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## Talmudic Metrology I The Mile as a Unit of Length

It is generally accepted in the rabbinic world that a mile is equivalent to 2,000 cubits and represents a length ranging from about 900 to 1,160 meters. In this paper, we intend to prove that the mile mentioned in the Talmud is actually always the Roman mile of about 1,481 m.

To find the definition of the cubit, we derive from the *Mishna Yoma* 6: 4 and 5, that the Sabbath limit is a Roman mile, which is equal to  $2,000\sqrt{2}$  cubits. This would correspond perfectly to the opinion of R. Tam on the matter were it not for the definition of the mile, which he considered to be equal to 2,000 cubits, based on Rashi's interpretation.

We analyze a number of talmudic passages to show that they are compatible with our thesis. We further analyze a variety of *midrashim* to determine at what stage the mile of 2,000 cubits' length first appeared -- in other words, when they forgot that the mile is the diagonal of 2,000 cubits, i.e.,  $2,000\sqrt{2}$  cubits, and identified it instead with 2,000 cubits. We analyze two contradictory *piyyutim* of R. Eleazar ha-Kalir, and try to reconcile them on the assumption that he was nevertheless aware of the true definition of the mile. Finally, we show that the cubit of 0.524 meters, deduced from the mile, is compatible with the supposed height of the average man in the talmudic period, according to the talmudic saying that men have a height of three cubits.

### I. INTRODUCTION

The units of length used in the Talmud are well known, and do not give rise to any controversy about their relative values.

Units of length:

1 *parsah* = 4 miles

1 mile = 2,000 *amah* (cubit)

1 *amah* = 6 *tefakh* (breadth of the hand)

1 *tefakh* = 4 *etzba* = 4 *agoudal* (thumb)

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Problems begin when we try to express these lengths in absolute values, for example, in the metric system. Today, the accepted value of the *etzba* ranges from 1.90 cm.<sup>1</sup> to 2.4 cm.<sup>2</sup> The first value is derived from the volumes of the *revi'it*<sup>3</sup> and the egg,<sup>4</sup> deduced from data given by Maimonides,<sup>5</sup> and the second value represents the average breadth of men's thumbs. By contrast, in the 19th century and in the first decades of the 20th century, the accepted value for *etzba* was 2.2 cm. The supposed length of the *etzba* has thus varied throughout history, and also from region to region.

Opinions regarding other talmudic units of length have varied similarly, and, indeed, rabbis in Russia or under Russian influence considered the Jewish mile to be equal to the Russian itinerary unit, the *verste*<sup>6</sup> (1,067 m).<sup>7</sup> As a result, there is much confusion and, concomitantly, a broad margin of uncertainty about the true length of the talmudic mile.

In the present paper, we reexamine the question, and show that the uncertainty about the true values of the talmudic units of length is of post-talmudic origin. In the Talmud, there is no doubt and no controversy about these lengths. This paper rediscovers these lengths based on distances expressed in the Talmud in miles.<sup>8</sup>

- 1 This value is considered the minimum possible, and is the value given by Maimonides.
- 2 This rather high value is considered the maximum possible, and is suggested by R. Abraham Karelitz.
- 3 The *revi'it* has, according to Maimonides, a volume of 74.375 cubic cm. One *revi'it* = 10.8 d<sup>3</sup> = 74.375 cm<sup>3</sup> and d = 1.9025 cm. (d represents *etzba*, the talmudic inch, i.e. the breadth of a thumb).
- 4 One *revi'it* is equal to 1.5 eggs. The volume of an egg, according to Maimonides, is 49.58 cm<sup>3</sup>. The reference to the egg is justified, because the egg is a natural volume to which the Rabbis often referred.
- 5 Maimonides indicates with precision the weight of the fundamental units of volume, filled with water, calculated in *dinars*. This allows us to know the volume of these capacities with the same precision as his units of weight. Indeed, the golden Arab *dinar* is well known, and its weight is 4.25 g.
- 6 This was based on the principle that the *etzba*, the talmudic inch, is a natural size, and that the value is therefore derived from the statistical measure of the breadth of the thumb.
- 7 It is a common practice to try to equate talmudic and local units. In Russia, Rabbis equated the talmudic mile with the *vestre*, so 2,000 cubits = 1,067 m.; 1 *amah* = 0.53 m.; and 1 *etzba* = 2.22 cm. *Arukh ha-Shulhan*, Y.D., 201:3. R. David Feldman on *Kizur Shulhan Arukh, Yalkut ha-Gershuni*. In Benish (1987), p. 91, other references are given. R. Moses Feinstein gives a similar value.
- 8 I express my profound dependence on the earlier books and studies written on this subject, especially the last books of R. Jacob Gershon Weiss and R. Haim Pinhas Benish.

## II. DISTANCES EXPRESSED IN MILES IN THE TALMUD

A few distances between towns are expressed in miles in the Talmud. By comparing these measurements to modern measurements, where possible, we can obtain likely values for the talmudic mile.

### A. The Distance Between Modi'im<sup>9</sup> and Jerusalem

#### 1. Talmudic References

B. Pesahim 93b is concerned with the distance between Modi'im and Jerusalem, because anyone who is beyond Modi'im at sunrise<sup>10</sup> on the eve of Passover is considered to be sufficiently far away<sup>11</sup> as to be exempt from going to Jerusalem to sacrifice the paschal lamb. Such a person is permitted to postpone the sacrifice until the following month (*Pesah Sheni*).

It is clear in the Talmud that, according to Ulla, the time necessary to walk from Modi'im to Jerusalem is six hours. Concerning the distance between Modi'im and Jerusalem, the Talmud also introduces Ulla's testimony that the distance is 15 miles. Due to the fact that this data can be verified, and also probably that Ulla traveled a great deal and was therefore reliable,<sup>12</sup> it has always been accepted that the distance between Modi'im and Jerusalem actually is 15 miles.<sup>13</sup> This is despite the fact that another part of Ulla's statement was rejected<sup>14</sup> and that the talmudic passage<sup>15</sup>

- 9 There are different versions of this name: Modi'im, Modi'in, Modi'it (*Mishna Hagiga* 3:5), Modiot (Y. Hagiga), and even Modaim (Graetz [1968]). Modi'im is mentioned in B. Kiddushin 66a, where Rashi writes that Modi'im is the town of the Hasmoneans. Modi'im, the town of the Maccabim, is mentioned several times in the Book of the Maccabim, in *The Jewish Antiquities* of Josephus, and at the beginning of the *Wars* of Josephus. The Book of the Maccabim mentions that Simon the Hasmonean built a mausoleum there in honor of his father and his brothers. It was an important building, visible to the sailors: I Macc. 12:29.
- 10 This is the opinion of Maimonides. According to Rashi, the traveler begins his walk at noon, and must reach Jerusalem before sunset, at about 6 p.m.
- 11 See Num. 9:10.
- 12 See the commentary on the mishnah: *Shoshanim le David* by R. David Pardo.
- 13 The origin of the disagreement between Ulla and Rabbi Judah about the distance between Modi'im and Jerusalem is uncertain. It could have resulted from:
  - A bad estimate of the distance due to the political situation and the impossibility of going from one place to the other.
  - A change of roads for political reasons.
  - Doubt about the exact location of Modi'im.
- 14 His opinion that a traveler can walk 30 miles between sunrise and sunset, 5 miles during the astronomical dawn, and 5 miles during the astronomical twilight, was rejected.
- 15 According to the conclusion of the passage, the travelers walk at a rate of one mile per 18 minutes; therefore, the distance from Modi'im to Jerusalem, covered in 6 hours, is 20 miles.

apparently settles on a distance of 20 miles between the cities.

Modi'im is also mentioned in B. Hagiga 25b, where Rashi writes that Modi'im is located 15 miles from Jerusalem, as is mentioned in B. Pesahim.<sup>16</sup>

## 2. Later References to Modi'im

Modi'im is mentioned in *Kaftor Vaferah*,<sup>17</sup> chapter 11.<sup>18</sup>

למערב בית שען כמו שעה היא מודיעית הנזכרת במסכת קידושין פרק האומר גבי אמר  
של ינאי המלך, דאמרינן אמו נשבת במודיעית. ואין זה מודיעים הנזכר סמוך לירושלם,  
שהרי מודיעית לחוד ומודיעים לחוד, וקורין לה מידעה, ואמרינן פרק מי שהיה טמא,  
אמר עולא מן המודיעין ולירושלם חמישה עשר מילין הויה, והוא קרוב למהלך חצי  
יום, כי היום כלו הוא מהלך מ' מיל.

