THE UPRIGHT SCREW-OPERATED PILLAR PRESS IN ISRAEL*

The oil press common in the 1st century C.E., all over the Roman Empire, was the beam-press. Its name derives from the long and heavy beam, which bore, together with attached stone weights, upon the cakes of previously crushed olives to extract their oil.[1]

In spite of their considerable weight and that of the attached weights, the press of the pressbeam (*prelum*) alone was not considered sufficient, and it was being pulled down by a system of ropes wound around a lever-operated drum or winch.

The great drawback of these installations was their bulkiness. Thus, with the ever-increasing demand for oil and its by-products, space and time-saving mechanisms for their production were sorely needed.

An important step in this direction was the introduction of the large vertical screw that passes through the horizontal pressbeam and

* This article, which bears upon the relationship between the Roman roads in Israel and oil presses was made possible to a large extent through the generous assistance of the Fritz Thyssen Stiftung of Köln, Germany. The author takes this opportunity to express his sincerest gratitude.

The following works are cited by name of author: E. Besnier, s.v. olea oleum, Dar.-Sag. IV, 1, pp. 162–72; G. Dalman, *Arbeit und Sitte in Palästina* (Gütersloh 1935) IV; H. Drachmann, *Ancient Oil Mills and Presses* (Copenhagen 1932). R.J. Forbes, *Studies in Ancient Technology* III (Leyden 1965). Hörle, s.v. torcular, *RE* IV A 2 (1901) 1727–48. S. Krauss, *Talmudische Archaeologie* (Leipzig 1911) II. A.S. Pease, s.v. oleum, *RE* XVII 2 (1937) 2454–74. K.D. White, *Farm Equipment of the Roman World* (Cambridge 1975). Z. Yeivin, "Two Ancient Oil Presses," *Atiqot* 3 (1965/6) 52–64 (Hebrew).

[1] On olive oil production in antiquity: Hörle; cf. Pease; R.J. Forbes 104–155. K.D. White, *Roman Farming* (London 1970) 225–7; White *Farm Equipment* 225–233. The basic monograph on oil presses: H. Drachmann, with bibliography. the basic research into Jewish oil production in antiquity: s. Kraus 214 ff. The comprehensive comparative study between ancient and 20th century arab agriculture in Israel: G. Dalman 201 ff. Cf. Avitsur, *Man and his Work, Historical Atlas of Tools and Workshops in the Holy Land,* (Jerusalem 1976) 87–93 (Hebrew). The main classical sources: Cato, *De Agricultura* 10–19; Heron, *Mechanica* 3.13–21, ed. Nix a Schmidt, (Leipzig Teubner 1950); Plinius, *Historia Naturalis* 18.315–17. Cf. Plin. 15.1–6.

permitted the efficient and manpower-saving screwing-down of the beam by means of horizontal handlebars in the screw. Pliny sums up this development in the following, well-known, passage:

"*Antiqui funibus vittisque loreis detrahebant et vectibus. Intra C annos inventa Graecanica, mali rugis per cocleam ambulantibus ab aliis ad fixa arbori stella, aliis arcas lapidum adtollente secum arbore, quod maxime probatur.*"[2]

I translate with Rackham:

"In old days, people used to drag down the pressbeams with ropes and leather straps, and by means of levers. But within the last hundred years, the Greek pattern of press has been invented, with the grooves of the upright beam running spirally, some makers fitting the tree with a star, but with others the tree raises with it boxes of stones, an arrangement which is very highly approved."[3]

The "*inventa graecanica*" did not solve the problem of the long beam. The application of the screw did however point to the next step: the invention of the true vertical screw-press, in which an upright screw activates a pressblock that bears upon the pressboards above the olives.[4] This press has ever since served in manifold purposes practically up to the present day, such as the printer's and the bookbinder's hand — press, to quote only two examples.

Pliny mentions this development in the continuation of the above quoted passage:

"*Intra XXII hos annos inventum parvis prelis et minore torculario edificio, braeviore male in media derecto, tympana imposita vinaceis superne toto pondere urgere et super prela construre congeriem*" (*HN* 18.317). (Within the last twenty years a plan has been invented to use

[2] Plin. *HN* 18.317.

[3] H. Rackham, Pliny — Natural History, Loeb Classical Library ed. V, pp. 387–9. Compare Rackham's translation with Hörle, ibid; Forbes 140–1; Drachmann 54. As far as divergencies are of consequence they will be dealt with in the text.

[4] The vertical screwpress was described for the first time, to the best of our knowledge, by Heron in the 1st century (?) BCE. His ideas were used inter alia in the construction of the garment press, as represented on a fresco from Pompeii, Dar. Sag., IV, 1, fig. 5796, mentioned in the Mishna, Shabbath 20,5; by Seneca *Tranq.* 1.4; by Martial 2.46.6, and as excavated in Herculaneum, A. Maiuri, *Ercolano* (Novara 1932) 58. Cf. Heron (above n.1). Drachmann 63 ff.

small presses and a smaller pressing shed with a shorter upright beam running straight down into the middle, and to press down the drums placed on top of the grape skins with the whole weight and to pile a heap of stones above the presses).[5]

We would like to draw attention to the fact that Pliny speaks of all these presses as wine presses. Archaeological survey, as well as the continuation of use, has however made it quite clear that the same types of press served also for the production of olive oil all around the Mediterranean. While the wine press never superseeded the common practice of treading the wine, both for home-use and on a large scale, there just was no other way of effectively extracting the olive oil than by some kind of pressing.

Ancient and modern examples for the beampresses of both varieties abound all over the Roman world, as well as in the *provincia* Iudaea (since about 135 C.E. Syria Palaestinae).

Ancient examples of the upright, vertical screwpress are much more scarce. As a matter of fact, so far they have been reconstructed from their bases only, which served both as press floor and as substructure to receive in appropriate sockets the two upright wooden beams, that carried between them the also wooden press apparatus. Presses of that type have survived in rural establishments in various countries up to the 20th century.[6]

The all-wooden press was indeed a "*parvum prelum*" that could be accomodated in a "*parvum aedificium*". However it is doubtful whether the average wooden ***torcularium*** of this kind was able to withstand the extra thrust and pressure needed for the pressing of large quantities of olives at one and the same time over a lengthy period.[7]

[5] Rackham (above n. 3). Cf. n. 30.

[6] Reconstructions of the upright vertical screwpress, apud Drachmann White 231–2, etc. Dalman 226–7. Dalman alone reconstructed a stone pillar press, but based the pillars erroneously upon the base slabs of the wooden presses. See infra p. 8 and n. 26.

Excavation of a *torcularium* (press house) containing a wooden frame vertical screw press (with only base preserved in situ): Z. Yeivin. Survival of upright, vertical screw presses in Israel, infra p. 12.

[7] With the increasing demand for olive oil (Rostovtzeff, *Social and Economic History of the Roman Empire*[2] (Oxford 1957) 158–9, 165, 227, 486, etc. Forbes 102–6) both for nutrition and sundry other purposes (infra p. 16–17) the need for time and space saving

Clearly, for an oil press of this type a more robust machinery is indicated and must have developed already in antiquity.

The first scholar to investigate oil presses in Israel comprehensively, was Dalman, who, following the observations of Clermont-Ganneau and Schick, acclaimed a pair of large, elongated orthostate pillars as the upright *arbores* of an oil press. Taking these and further examples from Kafr Rut and from Khirbet Madfana, near the Ladder of Tyre, as basis, he proposed to see definitely in these installations oil presses, and gives in his *Arbeit und Sitte in Palästina* a model of the reconstruction of a complete press, of which more in the following pages.[8]

The writer of the present article has been able to survey three largely identical pillar presses, which serve as basis for this article:

1. The press at Deir Abu Qabus — M.R. 1327 1511 (fig. 1)*

Site: A summit, 130 m above present-day Eshtaol, which has been built on the ruins of the Arab village of Ishwa. Rock cuttings, retaining walls and foundations of sundry buildings prove that the hill was intensively cultivated and that farm building existed nearby. Ceramical evidence and vestiges of walls in Eshtaol-Ishwa prove that it was densely populated in Romman-Byzantine times, and that the remains at Qabus are contemporary with them. At the south-west corner of the summit and in the midst of a hillock covering the ruins of a building — stands the press.

devices in the oil production industry must have been sorely felt. This is implied in Pliny (loc. cit. n. 2). The bulkiness of the beam presses is apparent from Cato, *Agr.* 18, who demands for the *prelum* (beam) 25 feet, and again from Pliny, who explicitly states "*longitudo in his refert non crassitudo*", which of course is correct for this and any other lever, according to the equation that the energy needed to move the weight is in a reverse ratio to the length of the lever arm. A transitional step to make the most of the space necessary for beampresses was the multiplication of the beams and the collecting vats: "*vasis quinis prela temperate V*" Cato *Agr.* 12) or: "Two beams that service two vats" or vice versa (Tosefta, Terumot 3.7 Zuckermandel p. 29,9).

[8] Dalman 226–9. C. Schick, "The Ruins of Jubeiah," *PEQ* 28 (1893) 201–3. M. Clermont-Ganneau, *Researches in Palestine* (London 1896) II, 82–3. As a matter of fact, a few upright screw operated stone pillar presses have been known and identified as such, but little attention was paid to them or to their reconstruction. Cf. Erzh. Leopold Salvator, *Paxos und Antipaxos* (Wien 1889) cit. apud Hörle 1739.

* Mapreferences are to the sheets of the survey of Israel map 1:100.000.

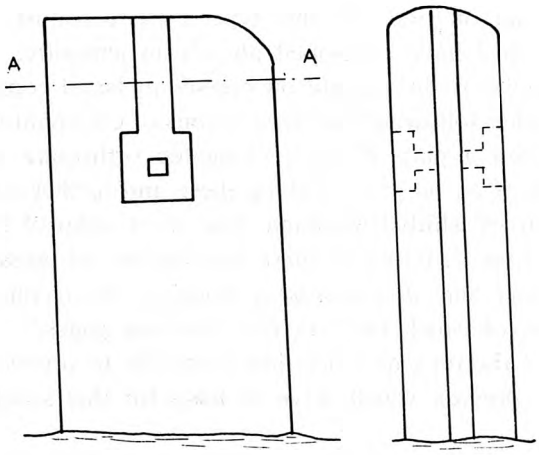


Fig. 1.
The press at Quabus. The eastern pillar.

