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Groundstone Indications from the Southern Levant for a 7th Millennium BCE Upright Mat Loom

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The southern Levant features a long-established matting tradition: *soumak* (weft wrapping) and also weft twined matting from the 10th millennium BC, and coiled matting from the 8th millennium BCE. The Chalcolithic period, 5th millennium BCE, attests to the introduction of plain plait, twill, sewn through techniques and also the use of the horizontal ground mat loom. Ellipsoid pebbles with opposed notches (groundstone) have been recovered from several sites from various periods. Such artifacts are generally identified as fish net sinkers.

We offer an alternative interpretation. We argue that the pebbles were used in the manufacture of papyrus (paper reed) or reed matting on an upright mat loom using the warp twining technique. The technique is known ethnographically from Israel to Japan.

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Introduction

When pebbles with opposed notches (waisted pebbles) are found in archaeological sites, they are generally identified as net weight sinkers. Indeed, many probably are, for example, those from the lacustrine sites of Ohalo II (Nadel and Zaidner 2002) and Eynan (Perrot, 1966), or riverine Jordan Dureijat (Marder *et al.,* 2015) and the marine site of Atlit Yam (Galilee *et al.,* 2004). At these sites the identification is consistent with the faunal profile. Rosenberg *et al.* (2016) argue that the notched stones, recovered from the sites of Beisamoun and Sha'ar Hagolan, were used as weights in line fishing, although this is one of the most inefficient fishing techniques which is generally only resorted to when all else fails (Stewart, 1982). Both Beisamoun, located on the western edge of the former Hula Lake and Sha'ar Hagolan on the Yarmuk River, are in locations with the potential for fishing. Fish bones were not recorded from Sha'ar Hagolan despite wet sieving (Hesse, 2002). The evidence from Beisamoun suggests that the fish finds, limited to two species only, were not from archaeological deposits but from the fishponds of the kibbutz which stocked these species (Bocquentin *et al.,* 2014, p.80 and p.86). Waisted pebbles from the Ghassulian Beer Sheva valley sites on the desert fringe are obviously not fish net sinkers. Thus, an alternative interpretation must be sought.

The ethnographic observations of the material culture of the Ainu of Japan brings this issue into focus, with probable archaeological analogies from pottery bearing sites of mainland China and Korea. Although fishing was a major component of Ainu subsistence, they did not use net weight sinkers (Hilger, 1971, p.79; Kent and Nelson, 1976, p.152; Watanabe, 1973, pp.19-31). Nevertheless, pebbles with opposed notches are an element of their cultural repertoire.

The current paper integrates archaeological, ethno-historical and experimental archaeology data.

Archaeological Evidence

Beisamoun a late Pre-Pottery Neolithic B (PPNB) site, 7th millennium BC, has an assemblage of 96 flattish, limestone pebbles with opposed notches. They range from 37-100 mm in length and 20-77 mm in width. They weigh from 20-243 g (Rosenberg *et al.,* 2016, Table 1) (See

Figure 1). Three pebbles feature string impressions in their notches (Rosenberg *et. al.,* 2016, Fig. 18) (See Figure 2).

Sha'ar Hagolan a Yarmukian Pottery Neolithic (PN) site dated to 6400-5900 BC has an assemblage of 36 notched limestone pebbles (See Figure 3). They range from 53-113 mm in length and 33-66 mm in width. They weigh from 30-180 g (Rosenberg *et al.,* 2016, Table 2).

Tel Sheva, a Ghassulian site in the Beer Sheva basin, dated late 5th millennium features an assemblage of 46 notched stones (Fabian and Gilead personal communications), but it is currently inaccessible due to difficulties caused by Covid 19 virus. A single waisted pebble weighing 180 g is representative (See Figure 4).

The Loom and its Components

My reconstruction is based on local ethnographic input when the technique was still a live-tradition. Raw materials within the Levant vary from area to area, dependent upon environmental resources and the economy of the practitioners. I live in the Beer Sheva (Beersheba) valley on the desert fringe. In my reconstruction I used common reed (*Phragmites australis*) which grows everywhere, even in the desert, wherever there is a body of water. The warp string was made from the bark of hairy sparrow-wort (*Thymelaea hirsute*) (discussed below), an indigenous wild bush and the stones were collected in the local *wadi.*

The structure is neither a loom nor a tensioning frame: it is essentially a support. Nevertheless, throughout it will be referred to as a loom. Its form varies from ethnos to ethnos, but the principle of manufacture remains constant (see ethnographic references). The loom on which my mat was made is not representative of the ethnographic examples. It is a 'LEGO' loom (See Figure 5), it was constructed in my house from imported bamboo. The elements feature interlocking, lap joints. It was constructed in this manner and from this lightweight material so that it could be dismantled and placed in my over-sized suitcase and be carried to Germany for demonstration purposes The loom is sophisticated in response to the constraints of the situation, but the principle of mat manufacture was identical to the ethnographic observations.

The loom form varies. It can consist of one or two vertical, embedded or mobile uprights with V-shaped natural crotches at working height level (Larsson, 1936, PL I, Fig. 2). In some situations (Watson, 1979, Pl. 5.9) a sufficiently deep hole in a wall was used in lieu of one of the uprights. In another case the structure consisted of two five-gallon (19.5 litres) cans and a transverse pole and another featured an embedded upright board (Kent and Nelson, 1976, Fig. 1). A flattish pole or plank (the support) is laid in between the two crotches (forks). The length of the horizontal pole determines the maximum width of the future mat. Some practitioners cut grooves into the transverse plank so that the strings will remain in position and the lines of warp twining will be evenly spaced. This will occur when there is a standardization of spacing.