*Kaftor Vaferah* seems to consider the town of the Maccabim, which it calls Modi'it,<sup>19</sup> to be a few kilometers west of Beit Shean, while the Modi'im of the *Talmud Pesahim* seems to be near Jerusalem. It is not certain whether Midda, mentioned by *Kaftor Vaferah*, refers to Modi'it or to Modi'im.<sup>20</sup> R. Y. Schwartz<sup>21</sup> held that it refers to Modi'im, which he places at a distance of 4.5 hours from Jerusalem.<sup>22</sup> According

Nevertheless, according to the interpretation of Rashi and *Tosafot*, the distance is only 15 miles.

- 16 According to the conclusions of Rashi and *Tosafot*, one can walk 16 miles in six hours. Nevertheless, they accept that the distance is only 15 miles. Therefore, *Tosafot* suggests that there was a border to cross between the two towns, which took the traveler out of his way. In any case, Rashi and Maimonides (see his commentary on *Mishna Hagiga* 3:5) agree that Modi'im is the same place in both Hagiga and Pesahim.
- 17 *Kaftor Vaferah* was written by R. Estori ben Moses ha-Parhi of Florenza (Perah), Andalusia, in southern Spain, 1280-1355.
- 18 P. 47, bottom, in the edition of Edelman (1851), p. 291 in the edition of Luncz (1897), p. 418 in the edition of Blumenfeld (1958), and p. 62 in the edition of the Institute for the Study of the Mitzvot of Israel.
- 19 In our printed edition, we read Modi'im in B. Hagiga, in B. Pesahim, and in B. Kiddushin. This is also the case in Rashi. In B. Kiddushin 66a, Rashi explains that Modi'im is the town of the Hasmoneans. R. Hananel writes about the same place, but he calls this location Har Modi'it, apparently like *Kaftor Vaferah*. But in B. Pesahim, R. Hananel speaks about Hamodi'it.
- 20 R. Y.G. Weiss seems to connect it to Modi'it, near Beit Shean. I prefer to connect it with Modi'im, near Jerusalem.
- 21 See Schwartz (1885), p. 54 and Borenstein (1886), p. 727.
- 22 *Kaftor Vaferah*, followed by Schwartz, seems to consider that a normal walker covers 40 miles (Jewish miles) in 12 hours and, consequently, the 15 miles between Modi'im and Jerusalem in 4.5 hours. Ulla's theoretical traveler walks slowly, and needs 6 hours to cover the 15 miles between Modi'im and Jerusalem. This opinion seems to accord with Maimonides, who considers that a man can cover 40 miles in a day: *Hilkhot Evel* 7:4,



to him, there were three different locations: Modi'it near Beit Shean; Modi'im of Pesahim and Hagiga, near Jerusalem;<sup>23</sup> and Har Modi'im of the Hasmoneans, which he places near the Arab village of el-Midyeh.<sup>24</sup> This opinion is accepted by two editors of *Kaftor Vaferah*, R. A.M. Luncz (1897) and R. Y. Blumenfeld (1954). However, the last edition of *Kaftor Vaferah* admits that there exists only one common place corresponding to el-Midyeh,<sup>25</sup> about 10 km. east of Lod; this is also the opinion of Pinhas Neeman (1972) and Prof. Z. Vilnai (1997).<sup>26</sup>

### 3. Analysis

Modi'im had already been described as being east of Lod (Diaspalis) by the early Christian writer Eusebius,<sup>27</sup> and was also placed east of Lydda on the Madaba

although the traveler, on the eve of Passover, is supposed to cover only 15 miles in 6 hours, when walking at a slow rate.

- 23 It is situated on an isolated mountain in Wadi Tzur. Y.G. Weiss identifies this description as Eitanim, a mountain on which the broadcasting authorities placed a relay station with high antennas, about 12 km. by air from the walls of Jerusalem. According to Borenstein, the village of Midan is even closer, at about 11 km. from the walls of Jerusalem.
- 24 This opinion of J. Schwartz seems contradictory and untenable. First, he places Modi'it west of Beit Shean and Modi'im of the Hasmoneans at the correct place of el-Midyeh. But Modi'im, in B. Kiddushin, is actually the site of the Hasmoneans, as explained by Rashi, ad loc. Second, he places Modi'im of B. Pesahim at a direct distance of about 12 km. and a true distance of about 14 km. from the walls of Jerusalem. Borenstein, who contested Schwartz's conclusions and placed Modi'im at el-Midyeh, the supposed site of the Hasmoneans, accused Schwartz of forgery because there never was a distance of 4.5 hours between Midan and Jerusalem. According to the words of Borenstein, Schwartz adapted the foot to the shoe and not the shoe to the foot.
- 25 On a 1948 map, I see the name Midya at this location, about 10 km. east of Lod, corresponding to the historical site of Modi'im, the town of the Maccabim.
- 26 The latter does not seem to be completely convinced. He mentions that, in the Middle Ages, people thought that the Maccabean tombs were in the Latrun area. Indeed, Madden (1854, p. 30) mentions that the site of Modi'im has always been considered uncertain, but that medieval and modern tradition place it at Soba. This location was identified either as Latrun or Kubab. The former is 24-25 km. from Jerusalem and the latter 3 km. further. The true ground distances are about 28 and 31 km. Equating them with 20 miles would give us a mile of 1.4 km. in the first hypothesis, and 1.55 km. in the second. These locations are still compatible with a distance of 20 Roman miles from Modi'im to Jerusalem.
- 27 Eusebius (260-339) wrote the *Onomasticon* in about 330. It contains placenames mentioned in the Bible and in the Christian Gospels, which he arranged alphabetically and by books of the Bible. He sometimes identifies them with places existing in his time, and includes their distance from nearby locations. At the end of the fourth century, the *Onomasticon* was translated into Latin by Jerome (Hieronimus). Of course he is not, *a priori*, a more reliable source than his contemporary Ulla. In the case of the distance between Tzipori and Tiberias, Eusebius gives an erroneous distance of 10 miles.

map.<sup>28</sup> The supposed historical site of Modi'im is represented on the new road atlas of Israel (scale 1:100,000; MAP – Mapping and Publishing): 28, J17, east of Maccabim Junction, and it is thought to correspond to the town of the Hasmoneans. The distance as the crow flies between Modi'im and Jerusalem is about 28 km. and the distance by road, taking into account the arterial deviations, must be at least 30-31 km. This corresponds to a distance of 20 Roman miles.<sup>29</sup> At a speed of 18 minutes per mile,<sup>30</sup> it takes six hours to travel this distance. As the conclusion of the talmudic discussion is, indeed, that it takes 18 minutes to walk a mile,<sup>31</sup> a distance of 20 Roman miles between Modi'im and Jerusalem is a fitting conclusion. Thus, Ulla's estimate of the walking time is vindicated, though his estimate of the distance is not. In any event, the mile considered in this talmudic passage is equal to a Roman mile.<sup>32</sup>

### **B. The Distance Between Tiberias and Tzipori**

The distance between Tiberias and Tzipori is listed as 18 miles in the Jerusalem Talmud and in the Midrash.<sup>33</sup> The distance, as the crow flies, is about 25.15 km. Therefore, a true ground distance of 18 Roman miles ( $18 \times 1.4815 = 26.667$  km.) is very likely.

- 28 This is a Mosaic map discovered in 1884, which represents the biblical Holy Land and neighboring regions.
- 29 The length of a mile was always considered to be 1,478 m. In the most recent edition of *Larousse*, the French encyclopedia, the length of the mile is given as 1,481.5 m. or 1,481.75 m.
- 30 It corresponds to a rate of a little less than 5 km. per hour.
- 31 See a comprehensive examination of this talmudic passage in J. Jean Ajdler, *Talmudic Metrology II: The Mile as a Unit of Time* (forthcoming).
- 32 Furthermore, this new element completely changes the comprehension of the text, because one mile in 18 or 22.5 minutes (Rabbi Judah) or in 24 minutes (Ulla and Rabbi Johanan) corresponds, respectively, to a speed of 4.9, 3.95, or 3.7 km./h. Particularly, the traveler of Rabbi Judah, who walks 20 Roman miles in 6 hours (the distance from Modi'im to Jerusalem), covers 1 mile in 18 minutes. It appears that 4.9 km./h. is a fast speed and only good walkers will be able to reach Jerusalem in time at noon, after a walk of 20 Roman miles in six hours. Maybe we are dealing with theoretical walkers, who can walk at the rate of 4.9 km./h. without fatigue for six or even twelve hours, without even taking the time to break for a meal. That means that normal people, who are walking at the average speed of 3.7 km./h. (the average speed of walkers, over long distances, was accepted to be one German league in two hours), will arrive after a walk of 8 hours, at 2 p.m. We must then conclude that Maimonides was right to have people travel in the morning. Otherwise, those people would not arrive in Jerusalem before the beginning of Passover.

