A Wooden Chest from West Saqqara and Its Enigmatic Contents
Remarks on Mummification Process in the Old Kingdom

with Appendixes by
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Since 1996, archaeological mission of the Polish Centre of the Mediterranean Archaeology of the University of Warsaw has been carrying out excavations works on the western side of Netjerykhet’s funerary complex at Saqqara, uncovering two cemeteries: the so-called Lower Necropolis, dated to the late Old Kingdom (Sixth Dynasty and slightly later times), and the Upper Necropolis, dating from the end of the Late Period to the Roman Period. Small mud brick mastabas reserved for the middle-class citizens form the definite majority of the Lower Necropolis tombs excavated thus far. The upper structures of the tombs have been utterly destroyed. Only several tombs of the upper-class officials, such as those of vizier Merefnebef or priest Nyankhenfertem, have been unearthed. They are cut in natural rock and decorated with unique and very well preserved reliefs and paintings. The Upper Necropolis comprises usually simple and poor burials cut into the dakka or in the wind-blown sand deposits.

In the season of 2000, the eastern facade of the ‘Dry Moat’, a gigantic ditch surrounding the Step Pyramid funerary complex, was exposed in the western part of the area under excavations. Two corridors, numbered 1 and 2, were found in the eastern part of the ‘Dry Moat’ uncovered by the Polish mission to date. Corridor 1 ends in a small chamber, in which a deposit of animal bones, a wooden harpoon, and most likely the foundation pottery deposit were found. Although the function of Corridor 1 remains a mystery, it was clear from the beginning that it was not designed to serve as a tomb. Corridor 2, in turn, presents a completely different situation. This is a funerary complex consisting of five chapels designated by letters A through E. There are twenty-two shafts cut in both the chapels and the corridor itself. With the help of ceramics, it was possible to determine that Corridor 2 remained in use in phase III and IV of the necropolis, i.e. during the reign of Pepy II. The upper part of the fill in both corridors was a wind blown sand which overlay a thick layer of mud, formed owing to intensive rainfalls in that area. Sandwiched in between the sand and mud was a relatively thick deposit, comprising thousands of mice skeletal remains. These deposits concealed all signs of human activity that once took place here, such as funerals, mortuary cult, grave robbery etc. The oldest pottery found within the deposits below the mud is dated to the late Old Kingdom (phase IV), while ceramics found on top of the wind-blown sand in Corridor 1 are dated to the Middle Kingdom. This indicates that the heavy rainfalls (and

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2 The first tomb was published in 2005, cf. MYŚLIWIEC et al., Saqqara I; the publication of the second tomb, which will come out as volume IV in the Polish Saqqara series, is in press.


1. Corridor 2, general view; photo taken mid-point down the corridor. The first shaft in the foreground is C2/17; one on the right is C2/15, while shafts C2/10, C2/11, and C2/9 are visible on the left (Phot. M. Jawornicki).

4. A sealing fragment, and stoppers found in the C2/10 shaft – Cat. Nos. 8–11 (Drawing: T.I. Rzeuska, inked by M. Orzechowska).
the mice extermination) took place between the end of the Old Kingdom and beginning of the Middle Kingdom.5

FUNERARY SHAFT C2/10

As has already been mentioned, a total of twenty-two shafts were cut in Corridor 2 and the chapels. All but one, which is a so-called false shaft C2/16,6 are funerary shafts. A special consideration should be given to shaft C2/10, located further inside by the north wall of the complex, between entrances to chapels C and D (Fig. 1). Its maximum depth is 4.36 m, and the sides of the mouth at the highest preserved part measure: 1.23 m (northern side), 1.12 m (eastern side), 1.15 m (southern side), and 1.26 m (western side), (Fig. 2).

The shaft was filled with tafla, containing a small number of objects: fragments of broken sealings (Fig. 4.8), stoppers (Fig. 4.10–11), pieces of charcoal, and the so-called false fillings – lumps of Nile mud that once had been used to imitate beer in beer jars (Fig. 4.9).7 At the depth of 1 meter down the shaft, rock fragments with traces of plaster were found. Half a meter below, in the south-eastern corner of the shaft, remains of a wooden statue were uncovered: a foot 9.5 cm long and 4.5 cm high, with a peg in the middle of the sole, which originally had been attached to a base. The largest group of objects is represented by numerous ceramic diagnostic fragments, primarily beer jars. Two types have been identified: Form 9 (three V-shaped bases)8 and Form 4 (three U-shaped bases and 24 rim fragments). Additionally, there were several non-diagnostic fragments of one or more bread trays, as well as bowl, plates, stand, and stopper fragments, which are presented below.9

1. Medium size, tall jar with modelled, medium high neck, ovoid body and rounded bottom (Form 22):
   No.: SQ 03–1283
   Ac.: K.03-58 (filling of shaft C2/10 up to 2.5 m of its depth)
   Clay: mixed clay P.60
   Technique: thrown on wheel
   Surface treatment: outside self-slipped, inside natural

5 For more about the heavy rainfalls in Saqqara in the period between the Old and New Kingdoms, see: K.O. KURASZKIEWICZ, J. TRZCNISKI, F. WELC, Preliminary report on Geoarchaeological Research in West Saqqara, PAM XIX, in press.
6 T.I. RZEUSKA, West Saqqara 2002. The Pottery, PAM XIV, 2003, p. 137, Fig. 6.
8 These Forms refer to the mission’s typology of vessels.
9 Ceramic material descriptions (manufacturing technique, bottom and surface treatment) in accordance with norms set for the West Saqqara necropolis presented in: ibid., pp. 35–54; clay typology based on the Vienna System.
Colour: outside – 2.5 Y 8/3 pale yellow; inside – 2.5 YR 4/4 reddish brown
Firing: red
Hardness: 2
Rim diam.: 5 cm; height: 4.7 cm
Preservation: 360° of rim
Dating: phases II–III\(^\text{10}\)