The string was made from the outer bark of *Thymelaea hirsute*. This bush grows in areas where the annual rainfall ranges from 180-300 mm. In drier areas it is found in relatively wet habitats such as wadis and at the foot of smooth-faced limestone outcrops. The bush attains a maximum height of two metres. It is noxious and thus resistant to grazing. Even black goats which eat almost everything avoid it (Danin, 1983, pp.81-82). Long branches were selected to maximize the length of the strips. The outer bark peels off with ease. The bark strips were soaked for a few minutes before twisting into cordage to render it more flexible. I knotted two strips together and tethered the knot under the thumb of my open left hand. The two strips were rolled separately and simultaneously down the left palm with the palm of the right hand until the middle of the fingers. The furthermost strand was lifted up and placed high up on the left palm behind the other strip. The procedure was repeated *ad infinitum* creating s2Z string. (See Figure 6) Earlier, I had made string rolling between the palms but bringing the rearmost strand to cover the foremost strand resulting in s2S string. Periodically I pulled apart the two strands of the string to tighten the twist. The string was very coarse but sufficient for the task. String that I had made six months earlier was still strong and usable. Better string can be made with the inner bark. It is sufficiently fine to be used for sewing buttons (Schmidt and Stavisky, 1983, p.116, citing Salaama abu-Ranen) (See Figure 7). It is preferable to make the string as thin and strong as possible. This has a dual benefit: it will reduce the gaps between the individual reed wefts rendering the mat stronger and also enable the pendant stones to carry a longer length of wound- up string.

I had tried earlier to make string from reeds. It was not successful even with fresh green reeds or when the reed stem was beaten along its length on an anvil. I tried soaking the reeds for 24 hours before twisting into string but that was not successful either. The resultant string had little tensile strength and snapped with ease. The fibres are too rigid for twisting to a degree that is consistent with cordage manufacture (See Figure 8).

I selected limestone pebbles from a wadi near my house. They were flattish, smooth and ellipsoid, about 10 cm in length and of roughly equal weight. I did not create opposed notches in the middle of the long axis as found in local archaeological deposits. I used them in the unmodified mode as observed amongst local practitioners and those of Syria and Kurdistan.

Mat Manufacture – Reconstruction

I used lengths of string about two metres long. They were soaked briefly before use. Within 12 hours they had become very dry and stiff. I then marked the middle of each string. I tied a stone to each end of each length of string. An equal length of string was wound around the short axis of each stone which was then secured with a half hitch. There was about 80 cm between the two stones. I centred the previously marked middle of each length of string on the transverse support of the loom. One half of the string (with its stone) hung to the front and one half of the string (with its stone) to the rear. I placed the first weft reed, on the strings, horizontally along the support. The first and last strings were about 10 cm from the ends of the reed. The remaining weighted strings were arranged along the support about 20 cm apart. This was the correct spacing according to an informant of Crystal's (2019, p.282). The mat would grow from the top (the support) and away from the mat maker. Beginning at the rightmost string, I tossed it over the support and over the first weft reed and to the back of the loom, in a leftward direction. The other half of the string I tossed from the back of the loom, over the support and the first weft reed to the front in a rightward direction thus enclosing the reed. Each pair of strings was manipulated in succession the same manner. The direction, front string to the left and rear string to the right remained constant throughout. Each successive reed is pushed away from the mat maker and moves to the back of the loom. The mat grows in a pile on the ground to the rear of the loom. There is no wind-up arrangement. The mat is finished with simply knotting together each pair of rear and front warp strings.

The product is a very hard, weak mat: definitely not for sitting or lying on. In an archaeological situation similar mats may have been used as structural elements e.g., anchored to embedded uprights as an internal division within a dwelling. It would have been more time and energy efficient than mud brick or field stone walling. Its strength and coherence could have been improved with the addition of mud plaster. Amongst the Ainu some of the mats manufactured in this technique are used within dwellings for partitioning internal spaces (Hilger, 1971, p.79)

Ethnographic Input

In the southern Levant the primary source of information regarding this loom type and the use of the mats is from the area of the Hula Basin, a former lake and malarial swamp, about 30 kms north of the Lake of Galilee. The area was drained between the years 1951-58 creating 60 km2 of new arable land (Karmon, 1960, pp.177-179). Although the drainage eliminated the malaria it generated, over the years, major ecological problems. A wetlands rehabilitation program was initiated in 1994 and a small area of the former environment restored (Hambright and Zohary, 1998). The former inhabitants of the Hula Basin fled in 1948 during the Israel War of Independence. Most relocated to Lebanon and Syria and some to towns and villages in the lower Galilee and others to the Tel Aviv environs (Khawalde and Rabinowitz, 2002, p.299). A local, craft researcher, Crystal (2019), tracked down the last of the elderly former inhabitants. They no longer made mats, but they remembered the manufacturing sequence from their youth. Some demonstrated the technique, often substituting alternative commercial products for those which had been formerly made by hand, others too old and too weak, explained verbally how and with what the mats were made.

Literary sources attest to dense settlement in the Hula Basin in Crusader times. In 1260 CE the Baybars ruler constructed an all-weather bridge across the Jordan River – Gesher Benot Yaakov – connecting Palestine with Syria. The arches of the bridge narrowed the bed of the river causing the Hula Lake to rise higher in winter and the swamp to expand to the north and cover the whole valley. The valley remained uninhabited for 500 years (Karmon, 1953, pp.5-8).

In the 1830s Palestine was conquered by the Egyptian Ibrahim Pasha and the Hula was once again resettled. The malarial swamp was not settled by upland Palestinian villagers but by Egyptian slaves, serfs, deserters, local social outcasts fleeing their villages and even Algerian refugees. Only those with no alternative options settled in the swamp (Karmon, 1953, p.5, p.9 and 11). The multiple origins of the settlers are reflected in the technologies reported by Crystal (2019) versus Larsson (1936).