### C. The Distance from Kfar Khananya to Tzipori

According to B. Behorot 55a, the distance from Kfar Khananya to Tzipori is 16 miles. The historical site of Kfar Khananya<sup>34</sup> is represented on the road atlas of Israel: 5, P6, and Tzipori is on the same map: 9, M8. This distance, measured on the Israeli map, is about 23.2 km. The road distance is then about 25 km., a little more than 16 Roman miles.

### D. The Distance from Tzipori to Kfar Otnai

According to B. Behorot 55a, the distance from Tzipori to Kfar Otnai is 16 miles. According to the *Encyclopedia le Geographia Talmudit*, Vol. 2, Kfar Otnai is identified with Kfar Lajun, 1.5 km. south of Meggido. On the Israeli road map, there is mention of the ruins of Kfar Otnai: 15, L9. The distance from Tzipori is about 21.75 km. for the most direct route, and therefore a ground distance of about 24 km. or 16 Roman miles remains likely.

### E. The Distance Between Khziv and Sulama de Tzur (or Sulamei Tzur)

The distance between Khziv and Sulama de Tzur (or Sulamei Tzur) is 3 Roman miles. Khziv is a small place at the mouth of the river Nahal Khziv, north of Acre. It is mentioned in the *Tanakh*,<sup>35</sup> *Mishnah*,<sup>36</sup> *Tosefta*,<sup>37</sup> *Talmud*,<sup>38</sup> and *Maimonides*.<sup>39</sup> There is no doubt about its location.<sup>40</sup> It should not be confused with another town of the same name in the territory of the tribe of Judah.<sup>41</sup>

Sulamei Tzur, literally, the ladder of Tyre, designates the steep road of steps cut into the rock, which connected the territory of Acre with that of Tyre, and formed part of the coastal road passing the twin headlands of Rosh ha-Nikra (Ras en Naqura) and Rosh ha-Lavan (Ras el-Abyad). It also designates a little village at the foot of the promontory of Rosh ha-Nikra that must correspond, more or less,

33 *Y. Taanit*; 4:5. See also *Midrash Ekha, Treni* 2:2.

34 Kfar Khananya is also mentioned in B. *Eruvin* 51a.

35 *Joshua* 19:29; *Judges* 1:31.

36 *Shevi'it* 6:1; *Hala* 4:8; *Demay* 1:3.

37 *Tosefta Shevi'it* 4:4.

38 B. *Gittin* 7b.

39 *Rambam, Hilkhot Terumot* 1:7 and 8.

40 It is generally believed that Khziv is south of the mouth of the Nahal Khziv. From *Tosefta Shevi'it* 4:4, one would think that Khziv was on the north side of the mouth of the river. R. David Pardo, in *Hasdei David*, believed that the text of the *Tosefta* was corrupt, because he did not think that there was a river at this place.

41 *Genesis* 38:5; *I Chronicles*, 4:22; *Joshua* 15:44; *Micah* 1:14.

with Kfar Rosh ha-Nikra. It is mentioned several times in the Talmud.<sup>42</sup>

From the account of a journey of Rabban Gamliel, originally from Acre to Khziv, but continued until Sulamei Tzur, we learn that the distance between Khziv and Sulamei Tzur is 3 miles.<sup>43</sup> This distance is about 4.5 km.,<sup>44</sup> and therefore we are again dealing with the Roman mile. The account of this journey has been reproduced, with slight variations, several times in the talmudic literature, because of the various teachings deduced from it.<sup>45</sup>

#### F. Distance from Jerusalem to the Rock

*Mishna Yoma* 6:4 and 5 says that the distance from Jerusalem to the rock from which the scapegoat was thrown down is 90 *ris*, as the carrier of the scapegoat covered a distance of 90 *ris* between the Temple and the rock. The Roman mile was divided into 8 *stadia*, but in Jewish and Arab metrology (and even in some Roman sources) it was divided into 7.5 *ris*;<sup>46</sup> 90 *ris* are equivalent to 12 miles, which was the width of the camp of Israel in the desert, and the maximum distance permitted on the Sabbath by biblical law. All the people who went part of the way to the rock with the carrier of the scapegoat walked one mile, a Roman mile, corresponding to the Sabbath limit according to rabbinical law. In B. Yoma 67a, there is a divergent opinion of Rabbi Judah and Rabbi Jose, according to which the distance is only 10 miles.

#### G. Distance between Jerusalem and Jericho

The distance between Jerusalem and Jericho is 10 *parsaot*.<sup>47</sup> The distance, as the crow flies, between the towns is about 24 km., and the road distance cannot be more than 30 km. or 20 Roman miles, which is the equivalent of 5 *parsaot*. Perhaps

42 B. Sabbath 26a; *Tosefta Pesahim* 1:28; B. Eruvin 80a; B. Baba Metzia 43b.

43 Rabban Gamliel was riding, just after Passover, from Acre to Khziv in the company of Rabbi Illai and his servant Tavi. After dining in Khziv, Rabban Gamliel was approached by a man who asked to be freed from a vow. As Rabbi Illai confirmed to Rabban Gamliel that he had drunk a *quartarius* of wine (a *revi'it*), Rabban Gamliel told the man to follow them until the effects of the wine wore off. After riding 3 miles, they arrived at Sulamei Tzur, where Rabban Gamliel dismounted, donned his *tallit*, and dealt with the matter.

44 G. Weiss (1984), p. 315, writes that Sulama de Tzur is 5.1 km. from Khziv. He apparently locates this village north of Kfar Rosh ha-Nikra. If he were right, the distance would correspond to 3.4 miles, which they rounded down to 3 miles. It is remarkable that all the distances in the Talmud are expressed in whole numbers.

45 Leviticus Rabbah 37; B. Eruvin 64b; *Y. Avoda Zara* 1:9; *Tosefta Pesahim* 2:9.

46 The *ris* is the equivalent of the *stadium*.

47 B. Yoma 39b and B. Yoma 20b.

we have here a transcription error<sup>48</sup> or an exaggeration, as is often the case with Rabbah bar bar Hannah.

#### H. Distance from Beitar to the Sea

Rabbi Johanan says that the distance from Beitar to the sea is 40 miles.<sup>49</sup> The ruins of Beitar are represented on the road atlas of Israel (scale 1:100,000; MAP – Mapping and Publishing): 29, L19, west of Batir. The distance between Beitar and the sea is about 46.75 km. It is possible that the mentioned distance relates to the distance covered by the blood of the victims of Beitar along the Nahal Sorek stream as it flowed to the sea, and therefore the distance is much greater than the direct route, and represents the meanderings of the river's path to the sea. This distance seems more compatible with 40 miles or about 59.25 km.

#### I. Distance Between Ono and Lod

The distance between Ono and Lod is 3 miles.<sup>50</sup> Ono and Lod are two ancient neighboring towns that are known from the period of the Second Temple.<sup>51</sup> Ono is considered to be a fortified town from the time of Joshua.<sup>52</sup> According to Neeman (1972), the old town of Ono corresponds to the Arab village of Kfar Ana, 9 km. from Lod. The distance of 3 miles mentioned in the Talmud is equal to 4.5 km., but, according to Pinhas Neeman, there is another reading in the text of Ketubot: it may read 5 miles, which better corresponds to a distance of 7.5 km.

#### J. Other Distances

There are many other distances expressed in miles in the Talmud, but it is not possible to use them to confirm our thesis because the actual locations are not known with precision:

- The camp of Israel from Beit ha-Yeshimot until Evel ha Shitim is 3 *parsaot* or 12 Roman miles.<sup>53</sup>

48 Eng. Yakov Loewinger has forwarded to me the main extant manuscripts, which all agree with the accepted reading of 10 *parsaot*. They are: manuscripts EMC 218270 and EMC 1623271 of Beit ha Midrash le Rabanim, 95 Munchen, Harl 5508(400), British Museum, and the first edition of Venice.

49 *Y. Ta'anit* 4:5.

50 B. Ketubot 111b.

51 I Chronicles 8:12; Ezra 2:33; and Nehemiah 7:37.

52 *Mishna Erahim* 9:6.

53 Numeri 33:49; B. Eruvin 55b; *Y. Eruvin* 5:4 and 3:4; *Y. Shevi'it* 6:1; B. Yoma 75b; *Targum Jonathan* Numeri 2:3; Rashi in Berahot 54b.

- The distance between Migdal Lougia and Tiberias is 1 mile.<sup>54</sup>
- The distance between Hamtan (warm springs) and Tiberias is 1 mile.<sup>55</sup>
- The distance between Jerusalem and Beit Khidoudo is 3 miles.<sup>56</sup>

### K. The Talmudic Mile

The mile, in Hebrew מיל, is a unit that was borrowed from the dominant Roman civilization. Its meaning is 1,000 double steps (the distance between the extremity of the heel of one foot and the next position of the same heel as one walks). More commonly, the mile is 2,000 steps (the distance between the extremity of the heels<sup>57</sup> as one walks or, in other words, the distance between the right heel and the left heel while walking).