2. Medium size platter with rounded rim (Form 49):
No.: SQ 03-1312
Ac.: K.03-49 (filling of shaft C2/10) + K.03-58 (filling of shaft C2/10 up to 2.5 m of its depth)
Clay: Nile C
Technique: hand-built, bottom scraped
Surface treatment: uncoated
Colour: inside – 2.5 YR 5/6 red; outside – 10 R 5/6-8 red
Firing: mix
Hardness: 2
Rim diam.: 26 cm; base diam.: 25 cm; max diam.: 27 cm; height: 2.6 cm
Preservation: 90° of body
Dating: phases III–IV

3. Plate with long-ledged and outside modelled rim (Form 96):
Ac.: K.03-58 (filling of shaft C2/10 up to 2.5 m of its depth) + K.03-63 (filling of shaft C2/10 at depth of 2.5 m and below)
Clay: Nile B1
Technique: thrown on wheel
Surface treatment: inside – red-slipped; outside – red-slipped on rim, below uncoated
Rim diam.: 25 cm; max diam.: 26 cm; height: 4.4 cm
Preservation: 120° of rim
Dating: phases III–IV

4. Large, straight-walled plate with rounded, grooved rim (Form 99):
Ac.: K.03-58 (filling of shaft C2/10 up to 2.5 m of its depth)
Clay: Nile B1
Technique: thrown on wheel, bottom scraped
Surface treatment: red-slipped
Rim diam.: 31 cm; max diam.: 32 cm; height: 3 cm
Preservation: 70° of rim
Comments: outside and inside traces of fire
Dating: phases III–IV

\(^{10}\) Pottery dating based on \textit{Rzeuska, Saqqara II, passim.}
5. Large plate with rounded, grooved rim (Form 99)
   No.: SQ 04-1467
   Ac.: K.03-63 (filling of shaft C2/10 at depth of 2.5 m and below) + K.03-68 (filling of burial shaft C2/11)
   Clay: Nile B1
   Technique: thrown on wheel, bottom scraped
   Surface treatment: red-slipped
   Colour: 10 R 5/6 red
   Firing: oxy
   Hardness: 3
   Rim diam.: 34 cm; max diam.: 35 cm; height: 3.5 cm
   Preservation: 90° of rim
   Comments: outside traces of fire
   Dating: phases III–IV

6. Deep bowl with modelled rim (Form 154):
   Ac.: K.03-58 (filling of shaft C2/10 up to 2.5 m of its depth)
   Clay: Nile B1
   Technique: thrown on wheel
   Surface treatment: red-slipped
   Rim diam.: 25 cm; max diam.: 26 cm; height: 4.4 cm
   Preservation: 120° of rim
   Dating: probably phases III–IV

7. High X-shaped stand (Form 216):
   Ac.: K.03-58 (filling of shaft C2/10 up to 2.5 m of its depth)
   Clay: Nile B1
   Technique: thrown on wheel
   Surface treatment: red-slipped
   Rim diam.: uncertain; pres. height: 5.4 cm
   Preservation: uncertain
   Dating: phase I, probably the form is present in phases II–IV as well

8. Fragment of sealing:
   No.: SQ 03-1219
   Ac.: K.03-58 (filling of shaft C2/10 up to 2.5 m of its depth)
   Clay: Nile mud with organic tempering (chopped straw)
   Technique: hand-made
   Colour: Gley 2 4/1 5PB dark bluish grey
   Firing: unfired
   Hardness: very soft
   Max pres. diam.: 6.5 cm; height: 3.2 cm
   Preservation: partly preserved
9. Inner stopper
   No.: SQ 03-1220
   Ac.: K. 03-58 (filling of shaft C2/10 up to 2.5 m of its depth)
   Clay: Nile mud
   Technique: hand-made
   Colour: Gley 2 3/1 5 B very dark bluish grey
   Firing: unfired
   Hardness: very soft
   Max diam.: 9.3 cm; height: 6.2 cm
   Preservation: part of rim missing

10. Conical stopper
    No.: SQ 03-1221
    Ac.: K. 03-58 (filling of shaft C2/10 up to 2.5 m of its depth)
    Clay: Nile mud
    Technique: hand-made
    Colour: Gley 2 3/1 5 B very dark bluish grey
    Firing: unfired
    Hardness: very soft
    Max diam.: 5.6 cm; height: 3.9 cm
    Preservation: partially broken

11. Stopper
    No.: SQ 03-1225
    Ac.: K. 03-63 (filling of shaft C2/10 at depth of 2.5 m and below)
    Clay: Nile mud
    Technique: hand-made
    Colour: Gley 2 3/1 5 B very dark bluish grey
    Firing: unfired
    Hardness: very soft
    Max diam.: 6.3 cm; height: 3.9 cm
    Preservation: complete

The mixed character of the upper fill of the shaft, especially the fragmentarily preserved ceramics, part of the wooden statue, as well as the fragment of white plaster used for coating the burial chamber entrance blockage or upper part of the shaft (a sort of ‘sealing’ method)\(^1\) indicated that this shaft, just like all other burial shafts uncovered at the necropolis thus far, had been robbed out. The offering pottery, originally placed in shaft C2/10 during the funeral, was thrown out by grave robbers, causing breaking and mixing the ceramics with material from other shafts. Thus, it is difficult to determine the primary

\(^1\) At the West Saqqara necropolis the entrance to burial chambers was occasionally painted white. The first intact shaft found at the Tabbet el-Guesh necropolis in Saqqara South, shows, in turn, that its upper surface was painted (sealed) with white paint; personal communication of Dr. Vasco Dobrev (IFAO).
5. Projection of the ground level of the C1/10 burial chamber
(Drawing B. Błaszczyk, inked by M. Orzechowska).

