STUDIES OF ANCIENT EGYPTIAN FOOTWEAR. TECHNOLOGICAL ASPECTS. PART I. CORDAGE SANDALS FROM QASR IBRIM

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1. Introduction

Footwear is often encountered on archaeological sites all over Egypt and from almost all periods, although surprisingly little has been published. Most footwear is made of hide, leather or plaited strips of palm leaf; footwear made entirely of cordage is less common. The specimens in this chapter (coiled, twined and woven cordage sandals), are the first category of footwear from Qasr Ibrim to be published in detail and the first in a series of technological studies of ancient Egyptian and Nubian footwear.[1]

Within the large numbers of footwear from Qasr Ibrim, predominantly leather and basketry, the examples of cordage sandals are few: only 16 have been registered (table 1). The terminology used in describing the cordage follows Veldmeijer (2005a, b); terms related to knots follows Veldmeijer (2007) and footwear terminology is after Goubitz *et al.* (2001). However, during the work, the necessity of reappraisal of some terms has become apparent and will be presented here as well.

Excavation number	Date	Technique
QI 82.2.18/69	Ottoman (1570-1811 AD)	twined
QI 66A/365	undatable	coiled
QI 82.1.24/13	Late Christian 2 (ca. 1300-1400 AD)	twined
QI 78.2.27/13	Post Meroitic (XC2 Group, ca. 600-650 AD)	woven
72/391	?	woven
QI 82.3.4/173	Classic Christian 2 (ca. 1000-1100 AD)	twined
QI 82.3.4/172	Classic Christian 2 (ca. 1000-1100 AD)	twined
QI 86.2.4/30	Early Christian 2 (ca. 700-850 AD)	twined
QI 84.2.23/116	Early Christian 1 (ca. 650-700 AD)	twined
QI 78.3.11/42	Classic Christian 1 (ca. 850-1000 AD)	twined
QI 95.1.2/31a,b	undatable	twined
QI 18024/A1 & QI 18104/A20	Post Meroitic (X1-X2 Group, ca. 400–550 AD)	twined
QI 78.2.2/52	Early Christian 1 (ca. 650-700 AD)	twined
QI 22008/A10	Late Meroitic (ca. 350-400 AD)	woven

Table 1. The various cordage footwear, their dating and technique listed.

[1] Reader is referred to the forthcoming catalogues for detailed description of each specimen individually (Veldmeijer, forthcoming a, b).

Montembault, V. 2000. Catalogue des chaussures de l'antiquité Égyptienne. — Paris, Réunion des Musées Nationaux.

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Veldmeijer, A.J. In press. Studies of ancient Egyptian footwear. Technological aspects. Part II. Wooden pattens from Ottoman Qasr Ibrim.- Journal of American Research Centre in Egypt.

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Whitcomb, D.S. 1979. Small objects. In: Whitcomb D.S. & J.H. Johnson. Eds. 1979. Quseir al-Qadim 1978. Preliminary report. — Princeton/Cairo, American Research Center in Egypt: 196-210.

simple sandals like the coiled one presented here, were made by the would-be owner him/herself. Indeed, some sandals are so crudely made that it is hard to believe that they are the product of a professional. On the other hand, this type of sandal might have been cheaper, and have been accorded less attention by the sandal maker; that is, a mass product. Sandals are made with a varying degree of care and it is tempting to suggest that they reveal social differences and/or professionalism versus 'homemade' footwear. However, chronological and distributional factors need further attention and examination in the light of other data. Another aspect which should be taken into account is the role fashion and status played in the wearing of particular footwear.

5. *Acknowledgements*

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Goubitz, O. 2001. Glossary of footwear terms from early Medieval times until 1800. In: Goubitz, O., C. van Driel-Murray & W. Groenman-van Waateringe. 2001. Stepping through time. Archaeological footwear from Prehistoric times until 1800. — Zwolle, Foundation for Promoting Archaeology (Stichting Promotie Archeologie): 317-324.

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Handley, F. 2000. Basketry, matting and cordage. In: Peacock, D., L. Blue, N. Bradford & S. Moser. Eds. 2000. Myos Hormos — Quseir al–Qadim. A Roman and Islamic port site on the Red Sea Coast of Egypt. — Southampton, University of Southampton. Online at: http://www.arch.soton.ac.uk/Projects/projects.asp?Division=1&SubDivision=2&Page=0&ProjectID=20) (version 9 November 2006).