In the rabbinic tradition, the definition of the mile seems different: it is the length of 2,000 cubits. It is only incidentally, thanks to the dictum of Rav Nahman (B. Erubin 42a), that we know that the length of a normal step is a cubit. The mile is then also 2,000 normal steps. It is generally agreed that the talmudic mile ranged between 900 and 1,150 meters, according to the length usually adopted for the talmudic cubit. The talmudic mile would then be a proper talmudic unit, without doubt inspired by the definition of the Roman mile but completely independent of it.<sup>58</sup>

But now we have seen that, in the Talmud, the different measurable distances given in miles are actually expressed in Roman miles. Borenstein (1885) therefore thought that the two miles, the Roman and the Jewish miles, were used simultaneously in the Talmud. Borenstein's conviction was grounded on his erroneous estimation of the distance between Modi'im and Jerusalem. Indeed, although he correctly placed Modi'im 10 km. east of Lod, he incomprehensibly estimated the distance from Modi'im to Jerusalem to be only about 22.5 km. (instead of the actual minimum of 28 km.), corresponding to 15 Roman miles or 20 Jewish miles. Thus, Borenstein premised his explanation of the contradiction between Ulla and Rabbi Judah in B. Pesahim 94a by saying that Ulla fixed the distance

54 B. Pesahim 46a.

55 B. Megilah 2b.

56 *Mishnah Yoma* 6:8.

57 See Rashi, B. Yoma 67a; R. Hananel, B. Yoma 67a; and Maimonides, *Commentary on the Mishnah*, Yoma 6:4.

58 Even under this assumption, which is still generally accepted today, the *parsah* must be equal to 4 Roman miles. This the only way to understand the dictum of Rava in B. Pesahim 94a, according to which the Earth measures (i.e. has a perimeter of) 6,000 *parsah* = 24,000 miles = 35,556 km. with an undervaluation of only 10 percent.

between Modi'im and Jerusalem at 15 Roman miles, which is 20 Jewish miles. Apart from the fact that this ingenious solution is actually based on a material error, Borenstein's conclusion is impossible. Had this been the explanation of the divergence between Ulla and Rabbi Judah, the Talmud would not have rejected Ulla's opinion without emphasizing this point. The Talmud does not actually recognize the existence of two different miles.

For this reason, we propose another solution: there has never been a Jewish mile, and the talmudic mile is the Roman mile. The rabbis of the Mishnah presumably understood that the only way to give a future to Judaism was to express the different units of measure – of volumes, capacities, weight, and money, but especially of length – according to the Roman standards.

In summary, contrary to the generally accepted opinion,<sup>59</sup> all the miles considered in the Talmud are Roman miles. Nevertheless, this seems to have been forgotten very soon thereafter.<sup>60</sup> This important conclusion<sup>61</sup> requires that we reexamine all distances, especially those expressed in cubits, to find the relation between the mile and the cubit.

### III. THE CUBIT IN BIBLICAL AND TALMUDIC LITERATURE

#### A. The Industrial and Agricultural Area Around the Levitical Towns

The distance of 2,000 cubits is mentioned in Num. 35:5 in the context of delimiting the agricultural and industrial areas around the Levitical towns. The Levitical towns were surrounded by a 1,000 cubit-broad belt reserved for industrial activities and by a second belt, immediately beyond the first, which was of the same breadth and which was reserved for agriculture. Both belts together had a breadth of 2,000 cubits.<sup>62</sup> If the town had a circular shape, then we consider the square that circumscribes it. The industrial sector then comprises the area between this first square and a second, concentric square, the sides of which are 1,000 cubits distant

59 With the exception of Borenstein.

60 For example, Rashi and R. Hananel in B. Yoma 67a write that 2,000 cubits = 1 mile. The fact of the matter was probably forgotten in Babylonia in about the fifth or the sixth century, and in Palestine in about the eighth century.

61 In a text still in manuscript, R. Raphael Levi from Hanover writes that he found, in old books, that the talmudic mile was equal to the Roman mile. But, as he still accepts that a mile is 2,000 cubits, this gives cubits of nearly 75 cm. Similarly, see Weiss (1985) on the subject of other rabbis, who proposed a mile of a similar length and consequently an exaggeratedly long cubit.

62 The subject is studied in Babli Erubin 56b.

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is greater than  $4\sqrt{2}$  cubits, then it is punishable.<sup>72</sup> Maimonides relies on the formal ruling mentioned above, from which we get the impression that it is not authorized *lekhathila*, but only *bediavad*, to carry for a distance greater than 4 cubits. But there is a parallel passage in Y. Eruvin 4:1: *כשהו נפנה מן הצד וכשהוא מתפלל לוכסן*, which says of a man who went outside the *tehum*, and who may therefore move only in the area of 4 cubits by 4 cubits:

When he turns, he turns to the side [he lays the excrement down on the corner of an imaginary 4 cubit square, on the circle of radius  $2\sqrt{2}$  cubits] and when he prays he places himself on the symmetrical point, still on the circle of radius  $2\sqrt{2}$  cubits.

It becomes evident that he may move aside *lekhathila* *לכתחילה* as much as  $4\sqrt{2}$  cubits<sup>73</sup> in order to withdraw by more than 4 cubits from embarrassing excrement, and to be able to say his prayer.<sup>74</sup>

Rashi<sup>75</sup> and R. Tam<sup>76</sup> – and, in a case of emergency, also Rabbi Abraham ben David<sup>77</sup> – think that one is authorized to carry in any direction for a distance of less than  $4\sqrt{2}$  cubits. Apparently, they consider that the 4-cubit square has no privileged orientation and that, therefore, one may always consider oneself to be walking its diagonal.

Ritva notes that the position of Rashbam, who considers the authorized limit to be 4 cubits in a cardinal direction and 5.66 cubits in a diagonal direction, is very weak because of the general formulation of Rav Akha bar Jacob. The latter should have been more specific if he wanted to differentiate according to the direction of the displacement.

72 This ruling seems to contradict *Hilkhot Shabbat* 12:15, where Maimonides says that one may move *lekhathila*, in all, a square of 4 by 4 cubits.

73 The commentators of the *Yerushalmi* have understood that this passage follows Rashi and R. Tam (who consider that the 4-cubit square has no privileged orientation). It is nevertheless possible to understand the passage according to Rashbam, for whom the square has a fixed orientation.

74 See *Mishna Berahot* 3:5 and B. Megilah 27b. See also Maimonides' *Hilkhot Kriyat Shema* 3:2 and 8.

75 B. Eruvin 51a.

76 B. Eruvin 51a, *Tosafot* *כדה יהו כל שומרי שבת* ובולן על ידי עירוב.

77 According to my understanding of his *hasagah* on *Hilkhot Shabbat* 12:19.

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### C. The Limits of the Sabbath Beyond the Town

In *Mishna Eruvin* 4:8, it says:

ואמר שביתתי במקומי, זכה לו מקומו אלפים אמה לכל רוח עגולות, דברי רבי חנינה בן  
אנתיגנוס, וחכמים אומרים מרובעות כתבלא מרובעת כדי שיהיה נשכר לזויות.

If he says that he takes his residence, for the Sabbath, in the place where he stands, then this place gives him a domain (where he can walk but not carry) of 2,000 cubits, circular in all directions, says Rabbi Haninah ben Antignos, but the Sages say that this domain is a square so that he wins the corners.<sup>78</sup>

If we reduce the town to a point, we can summarize the positions as follows: R. Haninah ben Antignos authorizes a person to walk in the circle of radius 2,000 cubits, while the Sages authorize him to walk inside a 4,000 cubit square. If the town is like a Levitical town, one is authorized to walk outside it in the industrial and agricultural areas.

Rashbam<sup>79</sup> understands this square, like the smaller square of 4-by-4 *amot*, to be oriented along the cardinal directions. Maimonides shares this opinion, as do Rashi and Rabbi Abraham ben David, although the last two shared the opinion of R. Tam as regards the 4-cubit square in the public domain.<sup>80</sup> On the other hand, R. Tam considers this larger square to have no privileged direction; he holds that it can be oriented in any direction and that, therefore, the area in which one is allowed to walk is a circle with a radius of  $2,000\sqrt{2}$  cubits. There is a serious argument for R. Tam, which was not invoked by the *rishonim*: although carrying outside the 4-cubit square is forbidden by the Torah, most of the Rabbis have accepted an extension of the authorized domain to a circle with a radius of  $2\sqrt{2}$  cubits. When one walks outside the square of 4,000 by 4,000 cubits, we are dealing with a

78 There is an interesting, old piece of evidence of non-Jewish origin about the Sabbath limit, which shows that one was permitted, according to all opinions, to walk from Jerusalem to the Mount of Olives. Indeed, in *Haasif* 2 (5646), p. 728, Borenstein mentions that the Acts of the Apostles 1:2 states that the Mount of Olives is the distance of a Sabbath limit from Jerusalem. Borenstein mentions further that Apipanius (a Christian priest of Jewish origin) asserts that the Sabbath limit is 5 *stadia*. Borenstein also writes that Josephus, in his *Antiquities*, states that the distance from the Mount of Olives to Jerusalem is 6 *stadia*. In fact,  $2,000 \text{ cubits} = (1/\sqrt{2}) \times (8 \text{ ris}) = 5.667 \text{ stadia}$ . The rounding-off yields 5 *stadia* in one direction and 6 *stadia* in the other. I am grateful to R. Gershon Weiss from Jerusalem for drawing my attention to this paper and sending me a copy.