The inhabitants of the Hula used papyrus (paper reed) for both types of mats they manufactured: a) mats woven on the upright tubular loom made in some villages only and sold to consumers external to the swamp (Crowfoot, 1934), b) for the mats manufactured in the warp twining technique on the loom with pendant stones used for the construction of their huts. The second category of mats was manufactured for self-consumption only (Larsson, 1936; Crystal, 2019). Papyrus was used for the manufacture of the string and also for the rigid weft. In times or places when papyrus was not available rushes were used instead although recognized as not being as strong as papyrus. There was a recognized division of labour in the manufacture of the mats: males harvested and split the papyrus stalks and the females twisted the warp string and made the mats. The males waded deep into the swamp and harvested the papyrus. It was cut at either water level or just below, the flowering head was lopped off and the butt trimmed. The stalks were collected and bound up into sizeable bundles. These were of a size that they could be turned into rafts (See Figure 9). The harvester stood on his bundle and navigated with a pole to the bank. There the papyrus was again re-divided into manageable bundles and transported on the backs of women to their villages. The papyrus was in excess of 6ft (183 cm) and towered above the heads of the barefoot women. A tumpline worn across the forehead and supported the load (See Figure 10) (Crystal, 2019, pp.276-277).

The papyrus was left out to dry for four days (Larsson, 1936, p.227) or for two or three weeks (Crystal, 2019, p.280). Cordage was manufactured in this manner: two short, stout pieces of giant reed stalk (*Arundo donax*) without their outer layer were bound together at the top and the bottom. It was held in the left hand supported again the calf of the left leg of a seated woman. The papyrus stalk was introduced with the right hand into the gap between the two stalks and slowly pulled through. The pressure exerted caused the stalk to break down into many long, thin strips. The string-maker sat on the ground and twisted the strands between the palms of her hands into two-ply string. Tension was provided by wrapping the twisted cordage around her big toe (Crowfoot, 1934, Fig. 2; Crystal, 2019, p.263) (See Figure 11).

Larsson (1936, p.227) states that the papyrus stalk was cut into fine, thin strips by the men and then twisted into cordage by the women. Larsson witnessed mat manufacture at the village of Salhieh. Crystal's (2019) input is from several villages. The directionality of the cordage is not stated. Even when examining the photos with a magnifying glass it is impossible to ascertain the direction. It undoubtedly varied from village to village dependent on the origin of the inhabitants.

The papyrus for the weft for both loom types was prepared in this manner: Two men sat on the ground one opposite the other at a distance the length of the papyrus stalks. One held firmly to one end of the stalk and the other pierced with either a knife or awl the centre of the other end of the stalk. He slowly pulled the two halves apart splitting the stalk into two. (Crystal, 2019, p.278). In contrast Larsson (1936, p.227) states that whole papyrus stalks were used for the manufacture of mats worked in the warp twining technique but split papyrus stalks were used for the mats worked on the tubular loom.

Larsson (1936, Pl. 1, Fig. 2) witnessed the manufacture of a warp twined mat on a loom with pendant stones at Salhieh. It is not known if this is at the same village where Crowfoot (1934) witnessed the manufacture of a woven mat on a tubular loom two years earlier. The mat was made inside a hut and there was insufficient light for a photograph of the loom, in lieu of which he made a pen drawing (Larsson, 1936, Pl. 1, Fig. 2). The loom used in its manufacture was free standing. It was made of six pieces of poplar wood, black and shiny from intensive use. The loom was assembled in this mode: two pairs of pieces of timber of equal length and thickness were lashed together at angle of approximately 600. They formed a pair of diagonal, triangular struts and constituted the two ends of the looms. The distance between the standing, triangular struts was the intended width of the mat. Two transverse poles were lashed to the front legs of the triangular struts. The upper pole was located approximately one quarter of the way down from the top of the diagonal and the lower pole one quarter of the way up from the bottom of the diagonal. Strings with attached stones were hung over the uppermost pole. The manufacture of the warp twined mat took place only within the huts whereas the tubular looms, not free standing, used in the manufacture of woven mats for sale, as seen by Crowfoot (1934) were built outside and supported by the external walls of the huts. Neither Crystal nor Larsson mention if the stones were artificially notched or if they were intentionally stored for later use.

The overwhelming majority of the dwellings of the Hula Basin were constructed from warp-twined mats over a structure of poplar saplings. The mats ranged from 3.5-5m in length and 2 m in width. There were two categories of mats: roof mats and wall mats. Both feature an organized finish along the left edge while the right edge was simply trimmed with a knife. Pairs of roof mats were sewn together along the length of the finished edge. The tunnel-like huts were constructed in this wise: two parallel rows of poplar sapling approximately one metre apart were embedded in the ground. The distance between the rows constituted the width of the huts. The tops of each sapling were lashed to their opposite member. Brushwood was lashed horizontally between the poplar ribs. The sewn seams of the roof mats were centred along the apex of the roof and the trimmed edges hung down on either side. The wall mats were placed with the finished edge uppermost overhung by the trimmed edges of the roof mats (Crystal, 2019, pp.272-273, p.274). The roof was covered with a layer of four or five mats and in winter that was increased to sometimes ten. It should be recalled that there are gaps between the weft rows and the area receives 400-600 mm rain per annum (Karmon, 1953, p.5). The mats used on the roof lasted for approximately three years (Crystal, 2019, p.271). The walls in summer were thinned down to a single layer and in winter increased to four or five layers (Larsson, 1936, p.228).

Bedouins of northern Israel also use the warp twined mat as an auxiliary wall to their tents of goat hair awning. They used 2-ply yarn of blended goat hair and sheep wool for the warp strings (Crystal, 2019, p.259). During the summer months the inner walls of goat hair awning are rolled up and tied leaving a single wall of matting. The mats with gaps between the rigid wefts are sufficiently dense to ensure privacy but at the same time permit the passage of air (Crystal, 2019, p.266).