Johnson, J.H. 1982. Small objects. In: Whitcomb, D.S. & J.H. Johnson. Eds. 1982. Quseir al-Qadim 1980. Preliminary report. Malibu, Undena Publications (American Research Center in Egypt Reports 7): 327-344.

much better resistant to wear than the softer grass. The preference for material, however, may have been largely dictated by the local conditions. A specimen described in more detail was recovered in Berenike (own observation; Wendrich, 2000b: 232-233). This woven sandal from a first century AD context was made with a fine fibre, which could not be identified due to its bad condition. It is comparable to the woven sandal QI 78.2.27/13 described above in that it has nine warps (of two zS_2 strings) and horizontal wefts and compares with the Meroitic sandal as well. Remarkably, no other finds of basketry footwear, cordage footwear or even leather footwear (except a possible sole, see Veldmeijer, 2007) have been registered from this site. From the south of Egypt, cordage sandals are reported from Kulubnarti, among which one with a basketry insole and cordage treadsole, sewn with leather thongs. These all are from Christian times or later (Adams & Adams, 1998: 63).

The lack of cordage footwear at Qasr Ibrim cannot be explained by extensive use and/or post-depositional processes, as the few examples stand in sharp contrast to the numerous basketry and leather specimens. On the other hand, cordage tends to lose coherence and fall apart quickly once the ply is damaged. The lack may be explained by the fact that the specimens belonged to visitors to the site and were not worn by the indigenous inhabitants. If so, they must have come from the south, because the double front strap seems to be a southern feature (see below). At Qasr Ibrim, it seems that cordage footwear never gained much popularity among the inhabitants, certainly not before Christian times. The many specimens of heavy fibre footwear reinforced with leather thongs, leather footwear, and even some examples of wooden pattens (Veldmeijer, in press) may be interpreted as supporting this suggestion.

Currently, the use of a double front strap running between the first and second, and third and fourth toe, is only known from footwear from Qasr Ibrim and more southerly sites. Many of the sandals from Qasr Ibrim, albeit of fibre (cordage, basketry) or leather, show this type of fastening. An example from a more southerly site in Nubia presents a leather sandal with the foot still *in situ* (Adams, 2005: figure 61, plate 25) but the Oriental Institute Museum Chicago possess even older leather sandals including foot and double front strap as well (own observation). Reisner (1923: 206-308) mentions that most of the spandals found in Kerma wear equipped with the double front strap too. At the moment, no examples are known from Egypt and it is therefore concluded that this is a distinctively Nubian feature. It remains uncertain for now when this came about and how long it lasted; the studied examples so far are of fairly recent date (from Christian times onwards). But the examples from Kerma suggests a long-standing tradition.

All footwear has been recovered from domestic contexts; whether people from Qasr Ibrim were buried with these kind of sandals remains uncertain, as only few Christian tombs have been excavated.

The quality of the pieces made using the various techniques differs, not only due to their construction but also due to the material. The sandals woven from plied cordage seem stronger than the coiled sandals, as presented here. Although it is known that in Pharaonic times sandals were made by professional sandal makers,[10] it seems not unlikely that the

[10] However, we do not know what types of sandals were made by the sandal maker.