79 See the same references as above, in *Tosafot Eruvin* 51a and *Yoma* 67a.

80 This position is probably justified by the deduction of the domain of Sabbath from the industrial area around the Levitical towns.

proscription of the Sages, not the Torah, and they should certainly have allowed walking in a circular domain of radius equal to  $2,000\sqrt{2}$  cubits.<sup>81</sup>

Ritva, in his novellae on B. Eruvin 51a, notes that the position of R. Tam is indeed a logical extension of his position in the matter of 4-by-4 cubits in the public domain. But he also notes that this position is very difficult, because there is no relevant affirmation by any *amora* that would be parallel to Rav Akha bar Jacob's affirmation with regard to the 4-cubit square. Ritva therefore prefers the position of Rashi, who does not share Rashbam's position in the matter of the 4-by-4 cubit square in the public domain, and who also does not share the position of R. Tam in the matter of the 2,000 cubits around the town. Had Ritva imagined that a mile could be something other than 2,000 cubits (i.e., that it could be 2,828 cubits), then, since there is a mishnah in *Yoma* 6:4 clearly stating that the Sabbath limit is 7.5 *ris* or 1 Roman mile, he would certainly have adopted R. Tam's conclusion.

#### D. Analysis of *Tosafot*

In B. *Yoma* 67a וכולן על ידי עירוב, *Tosafot* writes:

..... מכאן משמע דתחום שבת מיל והיינו אלפים ותו לא, כמו שהוכיח רשי, מיהו יש לומר דסימנא בעלמא הוא מיל כמו בכל דוכתא דנקט אלפים אף על גב דיהבינן ליה אלכסון, הכי נמי הכא נקט מיל אף על פי דיהבינן ליה אלכסון

[It has been explained at the beginning of this *Tosafot* that, according to R. Tam, one is allowed to walk a distance of  $2,000\sqrt{2}$  cubits. *Tosafot* continues] that this point of view is difficult in the present context [the text of the *Mishna Yoma* 6:4 and the *Gemara*] because we see that the man who was going part of the way with the one in charge of the scapegoat was allowed to walk 1 mile, which represents 2,000 cubits as Rashi has demonstrated it, and not more. Nevertheless, we can say that the mile mentioned here is only an indication in the same way as it is only an indication whenever 2,000 cubits are mentioned, although we give them a diagonal (and 2,000 cubits are actually 2,828 cubits). Here also, in the same way, it mentions a mile, although we give him a diagonal, and the different people going with the man in charge of the scapegoat are allowed to walk 2,828 cubits.

*Tosafot*, in B. Eruvin 51a, has mentioned the opinions of Rashbam and R. Tam. According to the latter, the square of 4,000 by 4,000 cubits has no privileged orientation, and the radius of the authorized domain around a town which is supposed

81 Haye Adam 76:2.

to be reduced to a point, is 2,828 cubits. In the same way, when the mishnah, *Yoma* 6:4, fixes the Sabbath limit to 1 mile, it is actually 1.414 miles. R. Tam was trapped by the equation 1 mile = 2,000 cubits, which was accepted by Rashi and Rabbenu Hananel (*Yoma* 67a), and which prevented him from discovering the true solution to the problem.

It must be observed, however, that Rashi did not accept this ratio without due consideration; he demonstrates it on the basis of a *piyyut* of Eleazar ha-Kalir, based on a *baraita* from Deuteronomy Sifrei. It seems to me that we are faced here with the true problem. Because of a lack of understanding, the mile has been identified as 2,000 cubits, but this is not possible, as the Roman mile is about 1,481.5 meters. This equation would give a cubit of 74 cm.

The mile (the Roman mile) is actually the true Sabbath limit, and is equal to the diagonal of 2,000 cubits (see the drawing above). R. Tam was correct in saying that the 2,000 cubits is actually the diagonal of 2,000 cubits, but the mile represents the Roman mile, the diagonal, and not the 2,000 cubits.

Therefore, the ratio between the mile and the cubit is as follows:

$$\begin{aligned} 1 \text{ Roman mile} &= 2,828.427 \text{ cubits} \\ 1 \text{ cubit} &= 52.4 \text{ cm.} \end{aligned}$$

#### E. Relationship Between the Cubit and the Mile

What is the origin of the equation by Rashi: 1 mile = 2,000 cubits? Of course, when Rashi considered that the Shabbat limit is a square of 4,000 cubits per side (we always consider a town reduced to a point), it is logical to identify 2,000 cubits with the mile, which is also presented in *Yoma* 6:4 as the Sabbath limit. But Rashi does not propose this argument in *Yoma* 67a. He relies on a *baraita* of Deuteronomy Sifrei, Ha'azinu 12, from which he proves that 1 mile is equal to 2,000 cubits. It is likely that this is the reason he decided to consider the Sabbath domain as a fixed square, like Rashbam and unlike R. Tam. He was committed to the equation 1 mile = 2,000 cubits, and he considered that the mile mentioned in the *Mishna Yoma* is a mile, in its strict meaning, and not  $\sqrt{2}$  mile.

#### IV: EXAMINATION OF DIFFERENT TALMUDIC PASSAGES

With the foregoing in mind, we reexamine several other talmudic passages to clarify this divergent concept and to confirm our main thesis:

$$\begin{aligned} 1 \text{ mile} &= 1,481.5 \text{ m.} \\ 1 \text{ mile} &= 2,828 \text{ cubits} \end{aligned}$$

1 cubit = 0.524 m.

*tehum Shabbat* = limit of Sabbath = 1 mile = 2,828 cubits.

### A. B. Yoma 67a

*Mishnah Yoma* 6: 4 does not offer any discussion on this subject; the limit of the Sabbath is 7.5 *ris* or 1 mile. The mile in the Talmud is always the Roman mile. This mishnah is surely in contradiction to Rabbi Haninah ben Antignos. It seems to be in accordance with the opinion of R. Tam, but it can also be considered in accordance with Rashbam as long as we accept that the distance of 90 *ris* or 12 miles covered by the scapegoat was always along the diagonals of a square oriented North-South, and thus bisected the cardinal directions. This interpretation nevertheless seems farfetched.

### B. B. Eruvin 42a

אמר רב נחמן אמר שמואל, היה מהלך ואינו יודע תחום שבת, מהלך אלפים פסיעות  
בינוניות וזו היא תחום שבת

Rav Nahman said in the name of Samuel: If a man was walking outside the town and he did not know the Sabbath limit, he might walk [from the limit of the town] two thousand average steps, and this gives him the Sabbath limit.

This ruling has been accepted by Maimonides<sup>82</sup> and by *Shulhan Arukh* O.H., §397:2. The Rabbis have always considered the limit of the Sabbath to be 2,000 cubits; it is now also 2,000 average steps; hence, 1 cubit is equal to such a step. Rashi writes that the normal step of a man is a cubit.<sup>83</sup> The accepted value of the rabbinical cubit is about 52 cm. and it is surely not greater than 55-56 cm.<sup>84</sup> One should walk 2,000 such steps<sup>85</sup> to reach the limit of the Sabbath.

In fact, however, such a step is not by any means an average step. It is almost impossible to walk with such small steps unless one is physically ill. To paraphrase R. Y.G. Weiss,<sup>86</sup> if you want to experiment and walk in such a way, with steps of about 52 cm., do not do it in your own neighborhood, nor on Shabbat on your way

82 *Hilkhhot Shabbat* 27:4.

83 Rashi, B. Eruvin 42a.

84 This is the maximum length adopted by the Rabbis.

85 The length of a step is the distance while walking between the extremities of the heels of the two feet when they touch the ground.

86 Weiss (1994), pp. 362-63.

to synagogue, because your acquaintances will worry about your health. Steps smaller than 65 cm. are not normal, and it would be difficult, if not impossible, to walk a long distance with a regular step of only about 52 cm. An average step actually has a length of about 75 cm., and a length of 90 cm. is possible, although not normal. Therefore, the 2,000 steps proposed by the Talmud for the distance that one may walk outside the town on the Sabbath approximates the Roman mile well. The Roman mile of 1,481.5 m. actually represents 2,000 steps of 75 cm.