Description: A pair of pillars of 1.38 m height above ground, and standing parallel at a distance of 1.55 m between each other. At the two narrow sides of both pillars, which measure 0.48 m, rectangular grooves have been cut out lengthwise, each 12–14cm wide. The broad sides of the pillars measure 1 m. A groove of 10–16.5 cm width runs down from the middle of their top towards their centre. At a distance of 50 cm from the pillar's top, the groove broadens, and forms a square cavity,

31×31 cm. In the centre of this cavity, the pillars are pierced by a hole, 8.5×8.5 cm. The press is situated in the southern room or yard of the above mentioned building. The size of this room is 10 m by 12 m.

Small finds: Out of a wealth of Roman-Byzantine potsherds strewn all over the slopes, a nozzle of an oil lamp was found (fig. 2). It is the typical "Herodian" lamp, belonging to the 1st century BCE and continuing into the 1st century or even the early 2nd century CE. (An exact parallel has been found at En Boqeq in the upper level which comes to an end about 70 CE.).

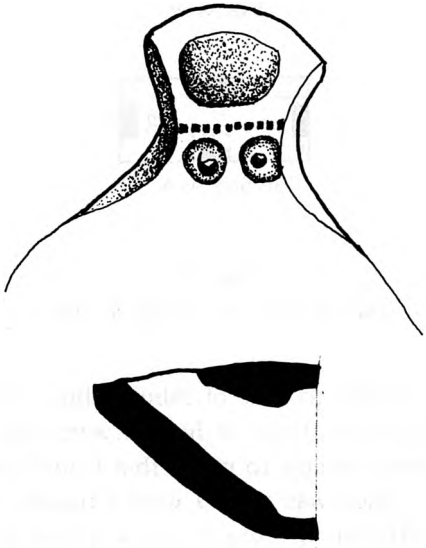
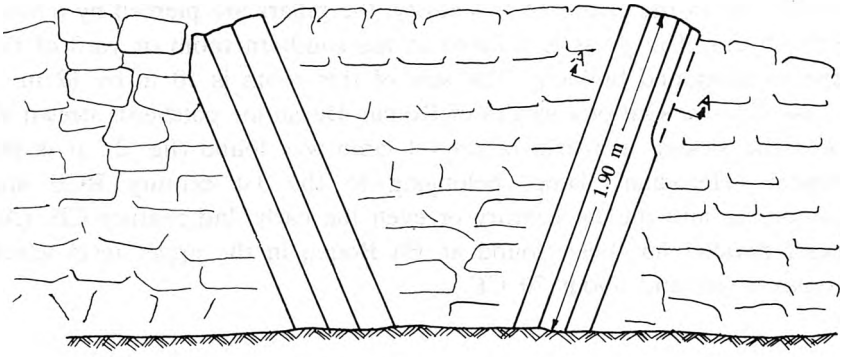


Fig. 2.
A Herodian lamp fragment from Quabus.

2. The press at Khirbet el Jubiya — M.R. 1643 1236 (figs. 3, 4)

Site: A terraced vineyard on the north-eastern slope of the hill named Qastal, that dominates the highroad to Jerusalem, above wady Qalonya. Vestiges of walls and diverse agricultural installations, partly rock-cut,



Side view

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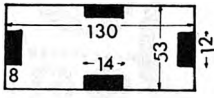

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Fig. 3.
The oil press in Jubiya in 1952.

point to a satting similar to that of Abu Qabus. Schick surveyed the place in 1892, when foundations of houses were still seen.

The ceramic evidence seems to prove that from Iron Age II onwards (900–600 BCE) the place was settled until Crusader times. Its apogee was in the Roman-Byzantine period, when it was perforce connected with "Colonia" and "Castellum", that have bequeathed their names to Arab "Qalonya" and "Qastal."

Description: A pair of pillars almost identical with those of Deir Abu Qabus. These were surveyed by Schick, who also made a sketch of them in 1892 (fig. 3). Already then, they were bent to the sides, but free standing. by 1954, when the author made his survey, they were incorporated in a recent partition wall.[9]

[9] Schick (Supra n. 8). Colonia: M. Avi-Yonah Gazetteer of Roman pal. p. 50; Castellum: ibid. p. 48.

The distance of the pillars from each other at their bases is -.50 m, their height to-day — 1.90 m. above ground; their breadth — 1.30 m, and their width — 0.50 m approximately. For other measurements (grooves, cavities and holes), see the sketch.

Not far away from the pillars, Schick found two well smothed stone slabs, measuring 4.3ft×3.8ft×2 inches each. On one of them there was a carving "in shape resembling a cross, although it was originally not

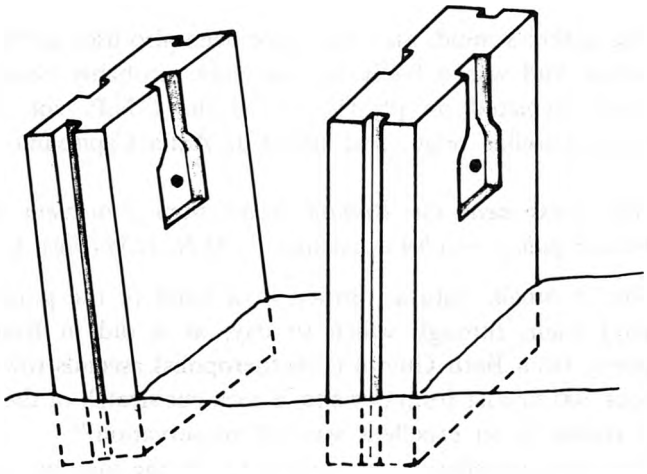


Fig. 4.
The Jubiya press as seen by Schick in 1892.
(Schick, PEQ 1893, p. 201.)

made as such". The engravin was rounded on all sides, "so that the cross point is the deepest part, about 4 in. deep". Another find made by Schick at that location were vestiges of an ancient olive mill, which has since then disappeared, as well as the above mentioned slabs.

Small finds: No clearly definable potsherds belonging to the Roman (pre-Byzantine) period have been found, except for the two fragments depicted on fig. 5, which are typical for the 1st century CE, but which,

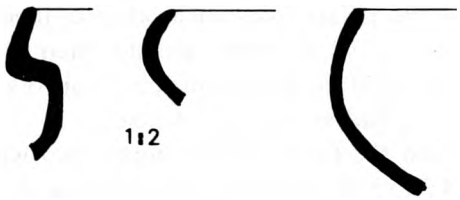


Fig. 5.
Two bowls and one jug, fragments from Jubiya.

to the author's mind, may well have been also used in the 2nd century.[10] Another find was a badly bruised coin, probably being the "medium bronze" depicted on pl. IV, 47, of the C.N.P. vol. I, belonging to Marcus Aurelius reign, and issued at Äelia Capitolina.

3. The press near the Roman Road from Jerusalem to Beth Govrin (Eleutheropolis) — Jebel es Sarsara — M.R. 1238 (Figs. 6, 7, Photos 1–3)

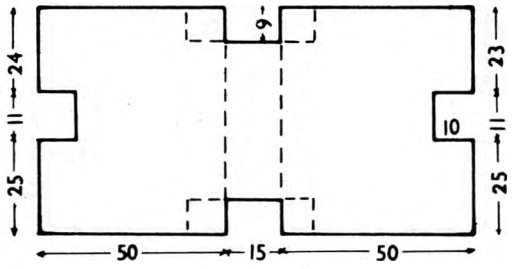
Site: A small, natural terrace in a bend of the gorge of the Nahal (wady) Elah, through which to day, as it did in Roman times, the highway from Beth Guvrin (Eleutheropolis) ascends towards Jerusalem. About 300 m east from our site, a rock-cut stretch of the Roman road is still visible in an excellent state of preservation.[11]

The press installations are reached from the road by a row of rock-cut steps. The debris of the plant have formed a small hillock, which is very much overgrown, but fragments of walls still in situ are traceable here and there. Without excavation, all one can safely say is that our press stood in a roofed and walled building.

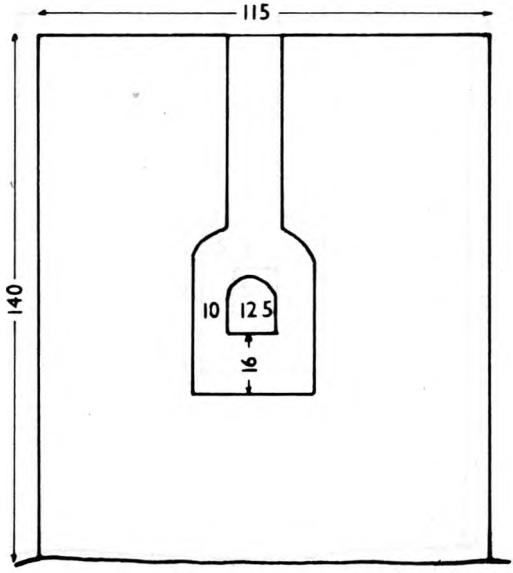
At the foot of the rock terrace that serves as base for the press site, just where the new macadamed highway overlays the Roman road, three burial caves are still to be seen, one of which has been cleaned by anonymus diggers. It contains three arcosolia ("kokhim").

[10] Thus at Tamara, not yet published. Y. Aharoni, *Excavations at Ramat Rahel* (Roma 1962) pl. 3, n. 24, 20, nos. 26–30, etc. De Vaux, "Fouilles de Kh. Qumran," *RBibl* 63 (1956) 559, fig. 4, 1–12. Idem, "Fouilles de Feshkha," *RBibl* 66 (1959) 245, fig. 2. C.H. Kraeling, ed., *Gerasa: City of the Decapolis* (New Haven, 1938) 563 (Tomb 8) fig. 41, 189, XI.