6. Northern wall of the C2/10 burial chamber showing ceramic vessels, Cat. Nos. 14–15, in situ
(Drawing: B. Błaszczyk, inked by M. Orzechowska).
contents of this shaft. Large plate (Cat. No. 5) in the catalogue serves as a good example of the scattering of one vessel’s fragments in different shafts. Matching fragments were found not only in shaft C2/10 but also in a nearby shaft C2/11. Regardless of the mixed nature of the pottery, it is worth to mention that all the vessels found in the shaft, except one rim fragment of a small jar (Cat. No. 1) from phases II–III, are dated to phases III–IV. Two rim fragments of large bowls (Nos. 4 and 5) appear to be quite interesting, as they are atypical of the ceramic material found at the necropolis. In the former, both the exterior and interior are charred, while in the latter only the outside surface bears marks of burning. This indicates something was either heated up/cooked in them (exterior charring), or burned inside the bowls (interior charring). These vessels were most likely used in the funeral or mortuary cult ceremonies, carried out in the chapels of Corridor 2. A special attention should also be given to two small stoppers (Cat. Nos. 10–11), used for plugging small and medium size jars, rarely found at the necropolis, as well as a fragment of the so-called internal stopper (Cat. No. 9). Traces of ash, burnt plants, and tiny fragments of grog (crushed pottery in clay) indicate that the last object was used to plug a beer jar filled with ashes containing remains of the burnt offerings.\textsuperscript{12}

**BURIAL CHAMBER OF SHAFT C2/10**

The entrance to the burial chamber is situated in the west shaft wall. At the time of discovery it was partially blocked by stone blocks; such blocks were absent in the northern part most likely owing to the robbers’ activity already in antiquity (Fig. 2). The burial chamber seems almost intact, but there is a hole in the wall neighbouring with shaft C2/11, which most likely was the way through which the thieves entered the chamber. Along the western wall there is a fragment of a rock, c. 0.20 m high, in which the burial pit was cut (Figs. 5–6). The sarcophagus was closed with an irregular lid, and at the time of discovery, both the lid and the rim of the sarcophagus were still sealed with white plaster (Fig. 7). In the south-western corner, immediately at the bottom of the sarcophagus, remains of a wooden chest were discovered, while in the south-eastern corner, at the entrance to the chamber, animal bones were deposited (deposit 3/2003), namely a skull and a leg of a bull (cow) (Fig. 15).\textsuperscript{13} A thin deposit of tafla, resting above the sarcophagus, contained a small number of pottery, amongst which two bowls (Cat. Nos. 13–14) and a jar (Cat. No. 15) deserve a closer look. Fragments of the first bowl (Cat. No. 13) were found both on and around the sarcophagus, while the second one (Cat. No. 14), broken, was leaning against the chamber wall north of the sarcophagus (Figs. 5–6, 8). The jar was wedged into the corner between the north-eastern corner of the sarcophagus and the northern wall of the chamber (Fig. 8). Additionally, a small thin-walled plate (Cat. No. 12), one


\textsuperscript{13} Personal communication of Prof. Dr. Salima Ikram, American University in Cairo.

fragment of a Form 7 beer jar with traces of sealing on its exterior, a stopper fragment, and non-diagnostic fragments of red-slipped plates and beer jars were found in the chamber fill.

12. Thin-walled small plate
   Ac.: K.03-69 (filling of burial chamber of shaft C2/10, above sarcophagus)
   Clay: Nile B1
   Technique: thrown on wheel
   Surface treatment: red-slipped
   Rim diam.: 19.4 cm; max diam.: 20.2 cm; pres. height: 1 cm
   Preservation: c. 35° of rim
   Dating: phases III–IV

13. Medium size, straight-walled plate with rounded rim, underlined with groove (Form 109):
   No.: SQ 03-1269
   Ac.: K.03-69 (filling of burial chamber of shaft C2/10, above sarcophagus)
   Clay: Nile B2
   Technique: thrown on wheel, bottom scraped
   Surface treatment: red-slipped inside and outside of rim, uncoated below
   Colour: red slip – 10 R 6/6 light red; uncoated – 7.5 YR 6/6 reddish yellow
   Firing: oxy
   Hardness: 1
   Rim diam.: 21 cm; max diam.: 22 cm; height: 5.3 cm
   Preservation: 240° of vessel
   Dating: phases III–IV

14. Medium size, bent-sided plate with long-ledged rim (Form 93)
   No.: SQ 03-1276
   Ac.: K.03-69 (filling of burial chamber of shaft C2/10, above sarcophagus) + K.03-72
       (filling of burial chamber of burial shaft C2/10, northern part)
   Clay: Nile B2
   Technique: thrown on wheel, bottom scraped
   Surface treatment: inside red-slipped, outside of rim red-slipped, uncoated below
   Colour: slip – 7.5 R 5/6 red; uncoated – 7.5 YR 5/6 yellowish red
   Firing: oxy
   Hardness: 1
   Rim diam.: 21 cm; max diam.: 22 cm; height: 5.7 cm
   Preservation: 270° of vessel
   Dating: phases III–IV
15. Medium size jar with modelled rim, short neck, rounded shoulders, spindle-shaped body, and pointed bottom (Form 17A)
No.: SQ 03-1276A
Ac.: K.03-72 (filling of burial chamber of burial shaft C2/10, northern part)
Clay: mixed clay P.60
Technique: thrown on wheel, bottom scraped
Surface treatment: self-slipped exterior, inside natural
Colour: outside – 2.5 YR 7/4 light reddish brown; inside – 2.5 YR 7/4 light reddish brown
Firing: oxy
Hardness: 3
Rim diam.: 7.5 cm; max diam.: 16.6 cm; height: 29.8 cm
Preservation: complete
Remark: jar closed with stopper and sealed; black ink-painted inscription on upper part of body
Dating: phases III–IV

