign of Nabopolassar (ruled 625–605 B.C.). We have no tablets for the 20 years of his reign.
4 The brief text of this tablet also contains the instruction that the taxes that were due on the 25th of month VII should now be paid on the 25th of month VI₂, the second month VI.
5 At the time when Thureau-Dangin published his above quoted paper it was believed that the 'series' of concern (mulAPIN) dates back to the Old Babylonian period. According to Landsberger (1949, p. 252), it is now thought that the series originated between about 1400 and 1000 B.C.
6 This and some other items of information to be indicated below were kindly supplied to us by Prof. Y. Arnon, formerly Director, The Volcani Institute of Agricultural Research, Rehovot, Israel.
7 It seems plausible to assume that in an area like southern Mesopotamia, a small to moderate increase in the scanty rainfall is not as significant as a drop in winter temperatures. With the present level of annual rainfall being 100–200 mm and, in view of a relatively intense solar radiation, a hypothetical increase of, say, 20% in precipitation, it still would not be possible to raise grain without irrigation.

References


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