[11] A. Alt, *PalJb* 25 (1929) 19 and bibl. there. S. Kalai, *Yediot* 21 (1957) 220–8 (Hebrew).

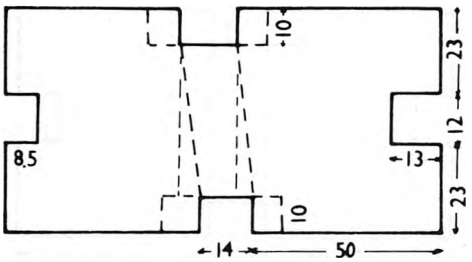


Top view

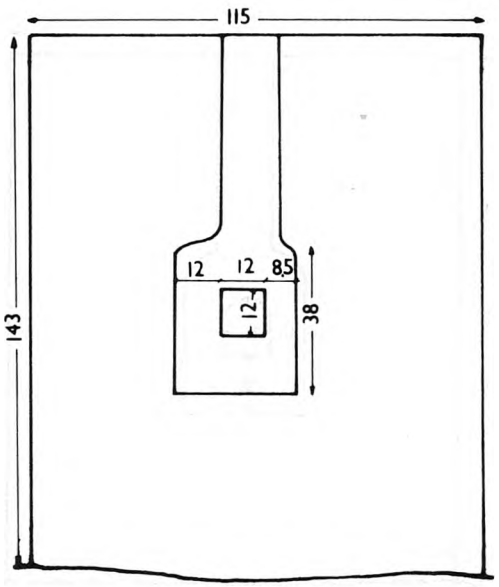


Side view

Fig. 6.
The press at J.es Sarsara.



Top view



Side view

Fig. 7.
The press at J.es Sarsara. The southern pillar.

On the opposite side — towards the north —, on the top of the mountain ridge above the road, there are remains of a massive wall, which may belong to a fort, erected for the purpose of guarding the ascent.[12] The potsherds are Roman-Byzantine, although some probably go back to the Iron Age.

Description: At the centre of the ruined building on the hillock, two parallel pillars stand to a height of 1.50 m above ground. their breadth is 1.15 m and their width — 0.60 m. the depth of the groove running down the centre of each of their narrow sides is 10 cm, and its width 11 cm. The width of the grooves on the broad sides of the pillars is 15 cm, and their depth, 6 cm. At a distance of 55 cm from the top of the pillars, the grooves broaden to form a rectange of 40cm×33cm approximately. The diameter of the hole sunk into the pillar at the centre of the rectangular cavities is 12.5 cm, and its section is somewhat "horse-shore" shaped in profile.

About one further meter must be added to the original height of the pillars, as proven by digging through the debris accumulated at their feet.

It is our contention that all these stone pillars are the "*arbores*" of the final model of the upright vertical screw press, Pliny's type three ("*parvum prelum*", above p. 3). This press is thus typified by its massive orthostate stone **arbores** that encase both the wooden press mechanism and the olive bales to be pressed by it.

These stone pillars were the answer to the problem of elimination of the reverse pressure and stresses that were exercised upon the frame when pressing larger quantities of fruit, and especially olives.

As mentioned above, there existed and still exists the all-wood variety of this press, which was more ideally suited to the pressing of grapes and sundry fruit and plants for the production of precious liquids and juices, in which capacity it seems, according to Pliny, to have been primarily introduced. Even there, the problem of the stresses did exist. This induced Drachmann[13] to reconstruct these presses with a specially heavy

[12] Most probably one of the line of **burgi** that protected the Roman highways according to the Mehiltha, Behodesh 1, ed. Horowitz-Rabin, pp. 203–4. Cf. Applebaum, *Yediot* 14 (1954) 220 ff. Gichon, "Towers on the Limes Palaestinae," *Acta IX Congr. Roman Front. Studies*, (Bucarest 1974) 519 ff; type F.

[13] Drachmann 58 ff. The primary uses of the upright screwpress: Cf. Hörle 1738–9.

Photo 1. Oil press at J.es Sarsara. Eastern view.

Photo 2. Oil press at J.es Sarsara. Northeastern view.

Photo 3. Oil press at J.es Sarsara. The southern pillar.

crossbeam, in which he saw a necessary component to hold the frame together and to guide and stabilize the upright screw. Accordingly, he translated the "*congeries*" of Pliny's account as "superstructure", the heavy crossbeam construction crowning the press frame.

As a matter of fact, all existing examples of the all-wooden pillar press have very heavy crossbeams for just these purposes, although not necessarily as heavy as those proposed by Drachmann.[14]

[14] For instance: The Jerusalem specimen: intra n. 28; the Bruckenthal museum press: ibid; the Cyprus press: infra n. 29.

In the stone pillar press, this superheavy superstructure was of course unnecessary, since much of the thrust was easily accomodated by the orthostate pillars, which could also serve indefinitely without being worse for wear and tear.

Scholars dealing with presses will agree that although all presses may in principle be assigned to any of the four main types of Pliny (Type two including two different species: with fixed and with rising screw), there however exist many divergencies in detail. One important factor is the means by which the press was activated, in our case, the type of handle or lever and its fixation to the pressing apparatus. By following-up the divergencies in this matter, we shall be able to understand the composition and functioning of Pliny's type-three press.

Following is the table giving the measurements of the above described presses, as well as of those published by Dalman:

Site	Height	Lenght	Breadth	Narrow Side Groove breadth	Depth
Qabus	138	100	48	14	12
Jubiya	190	130	53	12	8
J.es Sarsara	140	115	60	11	10
Beit Nattif	218	116	61	13	10.5
Kafr Rut	229	90	73	15	15
Kh. Madfana	103	75	58		

Site	Broad Side Groove Breadth	Depth	Cavity Breadth	Depth	Distance between pillars
Qabus	16.5	10	35	36	155
Jubiya	14	8	31	31	150
J.es Sarsara	15	6	40	32.5	
Beit Nattif	15	10	37	31.5	100
Kafr Rut	16	16	30	30	50
Kh. Madfana	17	20	15	21	73

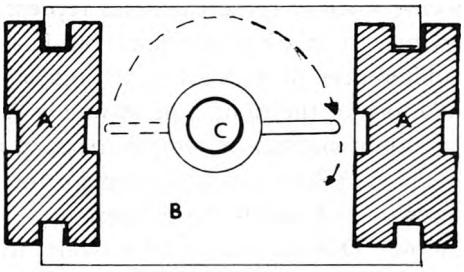
It is difficult to decide whether these examples represent a typical cross section of the screw presses in use in antiquity, but it seems possible that certain significant differences in measurements indicate the existence of different size installations of the same type as well as divergencies in the particulars of their motor mechanism. In this respect, the differences in the distances between the pillars are significant for the reconstruction of the whole installation, — of which more later.

As mentioned above, Dalman did build a model to demonstrate his reconstruction of these presses. In concentrating upon the stone pillar press, he was able to discard Drachmann's topheavy superstructure in favour of a lighter fixture, as well as to consider the purpose of the grooves and cavities chiselled into the pillars. As in Drachmann's all-wooden model, pressure is exercised upon the olives by means of a press board, screwed downwards by a vertical screw made of wood, that is kept in place and moving through a hole in a board on the top of the twin pillars. The grooves, cavities and holes upon the broad surfaces of the pillars serve as housings and casings for the wooden shafts and bolts that strap the upper hoard securely to the pillars, whereas the grooves, running down along the narrow sides of the pillars, serve as sunken rails to guide the four "r" shaped corner protrusions of the pressing board that were engaged in them, so as to stabilize the board's movement up and downwards.

So far does the reconstruction look feasible and must be accepted. But what is missing is the main component essential to the proper function of the press, i.e. the means by which the screw is turned in order to build up pressure on the crushed olives for the purpose of extracting their oil. As far as can be understood from Dalman's written explanation, and his reconstruction of a screw-operated beam press,[15] he suggested that that action was made by means of a horizontal handle fixed into the screw, as restored by us in fig. 8.

Albeit, it is to be doubted whether such a handle could activate a press, the distance between its pillars being 1.50 m. These measurements

[15] Dalman, loc. cit. and fig. 69. Hörle, op. cit. col. 1731 ff. Besinier 166–7, and Blümner, *Technologie* und *Terminologie der Gewerbe und Künste der Griechen und Römer* (Leipzig 1912) I, 332 ff, may all have influenced Dalman's reconstruction. They are however not quoted in this respect, nor is Drachmann.

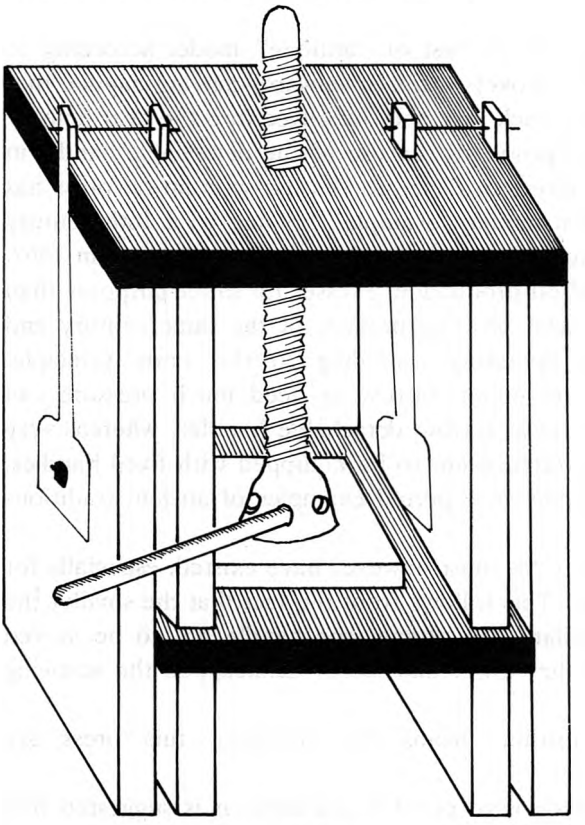


A-Arbores;
B-Prelum;
C-Cochlea.