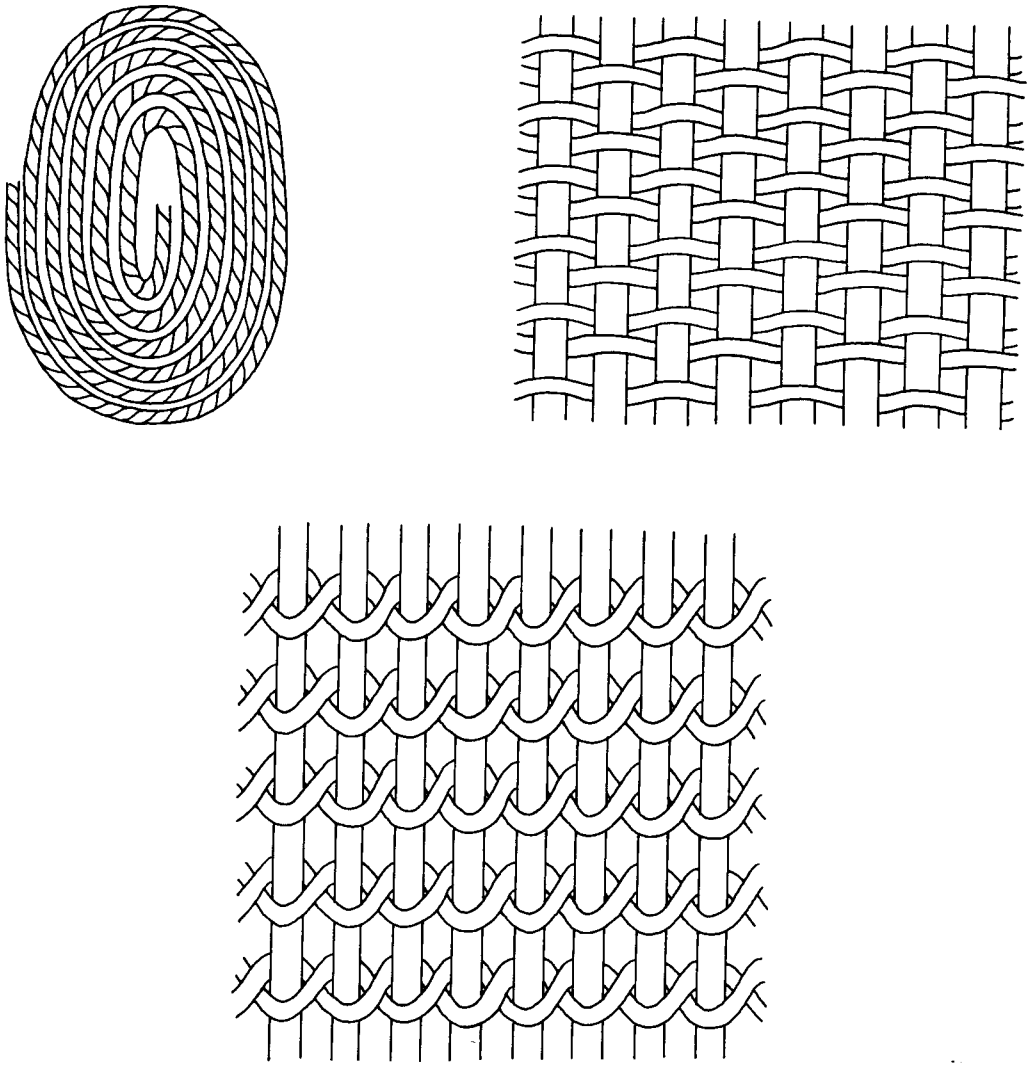


Figure 9. The three main techniques encountered in the cordage footwear from Qasr Ibrim. A: coiled; B: woven; C: twined. Drawing by E. Endenburg.

comes from Meroitic layers. Surprisingly, plied cordage footwear have not been recorded from Pharaonic and Roman contexts at Qasr Ibrim whereas this footwear is known from the Roman layers of Quseir al-Qadim (Handley, 1999, 2000; Richardson, 2001, 2002, 2003; Whitcomb, 1979) as well as from Islamic layers (Johnson, 1982). No detailed accounts on these have been published yet, but at least the coiled type was among them (Handley, 2000; Richardson, 2001, 2002). The authors state that the items were made of rough grass and bast. None of the footwear so far examined from Qasr Ibrim has been made of grass; only palm fibre is used. Using palm fibre makes more sense, because palm fibre, being rather stiff and very tough, is

3. Wear

Footwear often shows wear at the heel. This is no surprise because this part of footwear is subject to the greatest force. Also, the dragging of the heel over the ground results in extensive wear of the backside of the heel facing the ground (for examples QI 66A/365, QI 82.1.24/13, QI 82.3.4/173, QI 86.2.4/30). Another part of footwear that often shows a high degree of wear, but less than the heel, is at the ball of the foot. An especially severe instance is QI 86.2.4/30, in which the wear reduced this part to a hole. Probably, the owner of this piece walked on the edge of his or her inner foot, resulting in this extremely high degree of wear. The heel has also been completely worn although the end of the sandal is not. Other parts prone to wear are the straps, although in most cases it cannot be established whether the breakage or damage to the plies etc. is due to use or due to post-depositional processes.

4. Discussion

In basketry studies, the term 'coiled' is, according to Wendrich (1999: 136-137) "a technique which involves two systems: a passive system, consisting of one element (bundle, foundation) which is coiled and held into place by an active element (winder), which follows the coil." However, there are some difficulties using this term in the study of footwear (as has been done by Vogelsang-Eastwood, 1994: 140), previously recognised by Wendrich (1991: 137) who mentions in a remark on the definition that the technique is also known as 'stitched or sewn basketry', see also Wendrich 2000a: 256). In basketry these cores are spiralling, whereas in the referred type of footwear they are placed horizontally, thus at right angles to the length of the sandal (Veldmeijer accepted b). This clearly differs from sandals that have been made by coiling and stitching at right angles to the coil, like QI 66A/365. To avoid this confusion, in footwear studies, the term 'sewn' should be used to refer to types of footwear of which the appearance is cited above.[7] The term 'coiled' in footwear should be reserved for sandals made by winding a strand around itself two-dimensionally (this can be plied string, as presented above, or braids or even cores wound with fibre, seen in some sandals in the Petrie Museum and the British Museum[8]); cf. also Vogelsang-Eastwood (1994: 140), where figures 232 shows coiled basketry and figure 233a sewn sandal (*contra* the author).