Ethnographic Input External to the Southern Levant

Sweet (1974) conducted an anthropological study between the years 1950-1955 in the village of Tell Toqaan in northwest Syria. Bedouins sometimes passed through the village with their herds, stopping for a few days, on the way to their summer pastures. Her detailed study was of the permanent inhabitants and not of the transients. Thus, the ethnographic data regarding the Bedouin is limited. Nevertheless, she records an incident which is relevant to this study. A young Bedouin woman, staying in the village for a few days was commissioned by the chief landowner to make a warp twined mat as a divider for one of the tents in anticipation of a group of Bedouin who were to arrive. She used 2-ply woollen for the warp and reeds measuring ca. 5ft (1.5 m) for the weft. The stones, seven pairs of oblate stones, were collected from the wadi in the evening before she intended to manufacture the mat. They were not modified.

The loom consisted of two, solid rectangle, five-gallon tin cans. When used they were presumably filled with water to stabilize them. They were set on the ground and a pole, measuring 10 ft x 3 in. (3 m x 7.5 cm) was placed between them. These tin cans are pretty standard throughout the world measuring 34 cm x 24 cm x 24 cm. On the top of the cans and under the ends of the pole were placed rags to prevent it from slipping during the manufacturing process. On this minimal loom the mat was successfully made. Similar simple mats and higher quality mats were sold in the Bedouin market at Beirut during the same period (Sweet, 1974, p.135). The higher quality mats were worked in brightly coloured yarns and patterned and were used for Bedouin weddings. Sweet notes that it took four days to spin and ply the yarn but only one day to make the mat. Making yarn or cordage is labour intensive. Throughout prehistory and until late in the Industrial revolution yarn-string manufacture has been the bottleneck in all fabric production (Levy, 2020, p.182).

To emphasize the dichotomy in yarn-string production and fabric manufacture I mention the case of the Hula mat makers. Those who had been relocated to villages in the Lower Galilee continued to make mats for a few years. They adapted to the new environmental-economic realities by using identical or alternative raw materials transported from a distance. However, they dropped almost immediately the use of hand-produced, time-consuming cordage for commercial, imported string of sisal (*Agave sp*) (Crystal, 2019, p.259).

In Iran the same technique and loom type using young, lightweight reeds was attested in small-scale commercial projects in the manufacture of blinds for windows and doorways. They were manufactured in small workshops by males only. The loom again is minimal: a horizontal bar supported by two vertical posts with fist-sized stones for warp carriers and to provide tension (Wulff, 1966, p.221, Fig. 309).

Watson's (1979) ethno-archaeological study in western Iran focuses primarily on two permanent villages of Kurdish share croppers, practicing plough agriculture and raising small cattle. She also documents at Qala Kharawa a pastoral group which within the last generation had been forced, by the landowner of the pastures they used, to conduct some agriculture in addition to their traditional lifestyle of altitude transhumance. She documents the manufacture of a patterned warp-twined mat, measuring 1.5 m in width, using a single massive upright, a tree trunk, probably washed downstream in the winter torrents, and a hole in a mud brick wall (See Figure 12). The warp strings were of 2-ply goat hair yarn and the weft of reeds was periodically interspersed with contrasting slim, willow branches. The stones, limestone, had not been artificially modified, but she observes they were battered. Battering could not have occurred during mat production, but wadi stones will certainly become battered in their passage downstream in the violent winter torrents. These mats were used as tent dividers in their upland summer encampments.

The Nanays, hunters and fishers of eastern Siberia practiced seasonal migration in the wake of their prey resulting in two discrete settlement types. In summer they targeted the Siberian stag and inhabited spherical huts. The huts feature a sub-structure of thin branches. The walls were covered with warp-twined, reed matting and the roofs with strips of birch bark (See Figure 13). The warp-twined reed matting is made on a variant of the looms described above. The loom cannot be more than 30-40 cm high. It features an upright board, behind which are two slim uprights and a transverse bar. The warp strings and stones hang over the board (Ivanov *et al.,* 1964, p.705) (See Figure 14). The mat is worked by two women seated on the ground in contrast to western Iran and the Hula valley where the mat is worked in a standing position. The function of the upright board is not apparent. The only information is from a small pen drawing. The loom of the Ainu of Japan is somewhat similar. Again, it cannot be more than 40 cm high. It features two pairs of short, thick, intersecting struts that are lashed together with a transverse bar held in the crosses. The warp string is of twisted lime/linden bast and the weft of the leaves of bulrushes *(Typha latifolia*). The pendant stones feature opposed notches on the short axis, specifically created for the loom work. The loom is worked by a single woman, seated on the ground (Kent and Nelson, 1976, p.152, Fig. 1) (See Figure 15). The raw material is sufficiently soft that such a mat could be used as for sitting or sleeping.

Discussion

In archaeological sites one finds pebbles with opposed notches and it is speculated that they were weights used in the manufacture of mats in the warp-twining technique. However, apart from the Ainu, the expected ethnographic correlation is lacking. Why? This issue will be addresses case by case. The inhabitants of the Hula inhabited a malarial swamp. The average occurrence of malaria was 60-80% and the rate for children under 10 was 60-100%. Child mortality in the village of Mallaha between the years 1930-1940 was 100%. No child survived beyond two years of age (Karmon, 1953, p.23). Practically all of the inhabitants were sharecroppers of absentee landlords living in Syria and Lebanon – the payment for land rental was two thirds to three quarters of the crop yield (Khawalde and Rabinowitz, 2002, p.227). Reoccurring bouts of debilitating malaria coupled with malnutrition led to apathy. The Hula was the poorest and most backward area of Mandatory Palestine (Karmon, 1953, p.18). The gradual increase in population is attributed to an increase in refugees of all kinds. Natural increase played almost no part in population growth. Karmon (1953, p.24) sums up the physical and mental condition of the population: sick people lacking in force and will. Under these conditions the primary aim was simply survival. Any action in excess of the minimum required for the task was an unnecessary expenditure of energy. This would appear to be the reason for a lack of a second selvedge on the mats and the reference to the stones as simply of the dimension of a fist and no reference whatsoever to either storage of optimal stones for future usage or notching them to increase their functional performance.