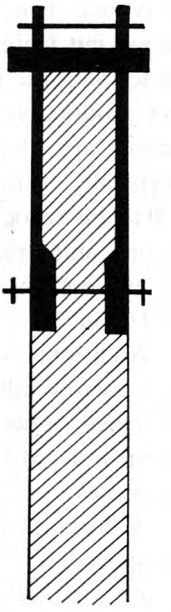
Fig. 8.
Operation of the pillar press, according to Dalman.

enable the fixation of a handle of about 60 cm protrusion to each side, but an action by such handle is both awkward and difficult because there is not enough space to grip and operate it freely. Moreover, the smaller the distance between the twin pillars, the shorter the handle fixed within the horizontal screw will be, and consequently it becomes nearly impossible to exercise the force necessary for activating the press.

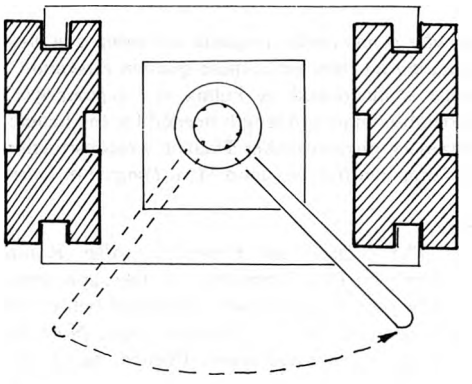
As against this, another method of activating the press is possible, namely the one proposed in fig. 9. Instead of a fixed handle, the length of which is limited by the distance between the twin pillars, the screw is turned by means of a long handle, protruding about half a meter or more from the pillars, and inserted into a socket in the screw shaft, freely extricable at the moment it reaches the edge of one of the pillars, after having made about a quarter of of a circle. At this stage, the handle is pulled out and inserted into another socket, cut into the screw shaft at a proper distance; and so on and so forth. This principle was known in the ancient world; Vitruvius mentions it explicitly as does Cato. A picture of an oil pressing installation in which the screw shaft is moved by such a handle (*vectis*) came to our attention through the discovery of the wall painting of the Casa degli Vettii in Pompeii. Here



General view



Section through middle of pillar



Section through width of press above handle

Fig. 9.
Pillar press operated by detacheable handle.

the oil press is depicted of the first or "antique" model according to Pliny's nomenclature (see above) with a downwards-moving handle, that has to be disengaged after each turn and reinserted into the next hole.[16]

Although there is thus proof for the use of the detachable handle in the classical period, no direct evidence for its use with an oil press has survived. The first known modern example[17] belongs to a 16th century wood cut from a series of arts and crafts done by Jost Amman in 1567, describing the process of oil production. Presses for other purposes than oil production, among them printing presses, of the same century and later, are depicted as operating according to the same principle. Typically, presses that are either narrow or need much pressure can often be recognized clearly as having detachable handles, whereas very broad and small presses often seem to be equipped with fixed handles. Doubtless, in all the Renaissance period examples of ancient traditions lived on.[18]

Additional screwing devices must however have existed, especially for the narrow pillar presses. This follows from the fact that the smaller the distance between the pillars, the oftener the handle has to be moved from hole to hole, and the slower and more handicapped the screwing becomes.

Accordingly, three further means for operating this press are proposed:

As long as no further decisive proof is available, it is suggested that all the three following models proposed here existed concurrently, and

[16] Vitr. *De Arch.* 6.6.3 "*ipsum autem torcular si non cocleis torquetur sed vectibus et prelo premetur, ne minus longum Pedes XL constituatur ita enim erit vectiaro spatium expeditum*". Cf. Cato, *Agr.* 19.2. the detachable handle is mentioned by Pollux as "περιστρόφις" (*Onom.* 4,--3. (Hörle 1741). Note the considerable minimum length needed for the handle, so as to get sufficient propulsion. This necessary proviso makes Dalman's reconstruction with a small fixed handle unworkable. The Pompeian frescoe, apud Mau, *Pompeii in Leben und Kunst,* p. 354, fig. 187.

[17] To the best of the author's knowledge.

[18] H. Sachs, *Eygentliche Beschreibung aller Stände auf Erden ... Aller Künste Handwerken und Händeln* (Frankfurt a.M. 1568) 99: Der Oelmacher. Cf. the paper press there, p. 21, and the printing press p. 22. The present article was completed before the publication of Z. Yeivin's report on the excavation of the Chorazin press. Note his reconstruction with a detachable handle, much as proposed above (Yeivin, fig. 3, pL. XIV). Cf. supra p. 8.

in addition to the one with the vertical shaft and detachable handle, as described on p. 222 above. The advantages or disadvantages of each type will have influenced its preference in various establishments. Before we go into detail, the following are our proposed reconstructions:

A. Type One-Overhead Propulsion Press (Fig. 10)

The screw is moved by making use of the circular motion of an animal, harnessed to a shaft, that was horizontally fixed to the upper

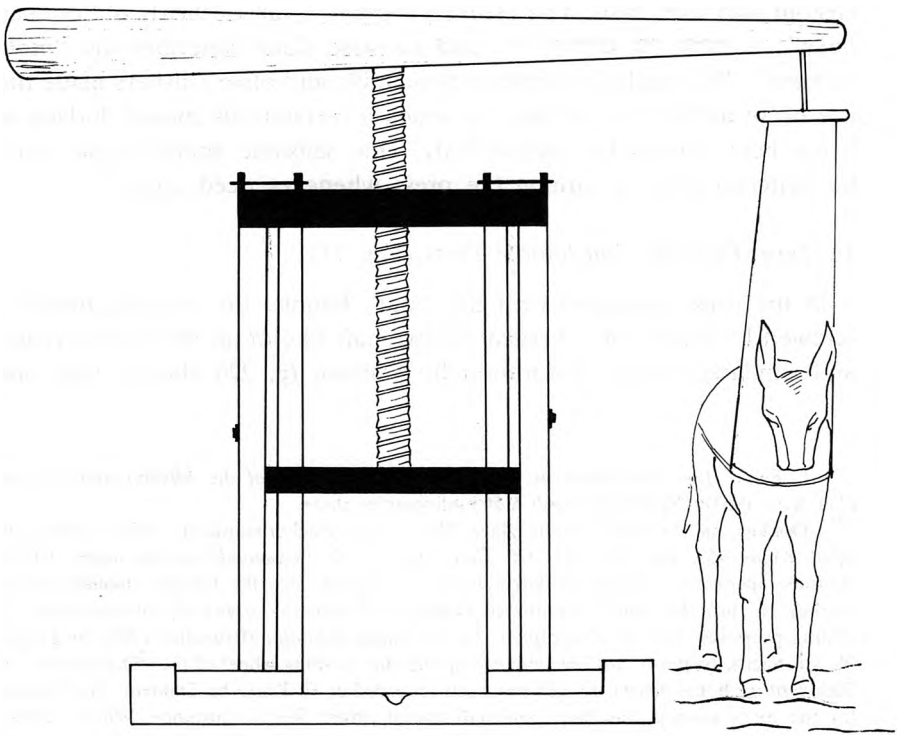


Fig. 10. Animal-operated press.

end of the screw. The screw protrudes above the board that tops the pillars and into which a hole has been bored, through which the screw is revolving. The use of an animal for similar purposes (with the Antillia wheel) has been recorded in this country from the days of the Mishna (2nd-3rd century CE) onwards.[19]

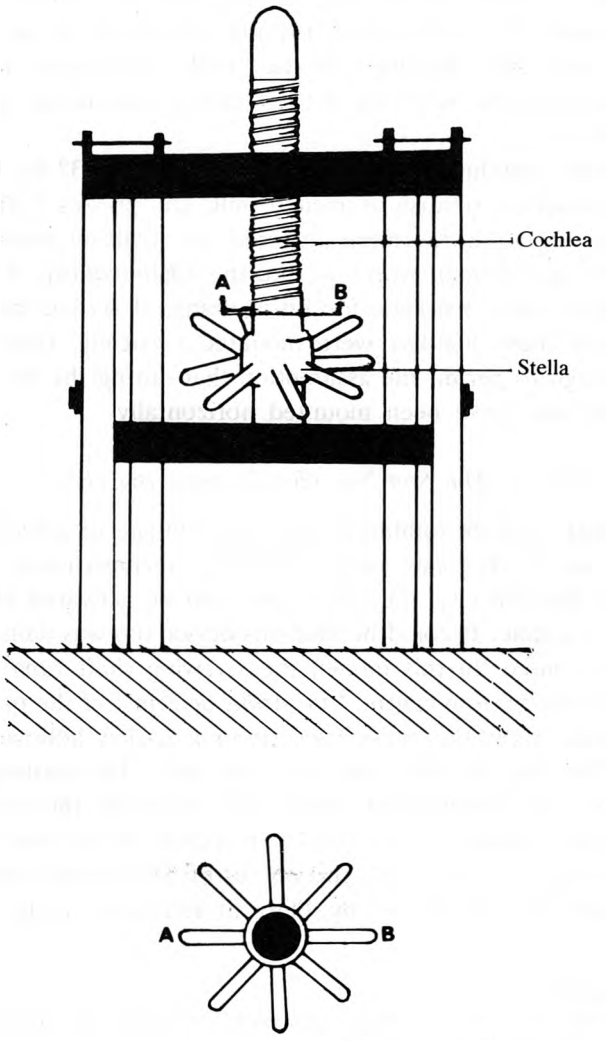
The tendency to keep the press under a roof and to allocate it as limited a space as possible, makes it feasible that, as was the case with Pliny's type-one press (vide supra), this model too may have been activated by human force, the labourer having been harnessed to the shaft "*vittis loreisque*" (by cords and straps). This explanation is plausible, because the screwing motion need not have been a continuous one for any length of time, like the drawing of water by the Antilia wheel. Our press needed only a limited number of turns between each new batch of olives. On the other land, the use of an animal was the custom also with mills. The Hebrew sources speak explicitly of "donkey mills" — ריחיים של חמור —, and likewise Cato, describes the "*mola asinara*". The similarity between flour mills and olive crushers made the use of an animal for the latter as much a certainty in ancient Judaea as it has been proven for ancient Italy. That selfsame animal could easily be switched over to turning the press whenever need arose.[20]

B. Type Two-The Star-handle Press (Fig. 11)

In the press equipped with the "star" handle, the pressing board is screwed by means of a vertical screw shaft like in all the former types, and similarly, in the restoration by Dalman (p. 220 above), with one

[19] I. Felix, *The Agriculture in Erez Israel in the Period of the Mishna and Talmud* (Tel-Aviv 1963) 336–40 (Hebrew) and bibliography there.