Two plates and a jar most likely were a part of the original grave goods assemblage that had been deposited in the tomb along with the deceased during the funeral. Though the first two objects were broken, it was possible to almost fully reconstruct them. The jar most likely has been found in situ; the plates, however, were most probably dislocated. The shapes of both plates (Forms 93 and 109) did not change throughout the Sixth Dynasty, but the very characteristic surface finishing allowed a precise dating. A new tendency occurred in phase III and became very strong during phase IV. Both the interior and the outer surface of the rim, c. 2–3 cm, were red-slipped, with the rest of the vessel left uncoated. A special attention should be paid to a Form 17A jar, executed in the mixed clay
At the time of the discovery it was still plugged with an inner stopper and sealed (half of the sealing preserved). A faded inscription in black ink is visible on the belly. Such vessels are typical constituents of grave goods deposited in tombs of the necropolis. Most likely, they were used as containers for milk. A small thin-walled plate (Cat. No. 12), also found in the chamber, represents a type which has been identified for the first time among the material from the necropolis. The examples of similar small plates (Form 55) measure c. 8–10 cm in diameter, against a slightly larger height. However, the plate retrieved from the chamber of shaft C2/10 shows entirely different proportions, with the rim diameter measuring 20 cm and the total height of a mere centimetre, which make this object very flat. All of the four vessels are dated to phases III–IV of the necropolis, determining the burial’s date to Pepy II’s reign. However, assuming that the Form 4 and 9 (phase IV) beer jar fragments found in the burial shaft represent a part of the original offering deposit (which seems highly likely), the funeral date can be narrowed down to the second half of Pepy II’s reign.

The western part of the burial chamber was occupied by the burial pit, which was cut in the natural rock so that its upper edge was c. 20 cm above the floor. At the time of the discovery the lid was found in situ and, more importantly, was still sealed in some places, which was truly surprising, as the entire burial complex had been looted. Thus, the thieves

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14 P. Paice, The Pottery of Daily Life in Ancient Egypt, JSSEA XIX, 1989, p. 51, Fig. 13a.

15. Animal bones found in the south-eastern corner of the burial chamber, immediately next to the entrance – deposit 3/2003: i.e. skull and leg of a bull (or cow – information due to the courtesy of Salima Ikram) (Phot. M. Jawornicki).
seem to have known the contents of the burial burial was valueless and hence left it intact. This assumption brings us to the conclusion that their knowledge of the customs was sufficient to know what and where it was to be found; they could even have come from a group associated with the necropolis, such as labourers cutting the tombs, workers decorating them, or perhaps even the priests and officials themselves, participating in funeral ceremonies or responsible for conducting the mortuary cult activities. A skeleton found inside the burial pit (Burial 389) has been preserved in a very good condition, mainly owing to its being covered with a thick layer of mud, most likely washed in by the already mentioned heavy rainfalls. The upper surface of mud is cracked, which provides evidence beyond doubt that the burial pit was at some point filled with water that must have penetrated the shaft fills and reached the burial chamber (Figs. 12–13). The deceased was a male, c. 35–46 years old, relatively tall (1.72 m), by the Old Kingdom Egyptian standards. Inside, in the north-western part of the burial pit, a wooden headrest was found (Cat. No. S/03/45). It is built of three parts: rectangular base, cylindrical stem with cannelures, and curved upper portion (Fig. 14). All three parts were connected to one another with pegs. The headrest is 23.5 cm high and its base is 19.5 cm wide by 9 cm thick, while the stem is 4.76 in diameter at the top and 8.27 cm at the bottom. Its location at the discovery, slightly to the left and above the skull, suggests that the man’s head rested on it.

WOODEN CHEST

The most intriguing object has been discovered in the south-western corner of the burial chamber, between the short side of the sarcophagus and the southern wall of the chamber. This is a rectangular chest (69 x 34 x 22 cm) made of cedar wood (Figs. 16–17). There are no indications of thieves moving or even opening the chest, which is yet another proof of their excellent knowledge of the valuables in the chamber. At the time of the discovery the chest was disintegrated into individual walls, most likely as a result of either decaying or loosening the pegs that held the walls together. The front wall was shifted slightly to the front and broken into three pieces. The side walls fell to the right and left sides of the chest respectively, while the back wall (also completely preserved) shifted towards the chamber wall. Although the lid remained on top of the walls, it was broken into three fragments. (Fig. 16) The base, obscured at the time of discovery, had two laths fixed to its exterior, thus creating two 9-cm-wide legs, parallel to the short sides of the chest (Fig. 19). All the walls were covered with a white gypsum-based paint, both inside and outside

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15 A similar situation was observed in the case of the so-called false shaft, which contained only remnants of the ritual of ‘Breaking the Red Pots’. Unlike burial shafts, false shafts were never plundered and thus remained intact, cf. T.I. RZEUSKA, The Necropolis at West Saqqara: The Late Old Kingdom Shafts with no Burial Chamber. Were They False, Dummy, Unfinished or Intentional?, ArOr 70/3, 2002, pp. 377–402.

16 For a detailed anthropological description of the remains, see the Appendix 1 by M. Kaczmarek.

17 K. MYŚLIWIEC, Saqqara. Excavations 2003, PAM XV, 2004, p. 121, Fig. 7.

18 I would like to thank Prof. Jarosław Zieliński of West Pomeranian University of Technology in Szczecin for the timber identification.
After removing the lid fragments, the contents of the chest came into sight: two broken ceramic vessels and four linen wrappings (Fig. 17).