The documented occurrence of the manufacture of a warp-twined mat at Tell Toqaan was commissioned. It was a onetime event. The mat maker did not anticipate reuse of the stones. There was no reason to invest time and energy beyond the minimum to successfully complete the task.

The Kurdish population from Qala Kharawa, Iran, were a pastoral population practicing transhumance, which within the last generation was affecting a partial transition to agriculture. The pebbles for their looms were not notched. They had still to acquire the values of sedentary populations: investment in material culture, specific tools for specific tasks and planned reuse of artifacts. In contrast the sedentary Ainu did notch their pebbles and their looms were organized, structured for anticipated repeated use as opposed to the *ad hoc* loom of the population at Qala Kharawa. Such behaviour of investment in tools characterizes healthy, sedentary populations (Testart, 1982, pp.523-524).

The Hula Basin populations, all practicing a similar lifestyle, attest to varying degrees of skill in the use of the same raw materials. As stated earlier, their origins vary. I propose that the greater degree of sophistication, e.g. crushing the papyrus stalk into long thin shreds, might be attributed to their long-term acquaintance with the attributes of papyrus. Inhabitants originating in the Nile Valley would have had the accumulated knowledge and experience of thousands of years of handling papyrus (Teeter, 1987, Pls.:V.4, VIII 1, 2, IX). In contrast, an upland family of Palestinian social refugees or Algerian political refugees would have lacked such familiarity.

Worthy of note in this discussion on warp twining are the findings from the Middle Pre-Pottery Neolithic (8th millennium BCE) site of Tell Halula in the northern Levant. The site features on-site pit burials in courtyards with evidence for linen fabrics in the twining technique. There were no selvedges. Alfaro-Giner (2012) conducted a reconstruction and arrived at the conclusion that the fabrics were manufactured in the warp twining technique. This was based on the difficulty she experienced in achieving a reconstruction in the weft twining mode versus the ease with which to achieve the same results with warp twining. I also proposed the presence of warp twining at Sha'ar Hagolan (Levy, 2020, pp.83-84, Fig. 5.9). The proposition was based on a figurine wearing a narrow stole with faint parallel fringe-like incisions on the short axis which suggests warp twining, but the evidence is not conclusive.

Conclusions

Twining is one of the oldest binding techniques attested in Eurasia and specifically in the Levant (Schick 2010, p.245). Impressions of twining on fired clay were recovered from the Eastern Gravettian sites of Pavlov and Dolní Věstonice dated ca. 26,000 BP (Soffer *et al.,* 2000, p.513). In the southern Levant a bitumen coated twined basketry fragment was recovered from the Pre-Pottery Neolithic A (9700-8500 BC) site of Gilgal 1 in the Jordan Valley (Schick, 2010, p.245). Most twining, when there is evidence of a selvedge, is weft twining; warp twining is rare. Despite the large fabric assemblages of the southern Levant, warp twining has yet to be confirmed. This discussion of the archaeological findings coupled with the ethnographic survey suggests a degree of mechanization not discussed earlier. The wide geographic dispersion of the warp twining technique and associated tool production with its primal technology probably suggests considerable antiquity. The potential for circumstantial evidence for weft twining in archaeological contexts in the southern Levant is greater than previously thought: artificially notched pebbles and selected waisted pebbles. Henceforth notched pebbles in groundstone assemblages can be included in the fabric (*sensu lato*) tool repertoire. Greater attention must be paid not only to notched pebbles of dimensions similar to those of net weight sinkers, but also to very small notched or even perforated lightweight pebbles suitable for fabric manufacture.