[20] Donkey mill: Tosefta Kelim, Baba Mez. 2, 14 (Zuckermandel p. 580). Further cit. apud Kraus 453, nn. 286, 287. Cf. Cato *Agr.* 4. 10, "*Quomodo oletum iugera CCXL instruere oporteat: ... molas asinarias unas ...*". There, also the harness, **molilia**, of the donkey to turn the mill is mentioned explicitly. A general survey of animal power for milling purposes, see: D. Kretschmer, *La Technique Romaine* (Bruxelles 1966) 19. Forbes 96. Cf. Sachs, (supra n. 18) the donkey turning the crushing wheel of the "Oelmacher". A 20th century horse-driven oil mill has been recorded at El Kerje by Dalman. The harness for the mola asinaria has been depicted several times: See for instance: White, *Roman Farming*, fig. 97 and A. Neuburger, *Die Technik des Altertums* (Leipzig 1919) 95, fig. 155. I might easily have been adapted so serve our press.



Cut of upper screw handle

Fig. 11.
Star-handle screw press.

difference: by using the "star" handle (as in fig. 11), the operator's hands always have a better hold on both bars to exercise more power and to maintain a consecutive turning movement. It is proposed to identitfy this "star" handle with the "*stella*" mentioned by Pliny as a means by which the screwing of the beam is done in his type-two press (p. 207 above).

The same consclusion was reached already in 1932 by Drachman in his comprehensive treatise of ancient mills and presses.[21] The use of the "star" handle is furthermore attested for ballistic machines of the Hellenistic and Roman world — like the *Cheiroballista* of Heron, and, according to some scholars, for lifting-cranes described by Vitruvius.[22]

Although these handles were mounted vertically, their existence is proof enough to permit the assumption that during the 1st century C.E. they could also have been mounted horizontally.

C. Type three — The Star-Nut Handle press (fig. 12)

The "star" handle minimizes the disadvantage of a bad hold on the handles, as is the case with Dalman's reconstruction. To further minimize this difficulty, the pillar press can be activated by means of a "star nut" handle. It could be that this device too was named "*stella*" in our Latin source. In this model, the screwing shaft runs from the top straight to the bottom centre, "*in media derecto*", of the press, and rests there either upon the press base or in a socket hollowed out in its centre. The shaft is fixed and does not turn. The turning is done by means of a star handled nut "*stella*" (?), which has the shape of a ring, in which horizontal bars are fixed like spokes on the hub of a wheel.[23] With the help of these bars the nut turns and presses upon the drum ("*tynpanum*"), as explained by Pliny in reference to the "new inven-

[21] Drachmann 91.

[22] E.W. Marsden, *Greek and Roman Artillery* (Oxford 1969) pl. 7. Kretschmer (supra n. 20) 24, 25. Blümner (supra n. 15) III, 111–7.

[23] The star nut was used, according to Hörle 2737, until recently, in rural Italy and Switzerland, as well as with medieval presses upon contemporary illustrations cited ibid, 1732 9. It could be that the nuts of the Pompeian garments' press moved upon a fixed screw shaft (supra n. 4) Cf. also Drachmann 77 ff. a similar explanation for the *stella* to that of ours was given by Meister in his *De Catonis Torculario* according to his quotation by Blümner, (supra n. 15) 348.

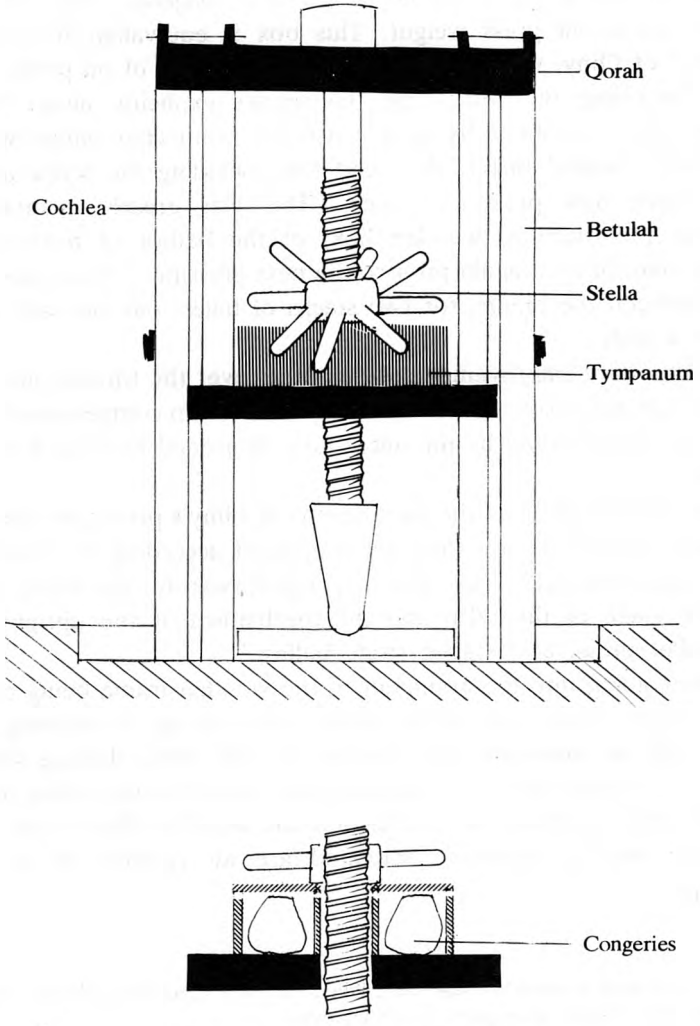


Fig. 12.
Starnut screw press.

tion". By "*tynpanum*" is meant the box above the pressing board ("*prelum*"), containing a ballast of stones ("*congeries*", fig. 12), which add an additional press weight. This box is equivalent to the "*arca lapidum*" of Pliny, when describing his second type of oil press. Again, when describing the third type, he speaks explicitly about heaping weights, and not about fixing a constantly connected ballast-weight.[24] The reason behind this is the need for rewinding the screw upwards before each new pressing process. This was greatly facilitated by emptying the drum (a wooden box) of the ballast of heaped stone weights, and filling it again prior to the next pressing.[25] There was ample space between the pillars, for two stacks of bales, one on each side of the screw-shaft.

The important improvement of this press over the former one was in the fact that the heavy heaps of ballast in the drum compensated for the loss of leverage caused by the necessarily shortened fixed spokes of the star handle.

In our identification of the components of Pliny's press type three, the "*congeries constructi*" are thus not translated according to Drachmann with "superstructure", but more straightforwardly according to the common usage of the term and the mechanism of the upright screw stone pillar press, as "heaped stone ballast."

Without going into the argument of the wooden frame being possibly the prototype of the stone pillar frame, and a change of meaning of the terms, such as discussed later (below p. 243) when dealing with the rabbinical sources, there is no getting away from the impression that the star nut press is nearest in construction and detail to Pliny's type three, while the models otherwise activated are all variants of the same archetype.

[24] "... *super prela construere congeriem*", Pliny, *HN* 18.317, similarily, Hörle 1741, who also denies the interpretation given by Drachmann.

[25] The lifting of the *tympanum* could have been assisted by counterweights larger but similar in principle to those depicted upon the Pompeian garment press (supra n. 4). In Judaea, the tomb of Helene, queen of Adiabene, in Jerusalem, was operated by counter weights. M. Kon, *The Tombs of the Kings* (Tel Aviv, 1947) 90–92 (Hebrew), fig. 13. Cf. *Paus.* 8.16,5. Heron, Mechanica, the Arabic translation, editio Teubner edd. L. Nix and W. Schmidt, III, 13, 14, 16.

[25a] See supra n. 24.

To conclude: the "star-nut" press is nearest in construction to the hird and last type of press mentioned by Pliny. It may be assumed that all the Palestinian pillar presses with a distance of over 1 meter between the pillars used this mechanism for their pressing process. In the presses represented by that of Khirbet el Madfana, and even more by the one at Kafr Rut, the best solution is by way of overhead propulsion. In an installation of the size of that found at Jubiya and broader ones, it is proposed that the screwing was done by means of a horizontal, detachable handle, reinsertable in sockets of about 90° distance from each other: the "*vectes*" (above p. 223, fig. 9).

The common press bases belong to two types. The first one, are either round or square stone slabs, that contain sockets for the insertion of the upright pillars as well as incised channels for collecting the oil and leading it off into the appropriate receptables (vide infra). The second type is similar to the first one, but lacks the sockets and usually has the form of a round disk, with a circular channel or some other channeling pattern.[26] The measurements of the sockets that belong to the bases of "type one" make their use with stone pillars impossible. These bases must have belonged to the all-wood variety of the upright pillar press that was used, according to our suggestion, mainly for wine, or else in restricted space, and for rather small-scale production. A good example for this press is afforded by Z. Yeivin's reconstruction of a press of this type, excavated by him in the ancient village of Chorazin. Z. Yeivin follows the ideas expressed by Drachmann, and somewhat more elaborately by White.[27] It is a more simplified construction than the stone-pillar press insofar as it dispenses the *tympanum* and the *congeries,* and exercises pressure by means of unconnected boards,

[26] Type one bases: Dalman 229–31. Type two bases: ibid 242. Some of the smaller ones of these "*Pressunterlagen*" may go back to the First Temple period (Cf. also Avitsur, supra n. 1 fig. 237). As mentioned above Dalman had reconstructed his upright screw pillar press with stone pillars upon type one bases. This is erroneous, with the exception of some especially large specimen, which might possibly have served small stone pillars with large tenons such as the Deir Karnakh (M.R. 2203 2590) specimen surveyed by the author. the simple slabs recorded for Jubiya and Kh. Madfana (Schick, [supra n. 8] 202; Dalman 228) served too as pressbases and the oil was channeled off by small walls of clay earth, such as in recent Arab presses.