16. Bent-sided bowl with simple rim and bent-point located in the middle of body (Form 167):
   No.: SQ 03-1274
   Ac.: K.03-71 (pottery found inside wooden chest)
   Clay: Nile B1
   Technique: thrown on wheel, bottom smoothed on wheel

19 The EDS analysis (X-ray microanalysis of molecules in microarray) under the electron microscope JEOL JSM–6380LA by Marek Wróbel, Faculty of Geology, University of Warsaw.

20 On the identification of material used in weaving, see the Appendix by I. Panenko.

19. Reconstruction of the wooden chest found in the C2/10 burial chamber (Drawing: M. Orzechowska, according to K.O. Kuraszkiewicz concept).

Surface treatment: red-slipped
Colour: 10 R 5/8 red
Firing: oxy
Hardness: 3
Rim diam.: 23.5 cm; max diam.: 25 cm; height: 12.5 cm
Preservation: complete
Dating: phases III–IV
17. Bowl bent-sided in the lower part of body, with simple rim (Form 175):
   No.: SQ 03-1275
   Ac.: K.03-71 (pottery found inside wooden chest)
   Clay: Nile B1
   Technique: thrown on wheel, bottom scrapped
   Surface treatment: red-slipped
   Colour: 10 R 5/6 red
   Firing: oxy
   Hardness: 2
   Rim diam.: 20–21 cm; max diam.: 21.5 cm; height: 10.2 cm
   Preservation: complete
   Dating: phase III, probably also IV.

Two broken bent-sided bowls (Cat. Nos. 17–18), one with a spout-rim, have been successfully reconstructed. Two vessels (Cat. Nos. 16–17) present shapes and surface treatment typical of the late Old Kingdom in phases III–IV (Figs. 20–21).

As mentioned above, the bowls were accompanied by four linen wrappings of which one was badly damaged and the remaining three has been completely preserved. They are 18–20 cm long, 11–12 mm wide, and 4–5 cm thick. They have light brown outer surface, against the dark brown or even black inside, as though they were wrapped around something. Even now one can see single layers of the linen bandages (Fig. 22), so delicate and fragile that they turn into dust when touched.

WRAPPINGS AND MUMMIFICATION IN THE OLD KINGDOM

When the linen wrappings were discovered at Saqqara, the chest was almost immediately interpreted as a canopy chest and the wrappings – due to their suggestive amount of four pieces – as its typical contents, namely the organs removed during mummiﬁcation procedures: liver, stomach, intestines, and lungs. However, such an excusably obvious interpretation will later on turn out to be incorrect. A similar discovery from Ranefer’s mastaba in Meidum, which will be discussed below, certainly influenced this interpretation.

In order to prove beyond doubt that we are dealing here with the organs, DNA tests have been carried out on the samples extracted from the outside and inside of the wrappings. Unfortunately, neither human nor animal tissues have been detected. Furthermore, the anatomopathological tests have also yielded negative results. In the course of the microbiological examinations, however, the presence of resin has been confirmed. This discovery led to further observations in the infrared spectrum (FTIR = Fourier Transfor-

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22 See the Appendix 2 by T. Benderitter.
23 I. Panenko has stated this is either ‘bitumen’ or ‘resin’. However, bitumen was not introduced to Egypt before the Ptolemaic period. Further analyses have, indeed, proven that the latter possibility is true.
20. Bent-sized bowl with simple rim and bent-point located in the middle of the body, found inside the chest – Cat. Nos. 16–17 (Drawing: T.I. Rzeuska, inked by M. Orzechowska).

21. Bowl bent-sided in the lower part of the body, with simple rim, found inside the chest – Cat. Nos. 16–17 (Phot. M. Jawornicki).
mation Infrared Spectrometry), which have revealed the presence of organic substances, such as oil, resin, proteins, and polysaccharides (plant gums) in all of the four samples. Additionally, non-organic substances, such as gypsum and calcium carbonate, have also been observed. These are most likely traces of gypsum coating of the chest. The tests have revealed the true nature of the wrappings: it can be said with certainty that they do not contain human organs. However, the identified substances are very often associated
23. EDS analysis of the white paint covering the chest found in the burial chamber (Phot. M. Wróbel).
with mummification, especially oil and resin. Oil was used in several stages of mummi-
ification for cleansing the body, and sometimes it was poured over completely wrapped
body. Liquid resin, on the other hand, was used during the wrapping of the body; it was
also employed to fill the skull and stomach cavity once the brain and the organs had been
removed. Moreover, its antiseptic quality, preventing the growth of bacteria, as well as its
strong and pleasant scent, masking the decomposition odour, must have been of a great
importance. More importantly, during the microbiological analysis of sample No. 3,
unidentified particles initially interpreted as human or animal tissue, were observed. As
they are most likely human corneocyte, there is a fairly strong indication that the wrap-
pings were indeed associated with the human body. Thus, trying to establish the function
of the wrappings, it is impossible not to touch the question of mummification in the Old
Kingdom.