Within the few cordage sandals registered, a relatively wide variety can be observed. The footwear is twined, woven and coiled, the three major categories (figure 9). These techniques were already used in more ancient times and may go back as far as the Old Kingdom and possibly further.[9] The only examples of Pharaonic cordage sandals published in depth thus far, comes from 18th-20th Dynasty Deir el-Médineh (Gourlay, 1981: 56-57).

Of the sandals discussed here most dated to Christian times. Those with basketry insoles are from slightly older context (Post Meroitic) and QI 82.2.18/69 is Ottoman. Only one example

[7] Note that another, rare type of footwear is made by coiling a bundle, which has been sewn. These are referred to as coiled sewn sandals (Veldmeijer, submitted).

[8] The footwear in the collection of the Petrie Museum and the collection of the British Museum are currently under study by the author.

[9] The techniques were already used in prehistoric times for making basketry and matting (own observation, Wendrich, 2000a).

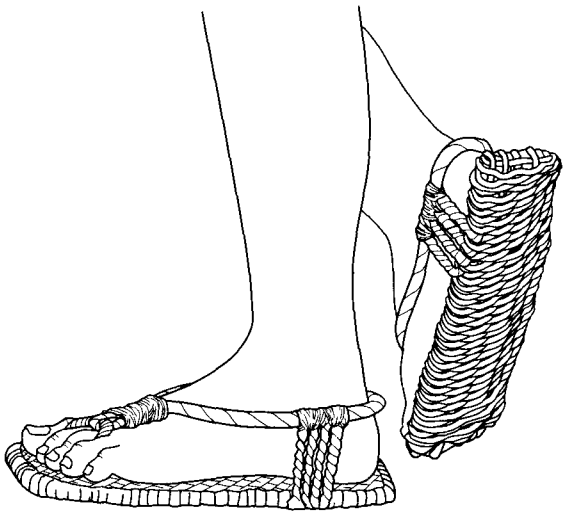


Figure 8. Artist impression of the sandal shown in figure 7.
Note that the plying of the cordage treadsole has not been indicated. Drawing by M.H. Kriek.

is fastened by means of coarse running stitches (approximately 25 mm long) of a strip of palm leaf along the entire edge, with spaces of 25-30 mm. The strap is made with care. It consists of a core (probably halfa grass), cladded Z-wise with strips of palm leaf. At the heel, the back strap is fastened at the left side by means of a zS_2 palm fibre string (diameters of 5 mm) which passes four times through the soles at points between 45 mm and 60 mm from the heel and looped around the core of the strap. The loops are held by this cladding. At the right side, the strings are absent. Instead, in the comparable position, a small piece of zS_2 string of unidentified material has been passed through the soles (at 45 and 60 mm from the heel and close to the edge) and looped around the strap and cladding. No attempt was made to wrap it with the cladding. On the ventral surface of the sole, each end of the string is fastened by means of an overhand stopper knot, a common way of fastening straps, but especially the front straps rather than the back straps. Remnants of the original attachment are still visible. The fastening at the right side is a repair because the right sandal shows, at both sides, the same attachment of the strap as described above for the left side of the left sandal. The front strap is fastened to the back strap by means of loosely [Z]-cabled $zS_2(?)$ string that leads through the loop of the strap. It passes through the soles twice (at 35 mm from the right edge, 30 mm from the left edge and about 40 mm from the front) and is fastened at the treadsole by means of overhand knots. The strap runs not only between the first and second toe, but also between the third and fourth toe. Towards the front, the front strap is wound three times around the two lengths of the strap, 80-120 mm from the front of the sandal, with a piece of undyed, tabby-weave cloth. It is held in place by a strip of palm leaf twisted around the centre of the cloth. The cloth in the right sandal also covers the string that ties the strap, suggesting that the cloth in the left sandal is largely missing. The strap is tightly constructed.