[27] Z. Yeivin 60–3. Drachmann 58. K.D. White 231–2.

placed above the olive cakes or baskets. for this reason, the lower end of the screw was pestle-wise widened, providing at the same time a stronger frame for the socket of the detachable handle.

Modern examples of this type are the press exhibited in the small open-air museum of the Ministry of Agriculture courtyard in Jerusalem, as well as the one exhibited in the Dumbrava Museum at Sibiu.[28] Not all wooden presses needed to have been as simple as these. A Cypriote example, also in use up to the present, has a fixed press board, moving in to perpendicular grooves, cut into the *arbores,* though detached from the screw.[29]

The second type of base is to be associated with stone pillars either for the screwbeam press or the upright screw press, whenever their base was not chiselled out of the base rock.[30]

Talmudic sources have preserved the nomenclature for part of the components of the installations serving for the collection, processing and storage of the oil and its by-products.[31]

From the collecting floor or basin, whose place was underneath the press or just in front of it, the oil flowed through channels or pipes into the "cistern", (*Bor* – בור), in which it remained until it became "clear" (*Zalul* – צלול). From there it was taken to the "sea" (*Yam* – ים), in which it was stored and refined by removing the foam gathered on its surface. In this manner, it was prepared for filling into various receptables for transport and home storage. It seems to me that the cavities, cuttings and cisterns near the press at Jebel es Sarsara should be explained as just such an installation.

Our next question concerns the origin and date of the pillar presses. Pliny, who was the first to mention the pillar presses in detail, calls it an invention made in his times, i.e., the middle of the 1st century CE.[32]

[28] Muzeul Bruckenthal, Sectorul in aerliber, Dumbrava. A photograph of this press is in the author's collection. Yeivin pl. XIV, 3.

[29] Avitsur (supra n. 1) 93, figs. 248–9.

[30] That is the case with the screw beam press that was operated until 1948 in a cave at M.R. 1329 1500, near Ishwa-Eshtaol, at the feet of Deir el Qabus hill.

[31] Mishna Maasroth 1, 7. Further cit. apud Kraus 222, 225, 601. Cf. Tosefta Terumoth 3.7 (Zuckermandel, p. 29).

[32] The exact date quoted by Pliny: "*intra XXII his annos*" (supra p. 2) is a good terminus post quem for the introduction into Iudaea. The examples from Pompeii and

Until systematic excavations will be carried out, the ceramic evidence from Israel permits only the general conclusion that the presses at Qabus and Jubiya were found in Romano-Byzantine sites that included in the surface pottery collected a few sherds definitely belonging to the 1st and 2nd centuries.[33] The site of Legio was founded in the Trajanic period, Kfar Nahum existed in the 1st century and onwards according to written sources,[34] as well as archaeological research.

Dalman does not mention any ceramic evidence, but in Kaft Rut we picked up two terra sigillata pieces and a broken oil lamp (fig. 13) that is parallel to the one found at Qabus.

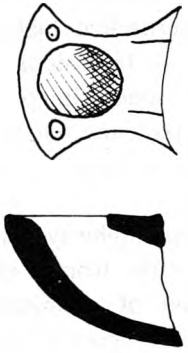


Fig. 13.
Oil lamp fragment from Kfar Lot.

Herculaneum (supra n. 4) afford a term. ante for the introduction of the upright screwpress for other purposes into Italy. Forbes, 142, argues for their invention in Greece in the 2nd century BCE and introduction into Rome in the 1st century BCE. The mention in the Mishna (supra n. 4) of the "householder's clothes press= מכבש של בעלי בתים gives us the turn of the 2nd century CE as a terminus quo ante.

[33] Above pp. 4–7.

[34] Legio: M. Avi Yonah, Gazetteer of Roman Palestine (Qedem, Monographs of the Institute of Archaeology, The Hebrew University of Jerusalem 5) (Jerusalem 1976) 75. The erection of the legionary base at Legio-Capercotnei can now be fixed to not later than 118 CE, according to a new reading of milestone no. XI on the road Sepphoris-Legio, by Roll and Isaak, soon to be published. The reading should be: "Trib Potestas IIII" instead of "Trib. Potestas /XIV" apud Hecker, *Yediot* 25 (1961) 175–6 (Hebrew). B. Isaac a. Israel Roll, "Judaea in the early years of Hadrian's reign," Latomus 38 (1979) pp. 54ff. Capernaum: Kfar Nahum: Avi Yonah, op. cit. p. 46.

Some clues to the dates of Roman Beit Nattif's history come from pottery found in two cisterns excavated by Baramki. their lowest level came to its end at the turn of the 1st century CE. Above, there is a layer of the 3rd century, when the two cisterns were used by a potter to store finished products, or, repectively, as a refuse dump. It is difficult to conclude clearly in what period the place was first thriving, but a likely proposition would be to connect the end of the lowest level (4) with the War of the Destruction of the Second Temple, though it also could be the time of Bar Kochba's revolt.[35]

It is important to note that most of the oil pressing installations are situated near the main Roman highways, or other major roads: the presses of Jebel es Sarsara and Beit Nattif are on the Beth Govrin (Eleutheropolis)-Beth Ther-Jerusalem highway; the press of Kafr Rut, near the Lydda (Diospolis) — Jerusalem highway; the one at Jubiya, near the Emmaus-Jerusalem road; the press of Abu Qabus, near the Beit Liqia (Beth Liqitaya?) road; the one of Khirbet Madfana, near the Tyrus-Acre highway and that of Legio, near the Zippori (Diocaesarea) — Caesarea road.

All the above mentioned highways and roads were of utmost importance for the passage of the Roman troops in the Bar Kochba war and in the following period of strengthening the Roman rule. In overpowering the mountain strongholds near Bethar, the roads Lydda-Beth Horon, Jerusalem-Bether-Beth Govrin, as well as the Emmaus-Beth Govrin were of special tactical and strategic significance. Although we do not possess any documentation for the Lydda-Emmaus-Jerusalem road from before the times of Marcus Aurelius, it too must have served for encircling and disrupting the region of southern Iudaea. The settlement of Colonia at the foot of the "Castellum" and the roads leading up to it did the same for the northern part of that region.

The Zippori-Legio-Caesarea highway was constructed around the year 118 in order to connect the new encampment of the third legion at Capercotnei (near Megiddo) with the existing network of roads for the purpose of policing Galilee. It is possible that another aim for building this road was to facilitate the expedition of reinforcements for the

[35] D. Baramki, *The Two Cisterns at Beith Nattif*, *QDAP* 5 (1935–6) 3 ff.

capture of the last bastion of the insurgent Jews in the Judean desert. At the same time, the Acre-Tyrus highway served as an important life-line to the Syrian rear.[36]

Not only are the above mentioned oil presses all situated near imporant Roman highways, but most of them are sited either in installations or areas which directly served the infrastructure constructed by the Romans for defending and policing the province: Jubiya is within the bounds of "colonia" or "Castellum";[37] Kafr Rut (ΚΑΦΕΡΟΥΤΑ of the Madaba Map) was a road station near the important cross-roads below the Beth Horon ascent;[38] Jebel es Sarsara is an installation possibly connected with the Roman road station at Khirbet Khan, about 2.5 kms to its east. The tower at M.R. 1525 1242, situated upon the ascent of the ridge opposite the oil press and over the road, could have served as a strongpoint for both.[39] In Khirbet al Madfana, the foot of the Ladder of Tyre, a Roman road station (*mutatio*?) is supposed by the author to have existed,[40] and Legio-Capercotnei was, as mentioned above, the base camp of the legio Tertia Gallica sine 118 CE approximately.

As far as Beit Nattif (Beth Leptepha) and Deir el Qabus are concerned, all one may safely say is that they were within the boundaries of the area which has been assumed, by general consensus, to have belonged to the *territorium* of the tenth Legion since the destruction of the Second Temple. From that area, the legion drew, then, at least part of its requirements in food and agricultural products. Beth Leptepha had been a district capital before the Roman conquest, which entailed the existence of public buildings and possible royal lands,

[36] For the road system, see: M. Avi Yonah, *A Historical Geography of Erez Israel from the Babylonian Exile to the Arab Conquest* (Jerusalem 1949) 73 ff. (Hebrew). I. Roll, "Routes Romaines en Israel," *Acta IX Congr. Roman Front. Studies* (Bucarest 1974) 504 ff. The date of Sepphoris-Capercotnei highway, supra n. 34.

[37] Avi Yonah (supra n. 36) 92 and bibl. there. S. Klein, *Erez Jehuda* (Tel Aviv 1933) 118, 150 (Hebrew).

[38] Avi Yonah (supra n. 36) 98. Idem, *The Madaba Mosaic Map* (Jerusalem 1900); Kuhl and Meinhold, "*Römische Strassen und Strassenstationen ...*" *PalJb.* 25 (1929) 113 ff.

[39] Supra p. 5 Kh. Khan: I. Press, *A Topographical-Historical Encylopedia of Palestine,* II (Jerusalem, 1948) 307.

[40] Survey of the surface remains from 1954, since disappeared. Not published.

hat would all have passed authomatically into imperial property, and incorporated in the network of military supplies.[41]

All the above points to some connection between the pillar-screw-press and the Roman military establishment. Furthermore, when we consider the considerable initial outlay for these presses, we are obliged to connect the appearance of these installations with initiative of the Roman authorities or that of individuals, who had been granted or otherwise acquired land from the Jewish *deditici.* Circumstances must have been ideal for the commercial acumen of *conductores* and other entrepreneurs.