25 See infra Appendix 4 by I. Panenko, Fig. 49.
26 The human epidermis is made of malpighien cells that are permanently moving towards the surface. When they reach the highest level (stratum corneum), they loose their nuclei and become corneocytes made only of keratins and flake. I wish to thank T. Benderitter for this note.
It is well known that one of the principal dogmas of the ancient Egyptian civilisation was a deep belief in immortality, in which human life does not end with death, but continues unchanged through eternity. This aspect of eschatology greatly determined the ancient Egyptian funerary customs, reflected in both the spectacular tombs (‘houses for eternity’), filled with the wealth of earthly goods, necessary in the afterlife, and the mummies – a key to the immortality in the bodily form. Our knowledge of mummification or, more correctly when referring to the Old Kingdom period, the body securing methods, is constantly developing, though many details are yet to be revealed. New information come from both the intense archaeological works, which have been carried out for many years in Egypt, and the more advanced research methods in biology, genetics, and molecular physics. It is well established that the main goal of all mummification procedures was to prevent the body decay and to shape the mummy so as it resembled human body. Whilst this objective remained unchanged throughout the millennia, the mummification methods kept evolving constantly.

During the Old Kingdom two methods were in use. The first one involved covering the body with the gypsum mass, resulting in the so-called stucco mummies. In the second method the body was wrapped in linen bandages soaked in resin. In both cases the embalmers aimed at shaping a mummy so as it resembled the deceased physically, sometimes they even modelled the facial features with a strong emphasis on individuality. Neither method was the mummification sensu stricto, as they did not involve dehydrating the body with special substances and removing the internal organs. Moreover, it has been observed that in some of the bodies thus ‘mummified’ the organs were left in the body. Only a small number of the Old Kingdom mummies survives to this day and very few have been submitted to detailed analyses. Nevertheless, general conclusions based on these rare instances have been formed. One of them is that the practice of removing internal organs and placing them in canopy jars was introduced already in the Fourth Dynasty. This custom is thought to have become popular during the Fifth and Sixth Dynasties, and to have lasted in an unchanged form till the Twenty-first Dynasty. But still, no clear evidence can be provided for applying the ‘real’ mummification methods, involving the use of natron, the organs removal, and their placing into canopy jars during the Old Kingdom. Thus, the statement that these procedures were common during this period is simply lacking any support.

Our view on the embalming methods used in the Old Kingdom is greatly determined by the case of queen Hetepheres. Although her body has never been discovered, her canopy chest is well known. It rested in a niche located below the ceiling of the burial chamber, at the end of the chamber’s western wall. The interior of the chest was divided

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28 Ibid., pp. 372–373.
29 IKRAM, DODSON, The Mummy, p. 375.
into four containers, each of them containing a small bundle wrapped in linen. At the opening of the queen’s tomb, three of the bundles were still immersed in a 3% natron solution; in the fourth container, the liquid had seeped out through a break in the wall.\textsuperscript{31} Significantly, there is no certainty that the bundles really conceal human organs, as they have never been examined. A. Lucas, who tested only the natron solution, wrote: \textit{In each compartment of the box is a flat package wrapped in woven fabric (presumably linen) that almost certainly contains viscera}. If, regardless of the weak evidence, the packages did contain the queen’s organs, this would make them both the oldest known instance of removing the organs and storing them outside the body and the oldest known canopy chest.

From the Fourth Dynasty onwards, special niches for canopy chests occur in the royal tombs, but only in a few cases the remains of their contents have been preserved. From the tomb of Djedkare-Isesi at Saqqara came a canopy chest in which a fragment of inscribed canopy jar was found along with something that resembled king’s embalmed organs.\textsuperscript{32} In the burial chamber of Pepy I a small package that possibly contained one of the organs was discovered in one of the four containers of the canopy chest.\textsuperscript{33} Unfortunately, neither of these remains have been examined.

These examples indirectly prove, as neither have we got the mummi\textsuperscript{fi}fied bodies nor have the remains from the canopy chests been examined, that the importance of removing the viscera from the body to delay the decomposition processes was well understood by the early embalmers of the Old Kingdom. Furthermore, the mentioned instances indicate that only the bodies of pharaohs and queens (mothers of the future pharaohs) were subject to the mummi\textsuperscript{fi}cation \textit{sensu stricto}. The situation is quite different in the case of citizens from the middle and lower social classes.

The principal evidence used to support the Old Kingdom date for the procedure of the internal organs removal and their subsequent placement in the canopy jars includes three elements: a visible incision on the mummi\textsuperscript{fi}fied body, wrappings, and canopy jars. It is worth to take a closer look at each of these aspects.

**Mummies with incision**

The principal evidence for the internal organ removal during mummi\textsuperscript{fi}cation procedures in the Old Kingdom is seen in the mummy of Ranefer from Meidum (mastaba No. 9), discovered by W.M. F. Petrie in 1891. This is how Petrie describes it:

\textit{The mode of embalming was very singular. The body was shrunk, wrapped in a linen cloth, then modeled all over with resin, into the natural form and plumpness of the living figure, completely restoring all the fullness of the form, and this was wrapped round in}

\begin{itemize}
\item G. Reisner, The Empty Sarcophagus of the Mother of Cheops, \textit{BMFA} 26/157, 1928, pp. 80–81.
\item A. Lucas, The Use of Natron in Mummi\textsuperscript{fi}cation, \textit{JEA} 18/3–4, 1932, p. 127.
\item R. Stadelmann, Die ägyptischen Pyramiden. Vom Ziegelbau zum Weltwunder, Mainz a/Rhein 1991, p. 194.
\end{itemize}
a few turns of the finest gauze. (...) In the recess in the south end, similar to that in Rahotep’s chamber, there were parts of the internal organs embalmed, forming lumps of resined matter wrapped round in linen, and fragments of such were in Rahotep’s recess. Some insects had lived on it for generations, and the place was deep in the cast skin. There was no sign of these organs having been in jars or enclosure; and it seems as if these recesses in the tombs were intended to lay the internal parts on after embalming, before the use of jars for such was introduced.34

Ranefer’s mummy was taken to London to be once again examined in the Royal College of Surgeons. In their report G.R. Smith and W.R. Dowson give a very detailed description of the manner in which the body had been wrapped and modelled. The report mentions that the body-cavity is closely packed with resin-soaked linen, with the following footnote information: It is known that viscera were removed at least as early as the IV Dynasty, as canopy jars of that period are known.35