Footwear made of cordage and basketry are more common. Often it has a basketry sole and/or upper which is reinforced with a cordage treadsole, consisting of woven, unspun palm fibre (for examples from Qasr Ibrim, see Veldmeijer, accepted a.). Cordage sandals with only a basketry insole are not often encountered and only two instances are recorded. These were excavated from different but associated contexts (Post Meroitic, table 1) and form the left and right members of the same pair (figure 7 and 8). Here the cordage sole is the main body of the sandal and the basketry insole only adds more comfort. It is evident that these are sandals and not the treadsole and insole of shoes, as there is nothing that suggests that uppers once were attached. The description below focuses on the left sandal, QI 18024/A13 (the right one is QI 18104/A20), which is the better preserved one. It has a length of 300 mm and a maximum width of 110 mm. The cordage treadsole consists of five vertical warps (each consisting of two parallel zS_2 strings) and the weft of zS_2 string forms a woven fabric. The insole is made of a 10-strand plait (width of the strands vary from 6 to 10 mm) of palm leaf in a 'over one-under one-shift one' pattern and is slightly smaller than the cordage treadsole (280 × 85 mm); it does not extend the treadsole. In contrast to the treadsole, the insole has an asymmetrical pointed front end, clearly indicating the orientation of the sandal. The heel is square. The plaited insole is fastened to the treadsole by means of the straps, discussed below, two stitches at the heel and one at each side of the toe. The basketry insole of the right sandal, however,

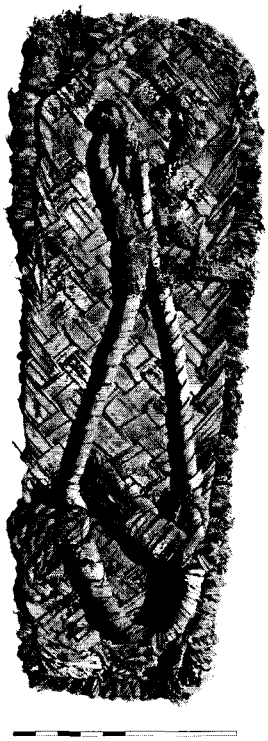


Figure 7. Sandal (left one, QI 18024/A13) consisting of woven cordage treadsole and basketry insole, dated to Post Meroitic (table 1). Courtesy of the Egypt Exploration Society.

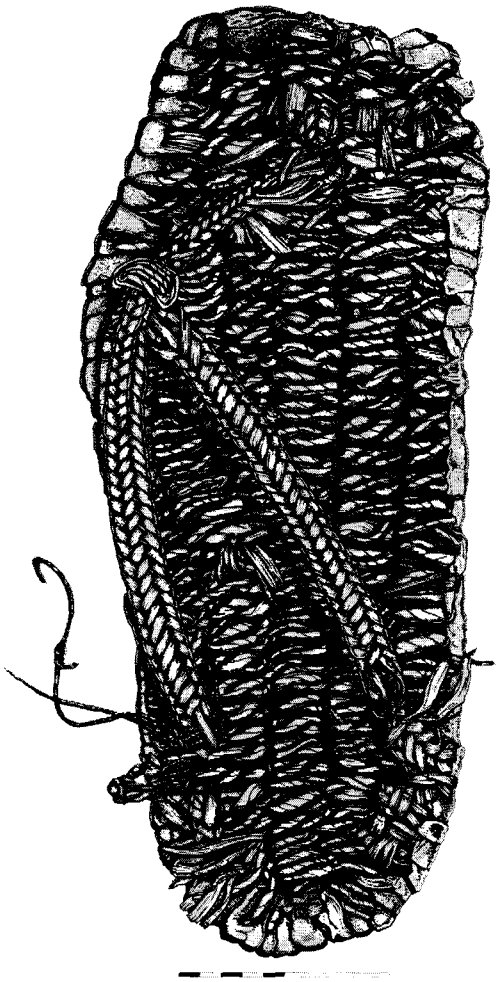


Figure 6. Woven sandal (QI 22008/A10) from Late Meroitic contexts (table 1) and oldest thus far encountered at Qasr Ibrim. Note the repair of the attachment of the left back strap with small soft fibre string. Drawing by A. England.

sewn with palm leaf strips, which must have functioned as decoration rather than reinforcement because the long sides of these kind of sandals are finished in itself and quite strong (cf. figure 5). The plaited straps are often seen and occur in a variety of forms. Here, the back straps are made of four small strips of palm leaf, plaited in an 'over one-under one-shift one' pattern around a core. The back straps are attached to the sole, slightly inwards from the edge (the left one is sewn to the sole with a soft fibre string, which is a repair). The two back straps are connected at the front; from here the left one continues to the front part of the sandal and inserts between the strings of the sole. It is secured by means of an overhand knot at the dorsal surface of the sandal. The width of the back straps is 10 mm.