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Gallery Image

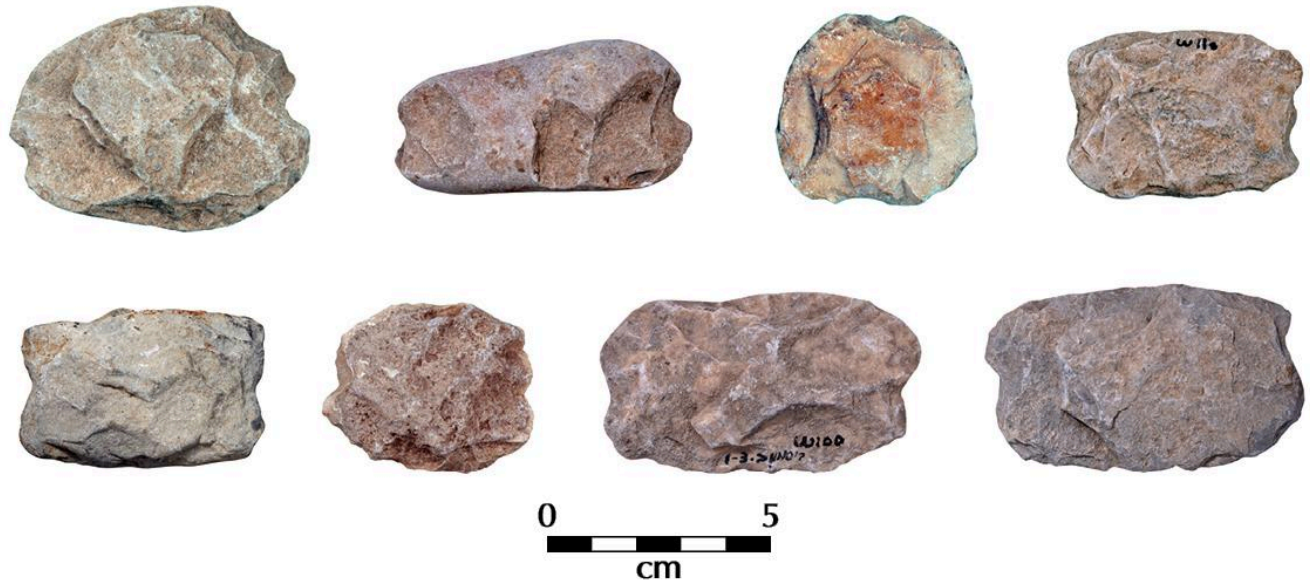

FIG 1. NOTCHED PEBBLES, BEISAMOUN, FROM ROSENBERG ET AL. 2016, FIG. 4.

FIG 2. NOTCHED PEBBLES WITH IMPRESSIONS OF CORDAGE, BEISAMOUN, FROM ROSENBERG ET AL. 2016, FIG.18.

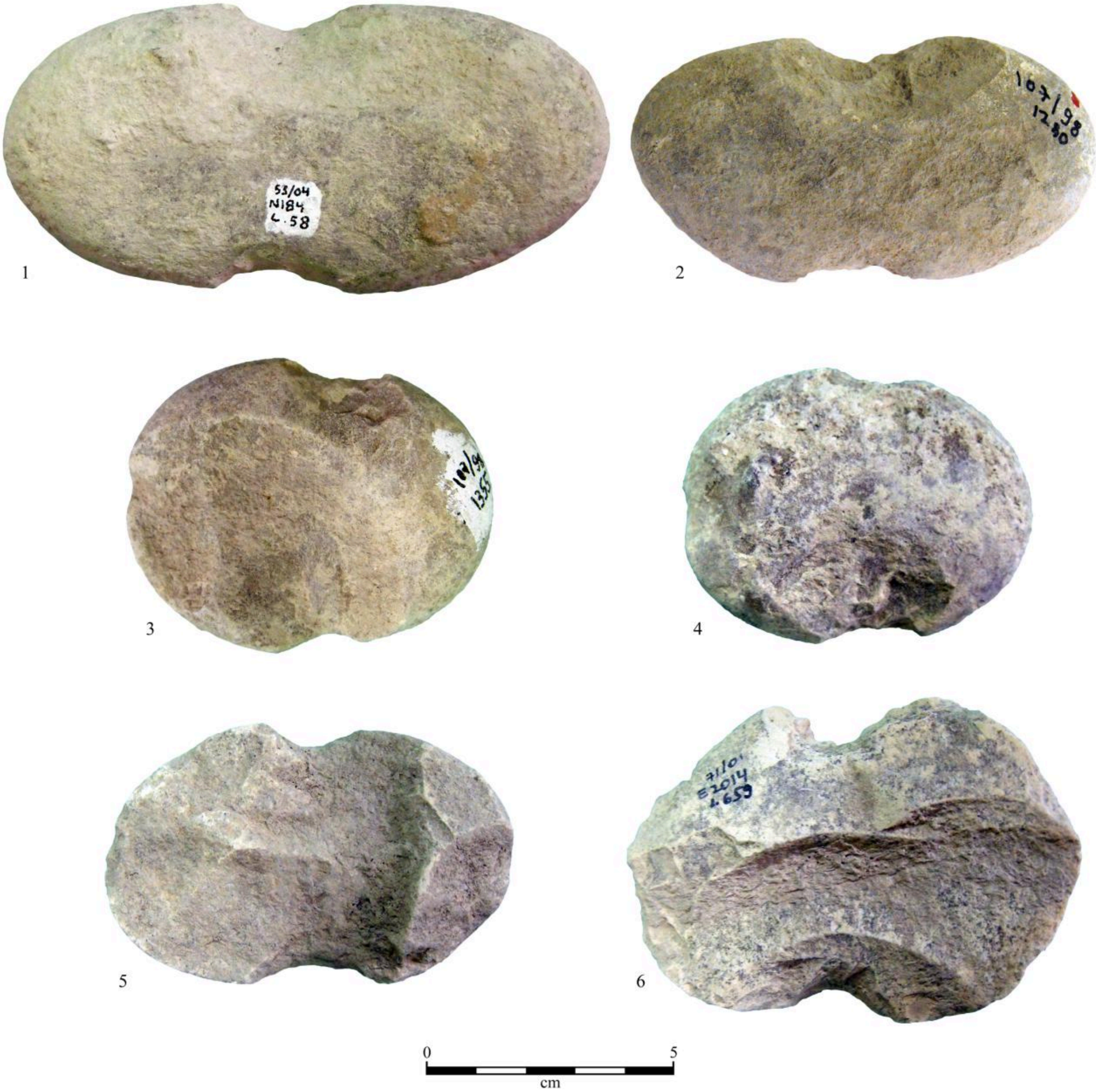

FIG 3. NOTCHED PEBBLES, SHA'AR HAGOLAN, FROM ROSENBERG ET AL. 2016, FIG. 20.

FIG 4. WAISTED PEBBLE, BEER SHEVA VALLEY, TEL SHEVA. PHOTO BY EVGENY OSTROVSKIY.

FIG 5. RECONSTRUCTION OF LOOM FOR WARP TWINED MATS. PHOTO BY DAVIDA EISENBERG-DEGEN.

FIG 6. CORDAGE FROM THYMELAEA HIRSUTE. PHOTO BY EVGENY OSTROVSKIY.


FIG 7. INNER BARK THYMELAEA HIRSUTE. PHOTO BY DAVIDA EISENBERG-DEGEN.