Reading the Petrie’s and Smith and Dowson’s reports carefully, one notices that neither of them clearly states that any incision marks were observed. This appears quite puzzling especially that in their extremely meticulous description many details were noted, including the mummy’s facial features, the wrapping manner, and even the circumcision. The report only mentions that the body cavity was packed with bundles. Unfortunately, it is not possible to re-examine Ranefer’s mummy, as it has been destroyed during a Second World War air raid. Taking all these into consideration, it appears that the mummy of Ranefer does not provide convincing evidence for the internal organs removal and their storage outside the body during the Old Kingdom period. There are strong indications that Petrie, as well as Smith and Dawson, assumed a priori that the presence of four packages (as mentioned above, this amount is suggestive of the canopy jars that contained the embalmed viscera) unequivocally proves that the entrails must have been removed and embalmed separately from the body. Thus, such an assumption has been based rather on a conviction than facts.

A similar situation can be observed in the case of a mummy discovered in a mastaba belonging to Senedjem-ib at Giza. It is occasionally used as evidence for removing of the internal organs during mumification. In their publication Smith and Dawson state: The embalming incision is clearly visible in the customary position and was plugged with a large cake of resin.36

Unfortunately, neither of the authors actually examined the mummy – they were basing only on a photograph published in G. Reisner’s report.37 However, the photograph in question does not show any incision mark, let alone this mentioned piece of resin plugging it. The alleged incision is also completely missing from the description. In a recent publica-

34 W.M.F. PETRIE, Medûm, London 1892, pp. 17–18.
36 SMITH, DAWSON, Egyptian Mummies, p. 76, although they add: Unfortunately, no detailed description of this mummy has yet been published, but a photograph of it appeared in the excavators reports. The whole treatment evidently resembles that of the Meidûm mummy.
37 G. REISNER, A Family of Builders of the Sixth Dynasty, about 2600 B.C., BMFA. XI/66, 1913, p. 58, Fig. 9.
tion of the tomb nothing is said about any marks on Senedjem-ib’s body left by removing the entrails.38

Wrappings

Five of the Old Kingdom tombs have yielded wrappings to date. Four sets come from the Fourth Dynasty mastabas in Meidum: three were found in the niches of the burial chambers in mastabas of Ranefer, Rahotep, and Nefermaat,39 while the fourth in the sarcophagus of anonymous mastaba No. 17.40

The fifth set of wrappings comes from a chest discovered in burial chamber C2/10 in the late Sixth Dynasty necropolis at Saqqara. Following Petrie’s example, I assumed that wrappings from the tombs of Ranefer and Rahotep were indeed embalmed viscera. However, after a series of DNA and anatomopathological tests, such assumption proved incorrect. Were the Meidum wrappings empty too? Only some of these have been examined and there is no certainty that all the wrappings did not contain the embalmed internal organs. However, those found in mastaba No. 17, identical in appearance to the Saqqara wrappings, were subject to examination: *The three packages which were found in the sarcophagus were examined by Dr. Rüffer, Director of the Quarantine Dept., Alexandria, who reports the contents to be only vegetable matter. Parallel to this is his report, that the packages, which were returned to the body, generally contain only a part of the organ, the rest of the package being filled out with vegetable matter and mud.*41 Thus, as in the case of the Saqqara wrappings, these objects do not contain the viscera either.

While trying to reveal the truth about the contents of the wrappings, another question should be posed: why does one assume that the wrappings must contain the organs? Is there any other indication of such content, besides their suggestive amount, corresponding with the number of the canopy jars? Assuming that entrails from the bodies of Ranefer, Rahotep, Nefermaat, and the anonymous deceased from Meidum had been removed, why would theybe stored *in this particular manner?* Why were the organs not simply transferred into a canopy chest and drenched in natron, as was the case of the entrails of queen Hetepheres? And why was this method not applied in the case of the pharaoh’s sons? Acquiring a chest executed in stone, similar to the one discovered at Giza, certainly did not present any problems for the people of the highest social status. What then could be other reasons behind this problem? We are unable to answer this question unambiguously at present.

38 E. Brovarski, The Senedjemib Complex, Part I. The Mastabas of Senedjemib Inti (G 2378), Khnumenti (G 2374), and Senedjemib Mehi (G 2378), Giza Mastabas 7, Boston 2001, p. 81, Pls. 54a, 55.
39 W.M.F. Petrie, Meydum and Memphis III, London 1910, p. 21: *some pieces of board... evidently from small box... and a small twist of fairly fine line.*
40 Ibid., p. 16, Pl. XI, 5.
41 Ibid., *loc.cit.* The wrappings are stored in the Petrie Museum of University College London, Inv. No. UC30896. Though the website does not state their exact provenance, the label with the inscription ‘Mastaba 17’ indicates that that is where they came from – cf.: <http://www.petrie.ucl.ac.uk/detail/details/index_no_login.php?objectid=UC30896&accesscheck=%2Fdetail%2Fdetails%2Findex.php>.
A possible solution may, however, involve natron. The access to this substance could have been reserved exclusively for the pharaoh himself and the queen – the mother of an heir to the throne – the only people of the quasi-divine status on earth.