This view is confirmed by the fact that the traveler on the eve of Passover, on 14 *Nissan*, leaving Modi'im at 6 a.m. and arriving in Jerusalem at the gate of the city at noon,<sup>87</sup> walks a distance of 20 Roman miles in 6 hours, which corresponds to 1 Roman mile every 18 minutes or 4.938 km./h. At this rate, the traveler normally makes 110 steps of .75 m. per minute. A step of 75 cm. is therefore most probable, and this seems to support the opinion of R. Tam. Rashbam could still argue that this is the maximum distance that may be walked in the bisecting line of the cardinal directions, but that seems farfetched.

#### C. B. Eruvin 42a

ואמר רב נחמן אמר שמואל: שבת בבקעה והקיפונה נכרים מחיצה בשבת, מהלך אלפים  
אמה...<sup>87</sup>

Rav Nahman says in the name of Samuel: if someone has elected residence for the Sabbath in the plain, and during the Sabbath non-Jews surround it with a wall, he may walk up to a distance of 2,000 cubits inside the perimeter of the wall.

This reference, as with all those to 2,000 cubits, means the hypotenuse of the 2,000-cubit square. This, at least, is the opinion of R. Tam.

#### D. Y. Eruvin 5:1

כמה הוה רחיק, רבי יצחק אמר מיל

At what distance [from the camp of Israel] did Moses establish his tent? At a distance of one mile. This distance nevertheless allowed the people to come and consult him on the Sabbath.

This excerpt also seems favorable to the opinion of R. Tam.

87 Now that we know that the traveler must walk about 30 km. in 6 hours, it appears that many people will take more than 6 hours. It is therefore better to adopt the time schedule of Maimonides, so that the latecomers can still participate in the sacrifice.

### E. Y. Eruvin 5:5

כמה היא מידת התחום? ארבעים חבלים

What is the length of the Sabbath limit? Forty ropes [of 50 cubits each].

According to R. Tam, this passage concerns the length of the basic dimension of 2,000 cubits, but the true distance is 2,828 cubits; the question is then the length of the 2,000 cubits of which we must calculate the diagonal. As they used only ropes of 50 cubits, they were obligated to construct a right-angled isosceles triangle whose two equal sides have a length of 2,000 cubits in order to measure the hypotenuse and find the true value.

In any event, all these passages support, or at least do not refute, the equation, 1 mile = 2,828 cubits. The mile is the diagonal of the 2,000-cubit square and the radius of the circle circumscribing the 4,000-cubit square.

## V. EXAMINATION OF PASSAGES IN *MIDRASHIM*, CLASSIFIED CHRONOLOGICALLY<sup>88</sup>

### A. Sifrei to Deuteronomy, Haazinu 12

שעתידים ישראל ליטול אורך מן המזרח למערב עד רוחב כ"ה אלפים קנים, שעורן ע"ה מיל

In the future, [each tribe of] Israel will take a space from the East to the West of a breadth of 25,000 *kanim*, corresponding to 75 miles.

One *kane* is equal to 6 cubits;<sup>89</sup> 25,000 *kanim* are equal to 150,000 cubits, corresponding to 75 miles if 2,000 cubits are equal to 1 mile. It is difficult to decide whether the author of this *baraita* still thinks that 1 mile is equal to an *alakhson* of 2,000 cubits<sup>90</sup> and therefore that an *alakhson* of 25,000 *kanim* represents 75 miles; or whether, instead, the author already equates the mile with only 2,000 cubits. The Sifrei on Numbers and on Deuteronomy were probably compiled in

88 Sifrei Deuteronomy and Genesis Rabbah are the oldest *midrashim*; their completion is dated to the fifth century CE. The completion of *Midrash Tanhuma* probably dates to the eighth century CE. The completion of *Targum Jonathan* also dates to the eighth century, while Exodus Rabbah and Numeri Rabbah are probably later. These last two *midrashim* were unknown to Rashi. The literary crystallization of the *midrashim* was probably preceded by generations of development. See the introductions to the five books of the Bible in *Midrash Rabbah ha Mevoar*. See also *Encyclopaedia Judaica*.

89 Rashi, B. Yoma 67a.

90 The diagonal of 2,000 cubits or 2,828 cubits.

Israel no earlier than the end of the fourth century CE.<sup>91</sup> Therefore, they belong to the early *midrashim*. The same text is found verbatim in Yalkut Shimoni 944. It is apparently on the basis of this *baraita*, as he calls it, that Rashi was persuaded that the mile of Yoma 67a is equal to 2,000 cubits, and therefore he concluded, in *Eruvin*, that the domain in which one is allowed to walk around the town is an area of 4,000 by 4,000 cubits, because one may walk a mile and not more. R. Tam agrees with the equation 1 mile = 2,000 cubits as “Rashi has demonstrated,”<sup>92</sup> but he accepts that the mile is mentioned symbolically, in the same way as the 2,000 cubits, and actually means this quantity multiplied by  $\sqrt{2}$ .

### B. Genesis Rabbah 53:13.

ותלך ותשב לה מנגד נאמר כאן 'ותשב לה מנגד' ולהלן הוא אומר 'מנגד סביב לאהל מועד' הכא את אומר 'הרחק כמטחוי קשת' ולהלן את אומר 'אך רחוק יהיה ביניכם וביניו כאלפים אמה במדה' הא למדנו נגד מנגד ורחוק מרחוק. אמר ר' יצחק 'כמטחוי קשת' שני טוחים בקשת מיל.

By the use, twice, of the hermeneutic rule<sup>93</sup> “*gezera shava*” based on the words מנגד and רחוק, we deduce that she [Hagar] moved off a distance of 2,000 cubits, in order not to see the death of Ishmael.

Rabbi Isaac said that, because of the plural form, one must understand two times the range of a bow. At first glance, we already have the equation 1 mile = 2,000 cubits. But this is far from definite. On reflection, it seems we have here two independent opinions. R. Isaac is probably the same R. Isaac who says in *Y. Eruvin* 5:1 that Moses removed his tent from the camp by one mile, probably to remain in contact with the people on the Sabbath. Apparently, R. Isaac considers that רחוק means one mile without seeing any need to find scriptural justification through the use of hermeneutic rules. Now, since it seems that the range of a bow is less than one mile, he uses the artifice of the plural form, and he equates twice the range of the bow with one mile.<sup>94</sup> For him, the mile is still the Roman mile, which was still known in Palestine in the fifth century CE.

91 See *Midrash Rabbah ha Mevoar* in the different introductions and *Encyclopaedia Judaica*.

92 *Tosafot* Yoma 67a.

93 The hermeneutic rules are the logical and grammatical rules used in the Talmud and *midrashei* Halakhah for the interpretation of the Torah.

94 The range of a bow must not exceed 200 m. The longbows used by the English army against the French troops in the 15th century had a range of 200 m. There is some exaggeration in the estimation of the bow range. It is probably because he already sensed

On the other hand, we have for the first time, and in contradiction with the former interpretation, another way of reading this passage. This reading uses hermeneutic rules, based on the analogy of the same word or root occurring in two different sentences, to transpose a distance found in one sentence to the second. In our case the process is used twice, and it is allowed to apply the distance of 2,000 cubits of the last sentence from Joshua to the distance considered in the first. It is then very likely that the two declarations are independent and contradictory, and that the two distances are not the same.

We have here two contradictory positions not only regarding the method of reasoning, but also regarding the distances under consideration. Of course, the distinction between the mile and the 2,000 cubits will not hold up for long. All of the elements required to create confusion are gathered here, and, in the next stage, the contradictory aspects of the two interpretations will be forgotten. Instead, both positions will be combined into one interpretation which connects the hermeneutic rule, the 2,000 cubits and the mile. So it appears in later *midrashim*.

### C. Midrash Tanhuma, Exodus 33:7

ר' יצחק אמר: מיל בענין שנאמר אך רחוק יהיה ביניכם לבינו באלפים אמה.

R. Isaac says that the tent of Moses was at a distance of one mile, as it is written [Joshua 3:4]: but there will be a distance of 2,000 cubits between you and the ark.

This passage parallels the passage of *Y. Eruvin* mentioned above, but the support brought from Joshua proves that the mile was now surely identified with 2,000 cubits.

### D. Targum Jonathan, Exodus 33:7

Moses established his tent outside the camp, at a distance of 2,000 cubits from the border of the camp of Israel, which was beyond communication. The Sabbath limit is now 2,000 cubits, no longer one mile.

### E. Midrash Tanhuma Numeri 2:2

וכן את מוצא ביהושע, כשהלך להחריב את יריחו, ויאמר יהושע לישראל: עתידין אתם לעמוד שם ולעשות את השבת שם. אלא אם תרחיקו מן הארון, לא תרחיקו יותר מאלפים

this difficulty that Rashi, on Genesis Rabbah, writes that anyone who cannot shoot an arrow a distance of 1/2 mile is not a professional archer.