FIG 8. REED CORDAGE. PHOTO BY DAPHNA POLLAK.

FIG 9. HARVESTING PAPYRUS, HULA LAKE AFTER CRYSTAL 2019: 276. DRAWING BY DAPHNA POLLAK.

FIG 10. WOMEN CARRYING PAPYRUS, HULA BASIN, FROM CRYSTAL 2019: 277.

FIG 11. TWISTING PAPYRUS CORDAGE, HULA BASIN AFTER CROWFOOT 1934, FIG. 2. DRAWING BY DAPHNA POLLAK.

FIG 12. MANUFACTURING A WARP-TWINED MAT, QALA KHARAWA, IRAN, FROM WATSON 1979, PL. 5.9.

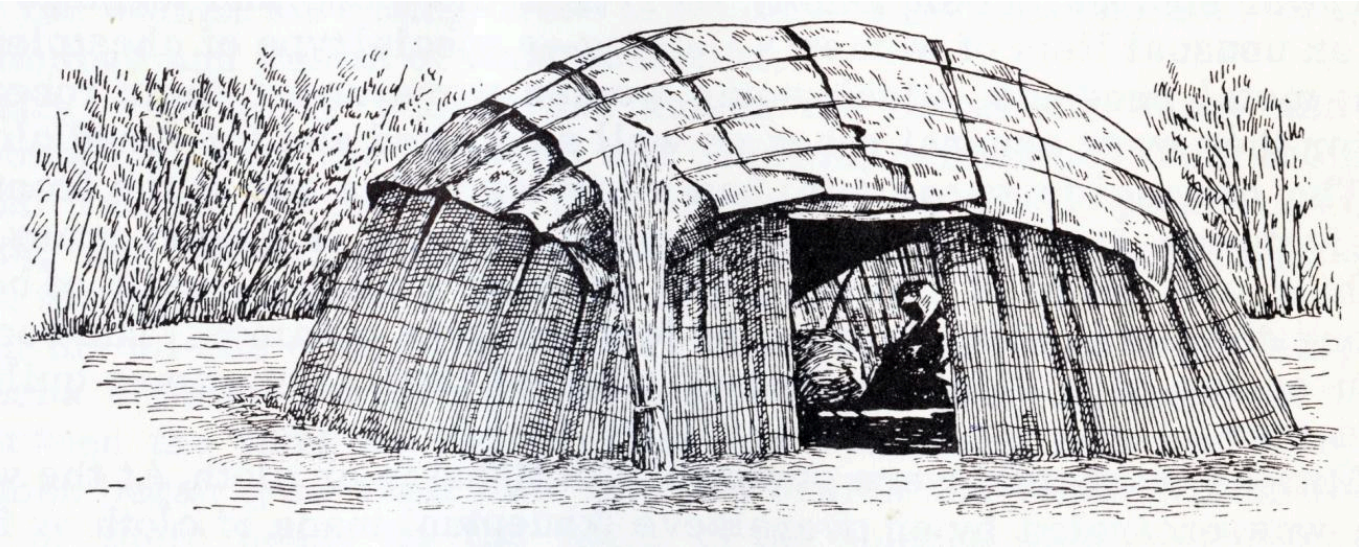

FIG 13. NANAYS, EASTERN SIBERIA, SUMMER DWELLING, FROM IVANOV ET AL. 1964 P. 705.