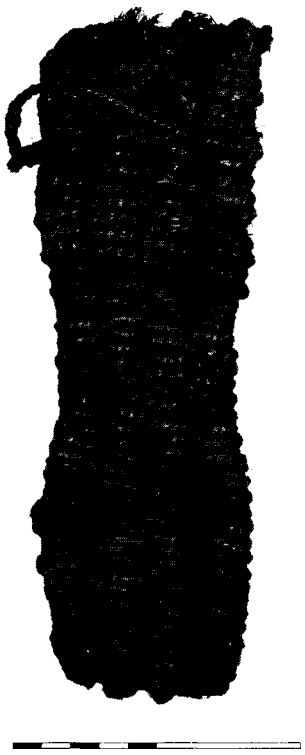


Figure 5. Sandal, woven with fine zS_2 palm fibre string (QI 78.2.27/13). Note the small and long shape of the sandal. From Post Meroitic layers (table 1). Photograph by E. Endenburg. Courtesy of the Egypt Exploration Society.

the rest of the sandal, but including the part under the heel as well. The weft is woven over one and under one warp after which this pattern is repeated in the following row, but alternating from the previous weft. The subsequent wefts are firmly placed together, forming a strong, rather inflexible sandal. The finishing of the weft is simply done by means of an S-overhand knot, placed against the warp. The strap is broken at one side, but the other side is still firmly attached. It is inserted between the warp and the end of the zS_2 string is inserted in the plies. Probably the end contained a stopper knot to prevent slipping out, although there are no such remnants visible.

The sandal in figure 6 (QI 22008/A10) is the oldest encountered thus far and dates from Late Meroitic context (table 1). The sole is woven as well but differs from the previous described one on various points, besides the measurements. The sole consist of five vertical warps, made of zS_2 string (as are the wefts) with diameters of 2.7 and 4.6 mm for yarn and ply respectively (the CIP is irregular). The total length is about 220 mm; the width at the ball of the foot is 92 mm and at the heel 72 mm. One long side is straight, but the other side, which is the outer side of the foot, is slightly expended at the ball of the foot. In this, the sandal is shaped after the form of the left foot (referred to as 'swayed'). The edges are

resulting in a decorative herring-bone pattern. The sole is bordered by a zS_2 rim and a similar zS_2 string runs longitudinally down the middle, dividing the sandal in two halves; the weft has been twined between the central and outer strings. The insole is reinforced with a leather treadsole in approximately the same shape. This treadsole is attached with a line of large leather stitches of 5 mm wide and about 20 mm long and run along the sides and presumably across the front, where the leather is now lost. At the rear, the treadsole has projections which curl around the side of the palm fibre insole and stand up some 30 mm. Their ends are rounded and in each is a triangular hole of 10 mm in diameter. The left one has a narrow leather strip sewn with small leather stitches around the edge on the outer surface. This strengthened the tie and helped to prevent the hole from splitting. A tiny leather fragment projecting from beneath it may prove to be the remains of a decorative leather patch 25 mm below the hole. On the right one, only a few stitches survive but it was presumably identical. The strap is a palm fibre zS_2 string which is fastened to the leather projections by means of half knots. It runs from the right projection towards the front where it is knotted to another piece of string by means of a reef knot. On returning, it is twisted once around itself and attached to the left projection. The front strap is pierced through the palm and leather where it is knotted, probably into an overhand knot. It runs only between the first and second toe. Because the front strap is situated 45 mm from left and 60 mm from right, it is suggested that the sandal is for the right foot. The heel of the insole is folded and fastened to the ventral surface of the insole and thus sandwiched between the fibre insole and leather treadsole. Another pair of sandals (QI 84.2.23/116) of this type but from early Christian context (table 1) differs in that it does no have leather soles. These heavily worn sandals have clear edges, made by 'cabling' the zS_2 warps (cf. Wendrich, 1999: 316, figure 15-16 below right).

The well-preserved Christian (table 1) sandal QI 78.2.2/52, twined in a herring-bone pattern, shows a notch at the front, a feature often seen in Egyptian footwear, fibre and leather alike. The strap, consisting of one sZ_2 string is fastened at the heel at both sides and runs to two points of attachment at the front. At the heel, the back strap also forms a strap that runs behind the heel, a so-called 'heel strap'; a same kind of construction as seen in QI 86.2.4/30, also Christian in date (table 1). The herring-bone sandal QI 95.1.2/31 (undatable) shows a well-made edge, constructed by the zS_2 warps which have been twisted, each with the following ones, into a [Z]-cable (cf. Wendrich, 1999: 316, figure 15-16 below right).