אמא לכל רוח, למה שתהיו רשאים לבא ולהתפלל לפני הארון בשבת: וכן הוא אומר – יהושע ג' ד' – אך רחוק יהיה כיניכם וביניו כאלפים אמא...

And similarly you find with Joshua when he went to destroy Jericho. He said to Israel: In the future you will be there and you will keep there the Sabbath. Therefore, if you move away from the ark, do not move away more than 2,000 cubits. Why? In order that you may come and pray in front of the ark on Sabbath, as it is written in Joshua: But there will remain between you and it a distance of 2,000 cubits.

Here also the Sabbath limit is 2,000 cubits, without any reference to the mile.

There seems to be a formal contradiction between this *midrash* and the *midrash* for Exodus 33:7. In Exodus, it seems that all the people may walk in the camp of 12 miles by 12 miles,<sup>95</sup> but they are not allowed to walk more than 2,000 cubits outside the camp. In Numeri, on the contrary, it seems that even inside the camp, people might not walk to the Tabernacle if it was more than 2,000 cubits from the sites of the surrounding tribes.<sup>96</sup>

#### F. Examination of Two *Piyyutim*<sup>97</sup> of R. Eleazar ha-Kalir<sup>98</sup>

##### 1. *Piyyut* of the Morning Service of the Second Day of *Sukkot*

This begins with: כי אקח מועד (Mahzor Rabbah Sefarad, p. 132); ברוחב שבעים וחמישה (Mahzor Rabbah Sefarad, p. 134). This passage is based on the passage of Sifrei on Deuteronomy mentioned above. Rashi understood it according to the following equations:

$$1 \text{ mile} = 7.5 \text{ ris} = 2,000 \text{ amot} = 333.33 \text{ kane}$$

$$1 \text{ kane} = 6 \text{ amot}$$

$$1 \text{ ris} = 44.44 \text{ kane} = 266.667 \text{ amot}$$

Rashi did not justify the ratio  $1 \text{ kane} = 6 \text{ amot}$ , but this is his position in his commentary on Ezekiel 40:5, where he follows the *Targum Jonathan*; Radak uses the same equation.

95 This is the conclusion of B. Eruvin 55b. See also Rambam, *Hilkhot Shabbat* 27:1.

96 R. David Pardo raises this problem in his commentary on Rashi, Numeri 2:2: *Maskil le David* (Venice, 1760).

97 *Piyyutim* are poetical and liturgical compositions, part of the Ashkenazic rites.

98 The exact period of ha-Kalir is not known. He is known as Rabbi Elazar berabbi Kalir from Kiryat Sefer. He is supposed to have lived in Israel, perhaps Tiberias, at the end of the Byzantine period, in the first half of the seventh century CE, before the Arab period.

## 2. *Piyyut* of the Morning Service of Sabbath *Shekalim*

This begins with: *אז ראית וספרת והכנת והקרת ומדדת... ומדת המיל שבעה ומחצה ריס, כל אמא מודדת שלישי בורת. ובשלשים קנים הוא קצב הריס. ושעור הקנה שש אמות וזרת, כל אמא מודדת שלישי בורת.* Rashi has already observed in B. Yoma 67a that this *piyyut* is in contradiction with the former; it is based on the following equations:

$$\begin{aligned} 1 \text{ mile} &= 7.5 \text{ ris} \\ 1 \text{ ris} &= 30 \text{ kane} \\ 1 \text{ kane} &= 6.333 \text{ amot} \\ 1 \text{ mile} &= 7.5 \times 30 \times 6.333 \text{ amot} = 1,425 \text{ amot} \end{aligned}$$

The origin of the ratio,  $1 \text{ kane} = 6.33 \text{ amot}$ , is not clear. It is probably his interpretation of Ezekiel 40:5 and 41:8. Radak writes the same ratio in his commentary on Jeremiah 31:39, in contradiction to his own commentary on Ezekiel 40:5.

It would be possible to reconcile these two *piyyutim* if we accept certain assumptions. First, in the *piyyut* of *Sukkot*, we must assume that the author of the *baraita*, as well as R. Eleazar ha-Kalir, was aware of the difference between the mile and 2,000 cubits. When he connects 25,000 *kane* with 75 miles, he does not mean that 75 miles are equal to 25,000 *kane*; he actually means that each tribe will receive an *alakhson* of 25,000 *kane*, which is equal to 75 miles. We then have the following equations:

$$\begin{aligned} 1 \text{ mile} &= 7.5 \text{ ris} = 2,828 \text{ amot} = 471.40 \text{ kane} \\ 1 \text{ kane} &= 6 \text{ amot} \\ 1 \text{ ris} &= 377 \text{ amot} = 62.85 \text{ kane} \end{aligned}$$

If we now consider that ha-Kalir, on the one hand, used an approximate value of  $\sqrt{2}$  and equated 1 mile with 2,850 *amot*, and, on the other hand, used the ratio of  $1 \text{ kane} = 6.33 \text{ amot}$  (the ratio  $1 \text{ kane} = 6 \text{ amot}$  is actually from Rashi, but not necessarily from ha-Kalir), we will have the following equations:

$$\begin{aligned} 1 \text{ ris} &= 60 \text{ kane} = 380 \text{ amot} \\ 1 \text{ kane} &= 6.33 \text{ amot} \\ 1 \text{ mile} &= 7.5 \text{ ris} = 2,850 \text{ amot} = 450 \text{ kane} \end{aligned}$$

And what about the *piyyut* of Sabbath *Shekalim*? We must accept that a slight corruption was brought to the text (already before the time of Rashi),<sup>99</sup> and we

<sup>99</sup> This is because Rashi writes the equation  $1 \text{ ris} = 30 \text{ kane}$ . See his commentary to Talmud B. Yoma 67a and to Genesis 14:17.

should suppress the ל and read: ובששים קנים הוא קצב הרים

The equations would then be:

$$1 \text{ ris} = 60 \text{ kane} = 380 \text{ amot}$$

$$1 \text{ kane} = 6.33 \text{ amot}$$

$$1 \text{ mile} = 7.5 \times 60 \times 6.333 \text{ amot} = 2,850 \text{ amot} = 450 \text{ kane}.$$

We now have perfect coherence between the two *piyyutim*. In his commentary on Jeremiah 31:39, Radak writes that  $1 \text{ ris} = 70 \text{ kane}$ . This, at least, is not too far from the ratio:  $1 \text{ ris} = 60 \text{ kane}$ . Thanks to these slight adaptations, we have succeeded in reconciling the two *piyyutim* of ha-Kalir. This strengthens our conviction that the mile mentioned in Deuteronomy Sifrei, and probably also in the passage of Genesis Rabbah cited above, is still the Roman mile, and that R. Eleazar ha-Kalir was aware of the difference between the mile and 2,000 cubits. Our slight adaptation solves all the problems and has the benefit of rendering useless all speculation about an imaginary metrical system proper to ha-Kalir. The confusion between the mile and 2,000 cubits appears as soon as the Roman mile loses its true significance, probably first in Babylonia<sup>100</sup> and later in Palestine. We observe a similar situation in Arab metrology and geodesy.<sup>101</sup> Nevertheless, the Roman mile, which was abandoned with the fall of the Roman Empire, would still influence the evolution of metrology in the major European countries.<sup>102</sup>

100 In the *sheiltot* of Rav Ahai of Shabha (about 680-752) we read, in *sheilta* 53:  
... משדר. אמה, מאלפים אמה, משדר. – The distance of the *tehum* is now 2,000 cubits.

101 The first Arab scholars bound their metrological system to the Roman mile. Their fundamental equations were:  $1 \text{ farsakh} = 4 \text{ Roman miles}$ ;  $1 \text{ Roman mile} = 3,000 \text{ Arabic cubits}$ , and therefore  $1 \text{ Arabic cubit} = 0.493 \text{ meters}$ . This equation is very similar to the rabbinic equation:  $1 \text{ Roman mile} = 2,828 \text{ Jewish cubits}$ . Later we find the following equations:  $1 \text{ farsakh} = 3 \text{ Arabic miles}$ ;  $1 \text{ Arabic mile} = 4,000 \text{ cubits} = 1,972 \text{ m}$ ;  $1 \text{ cubit} = 0.493 \text{ m}$ . In general, once the exact meaning of the Roman mile was forgotten, there was much confusion. Some calculated 56.66 miles per degree in their geodesic measures (Arabic mile of 1,972 m.), others 66.66 miles per degree (Arabic mile of 1,666.66 m.), and others considered 75 miles per degree (Roman mile of 1,481.5 m.). Because of this confusion about the mile, new measures of the dimensions of the earth were undertaken under the Caliph al-Mamun.