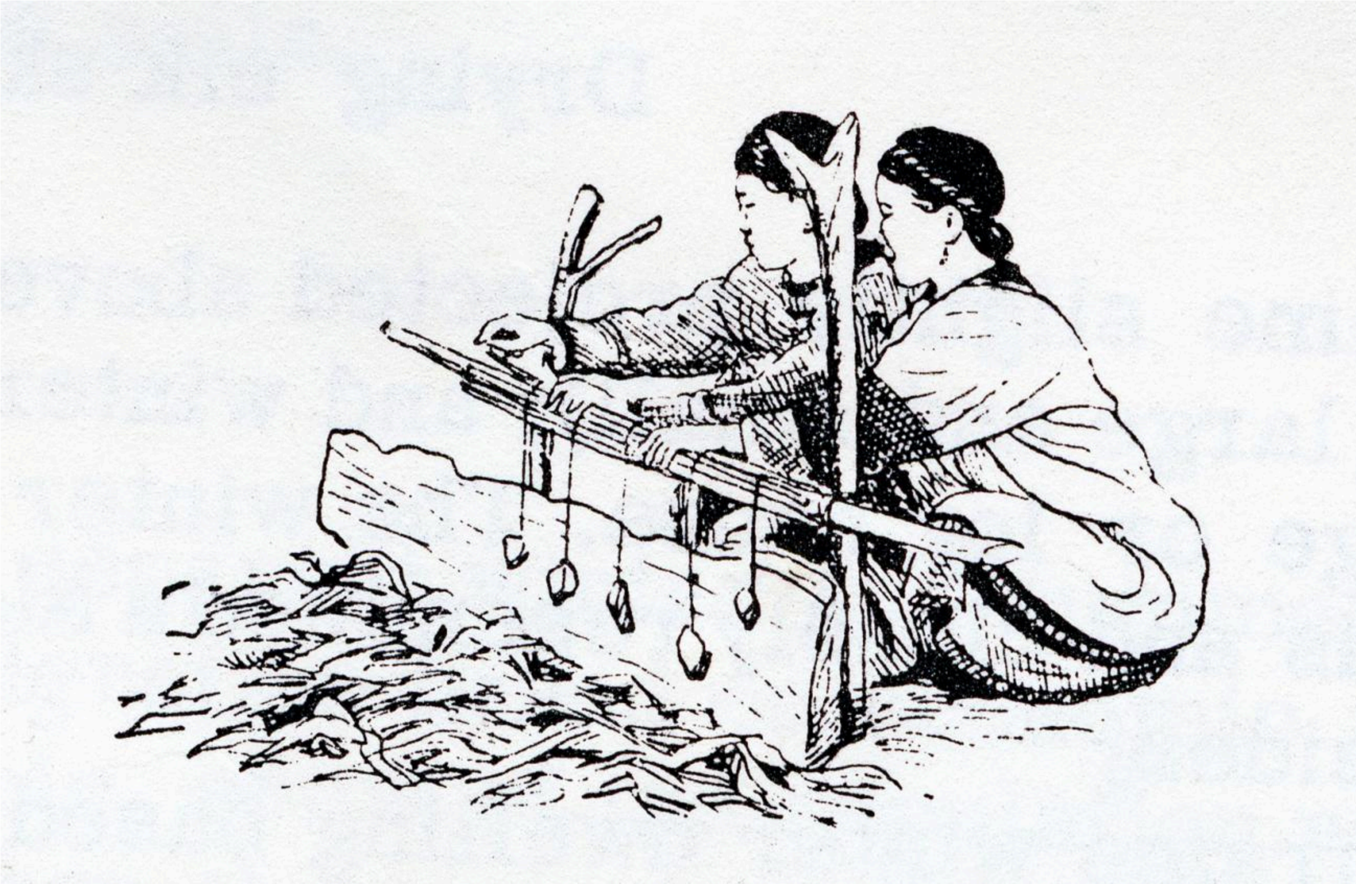

FIG 14. NANAYS, EASTERN SIBERIA, SUMMER DWELLING, FROM IVANOV ET AL. 1964 P. 705.

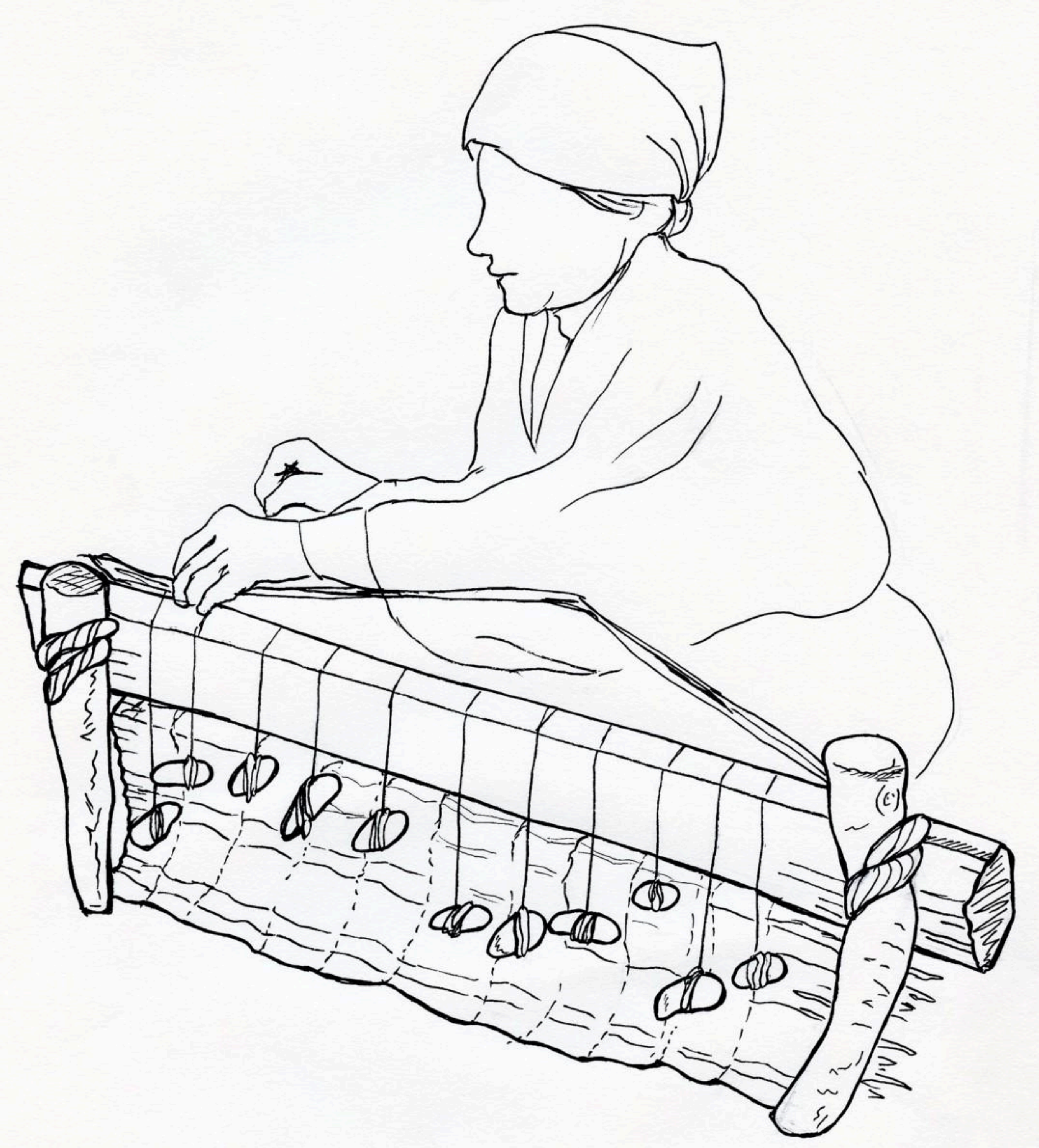

FIG 15. AINU, LOOM FOR WARP-TWINED MAT AFTER HILGER 1971: 65. DRAWING BY MICHAL MOTOLA