Against the initial installation of the pillar-screw-press by the Jewish farmers, most of them empoverished by the war and its aftermath, or by their more fortunate local gentile successors, speaks another weighty matter: the innate conservatism of the farmer and his suspicion of new methods and unfamiliar implements. Outward drive, incentive and initiative were needed to bring these innovations about.

The Bar Kochba War could have provided a motive and a need for such a kind of initiative, During that war, at least sixty thousand Roman soldiers were employed in Iudaea,[42] and, all of a sudden, there were not enough supply installations and the existing methods could not meet the growing demand for olive oil and its byproducts. First of all, olive oil was used as foodstuff, and among its many uses, it served as the main ingredient in preparing *frumentum,* the staple diet of the Roman legionnaires. It is to be compared to the Italian *polenta* or Rumanian *mamaliga* of to-day.[43] These dishes need as basic ingredient either animal fat (in the more northerly parts of Europe) or olive oil (in the

[41] Beth Leptepha as Hasmonean-Herodian district capital: Pliny, *HN* 5.14. Josephus, *BJ* 3.3.5 (misspelled Pella). Eshtaol: Jer. Sota 1, 17b, 8. B. Sota 9, 6 prove the existence of the place, as well as Eusebius, Onomasticon (ed. Klostermann 88, 12). M. Gichon, Qastal-Zora, Archaeological Survey, M.A. thesis, Jerusalem 1951, p. 15 f.

As for the legion and its territory: a Mocsy, *Zu den Prata Legionis, Stud. zu den Militärgrenzen Roms* (BZ Beith. 19) (1967) 211–15. H.v. Petrikovits, *Das Römische Rheinland* (Köln 1960) 65 ff and bibl. there.

[42] E. Schürer, *Geschichte des Jüdischen Volkes* ... (Leipzig 1901) 465 ff, n. 70,687 n. 116. L.H. Vincent and A.M. Steve, *Jerusalem de l'Ancien Testament* (Paris 1956) 778. Z. Yeivin, *Bar Kochba* (Jerusalem 1946) 69, 82–3 (Hebrew).

[43] See n. 7 above. J. Kromayer and G. Veith, *Heerwesen* ... (München 1928) 413. G. Veith, *Der Feldzug von Dyrrhachium* (Wien 1920) 253–4.

Mediterranean regions). In the year 46 BCE, a special tax was imposed on the Africans by Julius Caesar in order to ensure the regular supply of olive oil.[44] As late as 360 CE, a law was promulgated that olive oil belongs to the fixed components of the rations supplied to the Roman soldier.[45]

But not only as food did olive oil belong to the vital and staple military supplies. In countries where the olive was the main producer of oil, it was the main source for the supply of oil to the fighting forces, as a major item in their ammunition. "Scalding oil" was a standard commodity in the defence of towns and fortifications. Its uses were manifold. The description of Josephus of the use of boiling oil, that was poured upon the Romans scaling the walls of Iotapa, is just one instance.[46] One of its other uses was as incendiary against wood and other inflammable parts of the adversaries' engines of war and siege constructions. No wonder that Vegetius counts the oil among the standard tools of war of the legionary: "*Liquidam oleum, quod incendiarum vocant ad exurendas hostium machinas convenit praeparari*".[47] Other major uses of the oil by the Roman armies included, according to the general customs of the age, the oil as the main source for lighting and the preparation of signal torches, as disinfectant, as a cosmetic and as an ingedient for diverse remedies for the treatment of wounds and diseases.[48]

Of major military importance was the use of one of the by-products of olive oil manufacture, *amurca* (lees) — the foamy issue collected from the olives, before as well as after the pressing. *Amurca* was used as an important ingredient for preserving, lubricating, maintaining and servicing military equipment, tools and engines. Cato, for example, stresses the variety of uses of the *amurca*: .. "*Amurca decocta axem unguito et*

[44] Caes. *Bell. Africanum* 98. Plut, *Vit. Caes.* 55.

[45] *Cod. Theod.* 8.4, 17. Cf. S.H.A., *Aurel.* 7.5: Because of the unsettled conditions, the soldiers commandeered the foodstuffs needed for their upkeep, among those, the *oleum.*

[46] Josephus, *B.J.* 3.28.272.

[47] Epitoma 3.7, 15 (Teubner p. 133). Cf. ibid. p. 140, 19; 163, 2. For the diverse uses of he oil, see: Pease 2460 ff, especially 2465–6. The poorer the countryside in resinous materials and tar, the greater the demand for oil also for torches and the like.

[48] Pease 2460 ff.

lora et calceamento et coria"[39] — ... "he should lubricate with *amurca* the axles (of the vehicles and other machines), as well as the equipment, the foot-gear and the hides".

All this goes to prove the importance of olive oil in classical warfare. For the Judean theatre of war, the climate made the use of oleous lubricants a must. Whereas in certain regions during some seasons the excessive heat and dryness attacks wood, hides and diverse fibers, in others the great amount of moisture corrodes armor, weapons and all metal tools.[50]

The problem of the supply of these vital provisions became especially acute, because the Jewish farmers, who were the traditional, main growers of olives in Judaea, had all become involved in one way or another in the war, and ceased supplying. One step the Roman authorities took to counteract this development while the war was still raging, was the initially rather lenient attitude towards Galilee, the first part of Iudaea to be recaptured.[51] It was because of this treatment that Galilee survived as the major stronghold of Judaism after this war, which, in its later phases became more and more violent.[52] By the end of the four to five (?) year long conflict, Rome's traditional policy, of balance between Jew and Hellenized gentile, changed to crushing

[49] Cato, *Agr.* 92; see also 56–57, 59, 92, 98, 103, 128–30. Columella, De Re Rustica 1. 55.7. *Amurca* is the rabbinic "mesahamin" of Mishna Shevitit 2. 4–5. Pease 2456. Cf. Plin *HN* 15.8 (33–34).

[50] *Atlas of Israel* (Jerusalem 1952) sheet IV, 5 gives the exact data for the four seasons and the annual averages. It is the author's personal experience that weapons exposed to the average dew of any night, north of the Negev, will start to corrode, if not properly oiled immediately after.

[51] The astonishing survival of Galilee and its revival has been falsely explained by some scholars to point to the general exclusion of this region from the areas involved in the Bar Kochba War. Cf. A. Büchler, "die Schauplätze des Bar Kochba Krieges ...," *JAR* 16 (1904) 205–43, and against this: Z. Yeivin (supra n. 42) 60 ff, and the short resume of P. Prigent, *La Fin de Jérusalem* (Neuchatel 1969) 108. the present writer's view is fully expounded in his: *Der Bar Kochba krieg,* to be published soon, as well as his article: The Bar Kochba War, *Rev. Internat. d'Histoire Militaire.* No 42 (1979) pp. 82–99.

[52] The mention by DIO Cassius, 69, 13–14, of Hadrian's refusal to open his letter to the Senate upon termination of the war with the customary "*mihi et legionibus bene*" and the mention of 50 fortified towns and 985 other important Jewish settlements as having been completely destoyed, even if historically not exact, do present the proper atmoshphere as felt by the contemporaries.

Judaism in Israel, the strategic landbrige of the eastern Mediterranean. Hence the change of name of the provincia from Judaea to Palaestina. The political and social upheavals entailed in these activities brought great economic stress upon the country, that lasted for some decades or more. the famine and death are well attested by the Talmudic sources.[53] Moreover, the recuperation of the olive plantations was slower than that of other agricultural entrerprises, since it takes an average of 25 years to get a newly planted tree to bear.[54]

Thus, both the period during the Bar Kochba War and that immediately afterwards may have given the first impetus for the introduction of the upright screw stone pillar press. For the first possibility speaks the fact that the majority of these presses were constructed adjacent to routes of special military importance during the war (above p. 15). Against this, one has to bear in mind that it was an accepted Roman practice to construct large-size farming enterprises near highroads, so as to streamline problems of transport, and to save expenses. Cato, our authority, states categorically: "*Eundum fundum fructuusiorem faciunt vecturae, si viae sunt que plaustra agi facile passint.*"[55]

The case for the construction after the war is on one hand the presence of a garrison, comprising two legions, and as late as 139, a minimum of 15 auxiliary units, a force at least double than at the turn of the century.[56] On the other hand, the war had dislodged the Jewish farmers from their property, and large masses of land became available for reallocation. And since most of the Jewish farmers had been smallholders, the properties could be united into larger parcels that made for a more industrialized large-scale farming process. *Publicani, conductores* and other men with means, or their lessees or tenants,

[53] Cf. summary of situation and sources quoted apud M. Avi Yonah, *In the Days of Rome and Byzantium* (Jerusalem 1946) 16 ff (Hebrew).

[54] T. Jer. Pea 20a, 17. Rabbi Shimon Ben Yakim (active 250–280 CE) said: "In the old days, olives could not be found because Hadrian the Wicked came and devastated all of the country; now they are (again) abundant".

[55] Agr. 6., Cf. ibid 1. 3.

[56] The order of battle of the Roman army in Iudaea, or Palaestina, is not yet sufficiently established. The above number of *auxilia* is based on the *diploma* CIX (C.I.L. III, suppl. 3) solely, which mentions 3 *alae*, 9 *cohortes*, 2 *cohortes miliariae* and 1 *equitata*.

would move in with the necessary funds to make the best of the opportunities.

Another factor was the *Patrimonium Caesaris,* which, since the year 70, had been administering through its *procuratores* large estates in Iudaea[57] and could expand its activities, and indeed would do so as less private initiative met the demands of army and administration. In connection with this, it should not be forgotten that oil was one of the major products of the province,[58] and that it was of the greatest interest to the imperial authorities to revive this major contributor to the provincial taxes and revenues.[59]

A good comparison for the construction of farms purposely adjacent to Roman army supply lines comes from Germania.[60] Britain too has examples of the influence of military needs upon the expansion of agricultural production and the development of large "modernized" farming establishments.[61] As to be expected, the development in Iudaea is not an isolated phenomenon.