102 We find the following data in the old European metrology, before the institution of the metrical system:

In France:

Common league = 4,444 m. = 3 Roman miles

Marine league = 5,555 m. = 3.75 Roman miles = 3 German miles

League of an hour = 4,872 m.: distance walked in one hour.

This value is very close to the talmudic mile in 18 minutes and to our 5 km./h.

In Germany:

## VII. DISCUSSION ABOUT THE VALUE OF 52.4 CM. FOR THE *AMAH*

### **The Cubit and Man's Height**

According to the talmudic literature, there is a fixed ratio between the height of a man and the cubit. In B. Eruvin 48a, it says:

והני ארבע אמות היכא כתיבא? כדתניא "שבו איש תחתיו" כחתיו: גופו שלוש אמות ואמה כדי לפשות ידיו ורגליו דברי רבי מאיר. רבי יהודה אומר גופו שלוש אמות ואמה כדי ליטול חפץ מתחת מרגלותיו ומניח תחת מראשותיו. מאי בינייהו? איכא בינייהו ארבע אמות מצומצמות.

So four cubits represent the minimal space that allows a man to subsist during the Sabbath. When he is immobilized in this little area, three cubits are for his body and an additional cubit allows him to stretch his legs, according to Rabbi Meir. Rabbi Judah says that this additional cubit is intended to give him the possibility of taking something from beneath his legs and placing it under his head. Now, what is the difference between R. Meir and R. Judah? The one<sup>103</sup> considers rigorous cubits (עצבות, מצומצמות) while the other considers generous cubits (שוחרות, מרווחות).

Regardless, we see that the height of a man is considered to be three cubits. There are actually divergent opinions among the *rishonim* as to whether the three cubits represent the total height of the man, or whether this height of three cubits measures the man only up to his shoulders. From the above passage, however, it is clear that the three cubits represent the total height of the man. If they measured him only up to his shoulders, his total height would have been more than four cubits. Indeed, when a man stretches his arms, he adds more than one cubit to the height of the shoulders, because his arm (arm + forearm + hand) represents more than one cubit.<sup>104</sup>

We proceed to examine the heights of men to find a plausible metric equivalent for the cubit.<sup>105</sup> During the last century, an increase in height of about 1.5 cm. per decade has been observed. Scientific observations have been made in France and

Prussian league = 7,407 m. = 5 Roman miles.

German mile = 1,852 m. = 1.25 Roman miles.

103 There are divergent opinions about who held which opinion. Rashi understands that R. Meir speaks of generous cubits and R. Judah of rigorous cubits. On the other hand, Maimonides decides in favor of R. Meir, whom he says takes account of rigorous cubits while R. Judah takes account of generous cubits.

104 Novellae of R. Samuel Strashun, ad loc.

105 I am grateful to Martine Vercauteren, Professor of Anthropology at the faculty of sciences of the University of Brussels, for the information she provided me on this subject.

Belgium for about a hundred years, and men are now around 15 cm. taller than a hundred years ago. This increase in men's average height is related to industrial development and the improvement in standards of living, nutrition, health and hygiene. This increase in height during the last century has resulted primarily from the lengthening of the long bones of the legs. Similarly, the arms are lengthening (not, however, the breadth of the fingers). The proportion between the lengths of these long bones and the total height of the body is thus increasing.

Today, Belgian men have an average height of 1.78 m., whereas, in 1900, it was about 1.63 m. Beyond these variations, there are also regional differences; for example, it is agreed that Mediterranean people are shorter than people from continental Europe.<sup>106</sup> Under these conditions, though it is difficult to be precise, it is very likely that, in the talmudic period,<sup>107</sup> the average height of Jewish men was about 1.6 m.<sup>108</sup> This would be compatible with a cubit of 52.4 cm. and the rule that the average height of men was 3 cubits, especially if we adopt the opinion that these 3 cubits are generous.

#### VII. COMPARISON WITH OTHER PUBLICATIONS DEALING WITH THE SAME SUBJECT

Studies of the talmudic and biblical units of length are still very much in the news, and various papers have been published in recent years aiming to elucidate the subject. However, their approach is fundamentally different from the direct approach

- 106 Newton, in his *Dissertation upon the Sacred Cubit of the Jews* (London, undated), proved this from ancient statues. He noted that Polish Jews were shorter than Englishmen as well as English Jews. His booklet was written in Latin. An English translation was printed with the second edition of the works of John Greaves: *Miscellaneous Works of J. Greaves* (London, 1737). In his dissertation, Newton came up with a length of 52.33 cm. for this "sacred" cubit.
- 107 Our main concern is the height of men (Jews and Romans) in the talmudic period. The examination of statues (the method used by Newton) and of skeletons gives an adequate answer to the question. The more general subject of the evolution of the height of men through history and according to their geography remains a subject insufficiently studied and still debated. A recent article looks into the matter, and shows the fundamental importance of diet during three important periods of life. Indeed, people achieve their stature in three spurts: infancy, between the ages of six and eight, and in adolescence. Burkhard Bilgar, "The Height Gap: Why Europeans Are Getting Taller and Taller and Americans Aren't," *The New Yorker* (4 May 2004).
- 108 There were of course also tall men, as is related in B. Nidah 24b. Abba Saul was the tallest. Jewish people of Russia and Lithuania were particularly short at the end of the 19th century. *Arukh ha-Shulhan*, Y.D. 201:3, notes that the average height of men, apparently Jewish and non-Jewish, is officially 1.60 m. (probably based on an examination of military recruits).

of the present paper, in which we attempt to clarify different talmudic passages quoting distances that can be verified. This method seems direct and reliable, and is not dependent on assumptions. Some of the other articles<sup>109</sup> have tried to approach the problem of the Jewish units of length in an indirect way, by examining archeological remnants of the Temple and the Temple Mount, and comparing them with the measurements given by the *Mishna Midot*. Other articles<sup>110</sup> have attempted to determine the dimensions of the Ark of the Covenant through an evaluation of the weight of the gold used in the construction of the Tabernacle. This method rests, however, on several questionable assumptions; it must, furthermore, be remembered that there is a discussion<sup>111</sup> as to whether the cubits considered in the measurements of the Ark of the Covenant are cubits of 5 handbreadths (Rabbi Judah) or of 6 handbreadths (Rabbi Meir).

#### VIII. CONCLUSIONS

Moses's cubit (אמה מדברית) must have been very close to 52.4 cm. When the early *tannaim*, at the end of the Temple period, decided to adopt the Roman units of length, or more precisely, to bind the Jewish system of units of length to it, they identified the Roman mile with the diagonal of a 2,000 cubit square.<sup>112</sup> This gives us a cubit of 52.4 cm., practically identical with the Royal Egyptian cubit.

This cubit is compatible with two talmudic sayings, that: the average height of men is equal to 3 cubits; and that, in the absence of other information, one may walk 2,000 feet on Sabbath; and also with the results of archeological research on the Temple and the Temple Mount.

It would appear that the talmudic system of units of length, like the systems of other civilizations, was originally based on parts of the human body – but

- 109 1. שתי אמות מידה בהר הבית ובמקדש השני, הרב ר"ר זכריה דוד שב, תחומין ט, תשמ"ח.  
2. למידות הר הבית והמקדש, הרב זלמן קורן. תחומין ט, תשמ"ח.  
3. ואף על פי כן, שתי אמות מידה, הרב ר"ר זכריה דוד שב, תחומין ט, תשמ"ח.  
4. איתור תחומי הר הבית ומקום המקדש, א. גרוסברג, תחומין תשנ"ז.

According to this last article, the cubit which best fits the agreement between the archeological remains and the extant descriptions and measures from *Mishna Midot* and from Josephus is the cubit of 52.5 cm.

- 110 1. התאמת האגודל ליתר אמות המידה, פרופ' אברהם יהודה גרינפילד, תחומין ה' תשנ"ז.  
2. גישה מדעית לקביעת שיעורי תורה, האמה. גרינפילד, בדרך חוב 1, תשנ"ה.  
3. ערכי המידות בזמן מתן תורה, פרופ' אברהם יהודה גרינפילד, תחומין י"ח, תשנ"ח.  
4. מידה כנגד מידה, גרינפילד, מוריה גליון ז, ח, תמוז תשמ"ב.

111 See *Mishna Kelim* 17:10 and B. Baba Batra 14a.

112 In Arabic geodesy, a cubit was used that was the 3,000th part of a Roman mile.

subsequently became independent of the human body. Nevertheless, as the Rabbis observed, the *etzba* of about 2.2 cm. is very close to the breadth of a thumb. This is the reason why many rabbis succeeded in using a cubit very near to the correct *amah*.<sup>113</sup>

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113 Although the *etzba* of about 2.18 cm. and the *amah* of 52.4 cm. are not very popular today, similar values were used in the 19th and first half of the 20th century. For details, see note 7 above.