2.3. Woven sandals

The well-made piece of footwear in figure 5 (QI 78.2.27/13) dates to the Post Meroitic era (table 1) and is in good condition, although the heel is slightly worn. The sandal is for the left foot. The weft and the strap are the same type of string, namely zS_2 palm fibre. The string is very regular and has an average diameter of 1.7 mm for the yarn and 3.2 mm for the ply. The CIP is 67. The four vertical warps consist of two parallel, slightly thicker zS_2 strings, with an average diameter of 3.1 mm for the yarn and 7.2 mm for the ply. The CIP could not be calculated because the weft obscures too much. Measured at the surface, in the middle of the length of the sandal, these warps, visible as longitudinal bumps in the wefts, have an average width of 13.9 mm. The total length of the sandal is 230 mm. The width at the top is 60 mm, at the ball of the foot 72 mm, in the middle 59 mm and at the heel 75 mm. The loops of the warp are still intact at the top of the sandal. The lower part is folded under the heel, and is fastened by means of the weft which is woven not only around the first level of warp as seen in

makes sense because folded outwards, the fold easily catches dirt and, due to the fact that this side is much more prone to wear, the attached heel might loosen quickly, forcing the owner to repair it more quickly and more often. The strap of QI 82.1.24/13 consists of one sZ_2 string (diameter of 3.5 mm for the yarn and 4.9 mm for the ply; CIP of 62) of which the back strap is inserted in the wefts of the sole. The front strap is also put through the sole; one extremity is the beginning of the string, indicated by the eye. The string has been put through this eye, when coming back from the heel part, and put through the plies of the opposite part. The extremity terminates in a Z-overhand knot. The front strap goes between the first and second, and the third and fourth toe.

A variation on the above-described sandal is QI 78.3.11/42 (figure 4) and dates to the Christian era as well (table 1). This almost complete piece of footwear is made from palm fibre zS_2 warps and z-spun yarns as weft (also palm fibre). The diameter of the warp is 3.3 mm for the yarn and 5.7 mm for the ply. The CIP calculation could not be done due to the bending of the cordage, preventing a representative measurement. The average diameter of the weft is 4.3 mm. The total length is 270 mm, the width at the ball of the foot is 100 mm and the width at the heel is 71 mm. The weft is twined alternatingly in Z- and S-orientation,

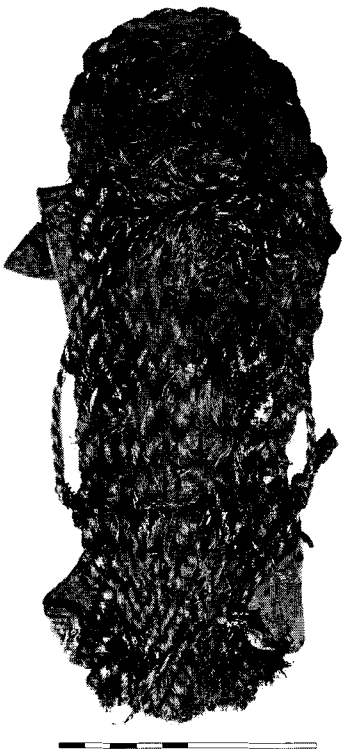


Figure 4. Twined sandal QI 78.3.11/42, consisting of a fibre insole and leather treadsole. Dated to Classic Christian era (table 1). Courtesy of the Egypt Exploration Society.



Figure 2. Twined sandal QI 82.1.24/13 is dated to Late Christian period (table 1). Photograph by E. Endenburg. Courtesy of the Egypt Exploration Society.

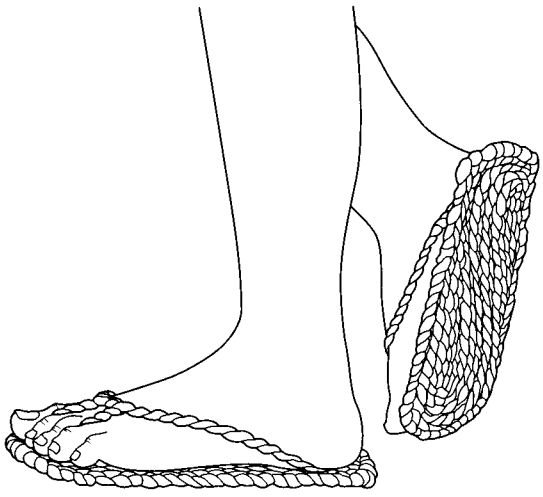


Figure 3. Artist impression of twined sandal QI 82.1.24/13, seen in figure 2. Note that the toe straps run between the first and second toe as well as the third and fourth toe, which is only seen in Nubian footwear. The back straps are inserted between the yarns of the twined sole. Drawing by M.H. Kriek.