To conclude the argument of when and why, there seems to be enough circumstancial evidence in the geographical closeness between roads and presses, military establishments and presses, in the extensive

[57] Confiscation of the Jewish lands: Josephus, *B.J.* 7.6.6. Cf. idem, *Vita,* 75, 7h. E. Schürer, *Geschichte des Jüd. Volkes in Zeitalter Jesu Christi* (Leipzig 1907) II, 103: Iamnia, etc., as Imperial Domain. Klein (supra n. 37) 150 ff, esp. p. 153–4 (Hebrew), the relative importance of the procurator from the initial stages of the provincial reorganisation during the Bellum Iudaicum: Josephus, *BJ* 6. 3. 3. 238.

[58] Josephus, *BJ* 3. 21.20. Bereshit Rabba 20.1: Rabbi Elasar Ben Shimon (middle of the 4th cent.) said: "It is easier to grow a legion of olive tress in Galilee than a child in (all of) Erez Israel." Siphre to *Deut,* 23, 24: "When the people of Laodicea in Syria were in need of oil, they sent an official to buy it. He went to Giscala and brought oil from a single individual for 1800 thousand denari ..." Cf. Beraitha Deut. 80, 10; Bab. Sanhedrin 101, 1; Maasser Sheni 1, 3; etc. Krauss 214 and footnotes, has many of the relevant sources.

[59] Hadrian's regulation of the cedar production in Lebanon must have been typical of the on-the-spot decisions of the "travelling emperor" to improve economic resources. Cf. E. Renan, *Mission de Phénice* (Paris 1864) 258. A Rustum, "New Traces of the Old Libanon Forest," *PEQ* 57 (1922) 68 ff.

[60] G. Schell, *Die Römische Besiedlung von Rheingau und Wetterau* (Mainz 1962) 74–77, Abb. 17, 18. Petrikovits (supra n. 41) p. 120.

[61] I. Richmond, *Roman Britain* (London 1955) 112 ff. S. Frère, *Britania* (London 1967) 267 ff. another instance of the supply to the military as incentive for agricultural development and for locating these enterprises near the highroads comes from the rear of the Danube frontier: E. Pašalič, *V Congr. Limit. Stud.* (Zagreb 1963) 167 ff.

initial monetary outlay needed to erect stone pillar presses, in the axiomatic conservatism of the local farmers, as well as in the archaeological finds so far available — to propose the introduction of this press in the 2nd century CE, possibly in connection with the Bar Kochba War or in its wake.

This of course does not necessitate the military character of the pressing establishments nor their direct service of the military, although this is quite feasible, especially during the initial stages of their introuction. It is permissable to assume that with the economic and social recuperation, even some Jewish landowners such as the Patriarch himself,[62] may have introduced the new type of press argound the Severan period. The private landowner and farmer, however, continued to use the beampresses down to the Mohammedan conquest and after, even in such major oil growing areas as Lower Galilee.[63] For this, there is ample proof. Indeed it has remained a major press in use until the introduction of 20th century equipment — which is one more point in favour of the thesis that the stone pillar press was a foreign invention never fully assimilated by the majority of the native population.

On the other hand, it is beyond doubt that our presses were indeed oil presses and intended for intensive production. In this respect we draw attention to the fact that at Jubiya, Kafr Rut, beit Nattiff and Madfane, *molae oleariae* were found adjacent to these presses.

The often expressed opinion that the upright, vertical screwpress was intended solely or chiefly for other commodities than olives must consequently be discarded,[64] at least as far as the stone pillar presses are concerned.[65]

[62] T. Jer. 17a, 25: the house of Rabbi (The Patriarch Jehuda I) had four oil presses at the four corners of the town (of Sepphoris ?). The patriarch as major land owner and among other things of oil plantations — see Krauss, *Antonius und Rabbi* (Wien 1910) 19–26.

[63] A typical oil pressing establishment with at least six beam presses has been discovered by A. Saarisalo at Kefr Sabt, north of Nazareth (*The Boundary between Issachar and Naphtali* (Helsinki 1927) p. 29).

[64] Hörle 1758–9. Forbes 140.

[65] Attention must be given to the fact that not all stone pillars belonged to upright vertical screwpresses. Only those with the same arrangements of grooves and cavities as ours may safely be recognized as such. Others have belonged to beampresses. With some it is difficult to say. thus with the press at Um el Awamid, north of Tyre, described bt

The Mishna has preserved the Hebrew terms for the components of the press.[66] It is worthwhile to compare these terms with their equivalent from the Talmud.[67] Following is the list:

Mishna	Equivalent	Talmud	Equivalent
ים (Yam)	*cupa*	טלפח (Talpakh)	Lentoid *cupa*
ממל (Memel)	*arbis* =grindstone	מפרחתא (Mafrakhta)	*orbis*
בתולות (Bethuloth)	*arbores*	כלונסאות ארז (Klunssaoth)	*arbores*
עבירים (Avirim)	*orbes* =pressboards	כבשי (Kivshei)	*tympanum*[68] =press drum
גלגל (Galgal)	*sucula*	חומרתא (Khumarta)	*cochlea*
קורה (Qorah)	beam	קורה (Qorah)	beam

W.M. Thomson, *The Land and the Book* (London 1889) 207 and fig. there. The grooves in the arbores of that press may have served to guide the pressboard (orbis), the massive stone lintel however makes us consider it to contain some type of upright screw.

[66] Baba Bathra 4, IV, 4:

המוכר את בית הבד, מכר את הים ואת הממל ואת הבתולות, אבל לא מכר את העריכין את הגלגל ואת הקורה.

Danby translates: If a man sold an olive press, he sold also the vat (Yam), the grindstone (Memel) and the posts (Bethuloth), but did not sell the pressing boards (Arikhin), the wheel (Galgal) or the beam (Qorah) (p. 371).

Goldschmidt's translation is to a large extent similar: "War eine Oelmühle verkauft hat, hat auch das Bassin, den Stein und die Pfähle mitverkauft, nicht aber hat er die Pressbretter, Das Rad und den Balken mitverkauft" (VI, p. 189). The term "*Arikhin*" of the Mishna corresponds to '*Avirim*' in the bab. Talmud.

[67] B. Baba Bathra 4, 67b:

"ים טלפחא ממל א"ר אבא: בר ממל מפרכתא בתולות א"ר יוחנן כלונסות של ארז שמעמידין בהן את הקורה עבירים כבשי גלגל חומרתא קורה קורה."

The translation of the terms from both the Mishna (above n. 66) and the Talmudic passage has been the subject for discussion from the Middle Ages onward, and has not yet been settled to the satisfaction of all concerned. Cf. Krauss 221–4 and relevant notes; Dalman 323–5; Yeivin, 53–5. Important for rabbinical sources and terminology: Y. Brand, "Beth Bad," *Sinai* 8 (1943) 404–325 (Hebrew).

[68] '*Avirim*' is not the only version of this term in the sources related to this Mishna. Cf. Krauss 222 and n. 536,7. Albeck's Mishna commentary, div. Nezikin (Jerusalem 1959) pp. 131, 433 (Hebrew). *Orbes*, as pressboards: (Ato *Agr.* 18.

The first two items mentioned do not concern us here, since they belong to the olive mill (*mola olearia*), which is the essential crushing device for the olives prior to their being pressed in the oil press in the narrow sense of the word. Comparison between the other four components proves that in promulgating Mishnaic law, the Rabbis had before their minds' eye a clear image of a winch (*sucula*) operated beampress, type one according to Pliny's description. However, the Talmudic sages already spoke of a screw operated press when translating "*galgal*" with חומרתא.

The question arises what kind of screwpress was meant. On the face of it it seems that it was Pliny's type two — the screw-beam press. We wish however to point out that these terms could equally well have applied to the upright pillar presses:

The term "*Bethuloth*" (or "*Klunssaoth*) could just as well be applied to stone pillars (not to speak of the wooden pillared species of the type). As a matter of fact stone '*arbores*' do appear also with the various types of the beam press during the Roman period in different sites and parts the empire.[69] E ymologically, '*Kivshei*' really means a pressing device, not necessarily pressing boards, and very well fits the *tympanum*. The term '*Khumarta*' of course suits both the screw of the beampress and that of the pillar type. The term '*Qorah*' is easily transferred to the connecting beam between the two posts which holds up the pressing mechanism.

If we remember that technical terms have always been borrowed from one machinery for a more advanced device of the same species,[70] there

The talmudic rendering of '*Avirim*' as '*Kivshe*': כבשי could be translated as any device exercising pressure upon items to be pressed. The latin '*tympanum*' proves that this device was originally a round drum (Cf. White 44–5, 81 — where the term denotes a hollow drum and a wooden wheel disc respectively), just as the *orbis* (not to be confused with the grindstone of the *trapetum*) was a round, disc shaped pressboard.

In the upright vertical screw press, this device became a square chest, to fit in-between the pillars.

[69] For example Figs. 29 a. 31; text pp. 95–96.

[70] N. 68 above. A good example drawn from a quite different device is the development of clock and watch components over the centuries. Compare the early paper bag gun "cartridge" with its present-day counterpart, the medieval ship's "rudder" with the modern one, the horse-drawn "cabriolet" with the pre-World War II motor car of the same name.

remains thus no objection to our suggestion that with the introduction of the upright pillar press, the terms applied to the screw-beam press were used to denote corresponding components of the latter.

The writer would like to conclude this paper with the conjecture that Hadrian may personally have been involved in giving the impetus to the introduction of the upright screw-press into Iudaea. As *Legatus Syriae*, it fell to him to see to the de facto operation of the supply services during Trajan's Parthian war. With his keen sense for economy and organisation, he may then have conceived the stepping up of oil production by introduction of the new machinery. The idea may of course also have been suggested to him by one of his advisors, or even by Pliny The Younger, who, both from the reading of his uncle's writings and his personal experience in olive growing Bithynia, may have drawn Hadrian's attention to this invention. When thus faced with the contingencies of the Bar Kochba War, or the need to revive the country's economy from the havoc wroght during the prolonged fighting, he saw to the introduction of the more advanced installation.

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