Figure 1. The only coiled cordage sandal found, QI66/365A, came from an undatable context. Photograph by E. Endenburg. Courtesy of the Egypt Exploration Society.

s-spun yarns used as wefts have an average diameter of 7.1 mm. Both warp and weft are made of palm fibre. The total length of the sandal is 260 mm; the width at the heel is 100 mm and at the toes 85 mm. The weft continues in the next row after bending at the front and back of the sandal; the result is a diagonal pattern. Twining is also seen in QI 82.2.18/69, QI 82.3.4/173, QI 82.3.4/172 and QI 86.2.4/30. The technique used in QI 84.2.23/116 is the same but the pattern is not diagonal; it seems that the diagonal pattern is a coincidence rather than an intended feature. The heel of the sandal is almost always folded towards the dorsal surface of the sandal.[5] Usually the extremities of the folded heel are inserted in the warp or the weft but sometimes they are stitching to the sole (QI 82.2.18/69). In one case, the heel is folded under the sandal, facing the ground (QI 86.2.4/30), and is carefully secured. Finishing the heel by folding has the advantage that the heel, obviously the part of the sandal which has to withstand great forces, is strengthened. Although it seems illogical to fold the heel towards the dorsal surface because it would be inconvenient, it

[5] In multiple layered soles, the sole on which the foot rests is called 'insole'; the foot rests on the dorsal surface whereas the ventral surface of the insole is the surface that is in contact with the sole that faces the ground (called 'treadsole'). The ventral surface of the treadsole is the surface that makes contact with the floor.

2. *Description*

All pieces of footwear discussed here is sandals. The definition of 'sandal' is always based on examples of leather sandals. For instance, Goubitz (2001: 322) defines 'sandal' as a leather sole with front strap and back strap. Montembault (2000: 243) in her catalogue of the Egyptian footwear in the Louvre defines sandals in a comparable way. However, this definition is not suitable for the Egyptian material because the definition has to include other materials as well. In Egypt, the favourable preservational conditions allow for the survival of other organic material, such as vegetable fibres. Therefore, the following definition is used: 'a sole only, which is made of one material or a combination of different materials (among which are leather, vegetable fibre or wood) with a back strap, and/or heel strap and/or front strap. The sole can consist of various layers.' This means that footwear with a closed heel are excluded (shoe); the same counts for footwear with a closed front part (slippers).

2.1. *Coiled sandals*

Only one example of a coiled sandal made of cordage (here plied palm fibre string) is among the footwear (figure 1). Unfortunately, the context is undatable. The ventral surface[2] of QI 66A/365 is slightly worn, but not all the way through; the heel is incomplete. The sandal is 260 mm long and 100 mm broad halfway along its length. The width at the widest point of the foot is 120 mm. The sandal is made by coiling (possibly one length of) zS_2 string eight times, which is held together by a zS_2 string (with average diameters of 2.1 mm for the yarn and 3.9 mm for the ply) which is sown through the coil from one side of the sandal to the other. The string of the coil has an average diameter of 8.2 mm (ply) and 5.6 mm (yarn). The front strap is constructed by means of folding the palm fibre yarn, thus creating an eye, and plying it, resulting in a zS_2 string. At the front of the sandal, this eye is used to tie the other end of the strap by means of a Z-half knot, after which it disappears between two windings and emerges at the other side, but from between the same row of windings. Here it terminates in an S-overhand stopper knot to prevent it from slipping out of the half knot. Following the end of the eye towards the heel, it is fastened by means of wrapping around the outer winding of the sole, after which it continues towards the other (left) side. Here, again, the string is fastened by means of winding, so creating a back strap. Another, third yarn, consists of a beige $sZ_n[S_2]$ cable[3] and provides a decorative effect against the brownish background of the palm fibre strap.

2.2. *Twined sandals*

The sandal in figure 2 and 3 (QI 82.1.24/13), from Late Christian context (table 1) possibly has nine horizontal warps of which most of the loops, with which it was attached to the frame, are still visible, and 16 vertical wefts, twined Z-wise.[4] The warp consists of zS_2 string, with a diameter of 2.9 mm for the yarn and 5.9 mm for the ply. The CIP could not be calculated because the weft obscures too much in order to take the necessary measurements. The

[2] The ventral surface is the surface that faces the ground; the dorsal surface is the surface that faces upwards.
[3] The material has not been identified, but possibly flax.
[4] Adams (1996: 179) refers to this sandal as being woven, but admits that the technique was not analysed in detail.