Canopy jars

The canopy jars pose a question just as intriguing as seen in the examples of the mummies and wrappings. Interestingly enough, these vessels seem to have occurred ex nihilo, as they do not have any direct prototypes. The oldest known canopy jar comes from the tomb of queen Meresanch III, who lived from the times of Khufu’s reign until the reign of Shepseskaf. Such jars, executed in various kinds of stones or clay became a typical object in the necropoleis of the Fifth and especially Sixth Dynasties. None of the discovered jars contained the viscera though. Only one example of canopy jar found by G. Steindorff in 1905 in mastaba D 20 at Giza contained a brown powder. The mere presence of the powder has served as a principal evidence for the actual use of the jar. However, as the powder has never been examined, it is impossible to state whether these were truly the remnants of the embalmed entrails.

The complete lack of internal organs inside the canopy jars should not be surprising. Taking it even further, it would be fairly astonishing to find them there, as the majority of the jars have an unexpectedly small capacity – the largest ones can contain c. 0.5–0.6 l. Thus, their ability to contain internal organs of an adult is rather doubtful, especially given the average measurements of the organs: liver 1.3–1.7 kg, intestines 8–9 m, lungs with the maximum capacity of c. 4600 ml, and each wrapped in layers of fabric! In view of these facts, most (if not all) of the canopy jars appear as symbolic objects rather than functional vessels. Such interpretation seems even more reasonable, if one realises a rich background of various magical procedures that the ancient Egyptians carried out to ensure their well-being in the afterlife, e.g. false beer and false grave goods in the tombs. All the evidence (or rather a notable lack of it) suggests that the false canopy jars should be added to the list.

SUMMARY

Summarising the above discussion, there is a strong indication that in the Old Kingdom the mumification sensu stricto, i.e. including the viscera removal and the use of natron, was reserved exclusively for the pharaohs and queens. There is no evidence that people representing other social classes, even other members of the royal family, had their bodies

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42 RZEUSKA, Saqqara II, pp. 440–442, n. 59 along with the references to other ‘false’ grave goods.
embalmed when they died. The two sets of wrappings which were said to contain the internal organs proved to be empty, and none of the discovered canopy jars contained human entrails.

What then are these enigmatic wrappings? They could have been bandages used in the mummification process to cleanse the body and apply the oils and resins. Once the procedure had been accomplished, they were folded, placed in a wooden chest along with two bowls, which were most likely used during the embalming, and then placed in the tomb with the deceased. Such interpretation finds a confirmation in the many ‘cachettes’, dated to different periods, that contained all the objects used during the mummification procedures, according to the custom of keeping all the objects that were in contact with the deceased in his/her immediate vicinity.44

Summing up, one has to admit that the evidence for the commonness of the internal organs removal during the embalming in Old Kingdom is rather weak.

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The orientation of the burial was north-south with the head to the north and facing east. The deceased was laid out supine in extended position with arms and hands extended along the body. The skeleton was very well preserved with all bones placed in their anatomical position. The colour of the bones was dark yellow and yellow.

Moderately robust morphology of bones has indicated a male individual. The frontal bone was not quite verticalised with a massive glabellar prominence, forming a pointed projection (scored as grade 3–4) with well-developed supraorbital ridges. Supraorbital margin had rounded edge. Orbital aperture formed a square shape. Frontal and parietal eminences were not formed. (Fig. 25.1). The external surface of the occipital bone was rough and formed massive nuchal crests with well-defined bony ledges. The volume of the mastoid process was not very massive with length 25 mm and width 26 mm indicative of a male sex. The mandible was robust with a well-marked muscular impressions and a massive mental eminence (Fig. 25.2). The greater sciatic notch of the innominate bone was very narrow (33 mm wide). The shape of obturator foramen was narrow and oval. The mean value of the left and right femoral head diameters of 46 mm have also indicated a male individual.

The estimated age at death has been based upon the age increasing closure of cranial suture, morphology of the pubic symphyses and auricular surface, and functional age of teeth. Ectocranial suture composite scores for the cranial vault were between 3 and 6 thus indicating a mean age of 35 years and for the lateral-anterior system scores were between 3 and 5, which correspond to the mean age of 40 years. Using the Suchey-Brooks system for estimating age-at-death, based upon morphology of pubic symphysis, we have arrived at phase 4, suggesting a mean age of 38 years. Teeth were so severely worn that made impossible to assess the dental functional age. Age changes occurring in the skull and the postcranial skeleton have indicated the individual 35–45 years old at death.

The skull was ellipsoidal in outline (Fig. 25.3). Cranial modulus with the value of 154 indicated a large skull. This individual was a long-headed (dolichocranic – the Length-Breadth Index value of 74.7) and high-headed (acrocranic – the Breadth-Height Index value of 98.6) with wide forehead (stenometopic – the Transversal Fronto-Parietal Index value of 69.0). The face was narrow (leptognathic – the Facial Index value of 92.7) with low-high orbits (hypsiconchal – the Orbital Index value of 75.0) and short and wide nose (camaerrhine – the Nasal Index value of 64.8). The mandible was strong with marked muscular impressions (Fig. 26).

25.2. Skull No 389 viewed from the norma verticalis (Phot. M. Jawornicki).

The estimated living stature was calculated using the Trotter and Glesser formulas for white men and the following bones: femur, tibia, humerus, ulna, and radius. The individual estimations were then averaged resulting in 172.4 cm. Thus, this man was taller than his peers from the Old Kingdom series excavated in Saqqara.\(^{45}\) Measurements (in mm) and indices of cranial and postcranial diameters are shown in the table below.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Cranial Length (g-op)</td>
<td>186</td>
</tr>
<tr>
<td>Maximum Cranial Breadth (eu-eu)</td>
<td>139</td>
</tr>
<tr>
<td>Minimum Frontal Breadth (ft-ft)</td>
<td>96</td>
</tr>
<tr>
<td>Max Foramen Magnum Breadth</td>
<td>28</td>
</tr>
<tr>
<td>Foramen Magnum Length (ba-o)</td>
<td>33</td>
</tr>
<tr>
<td>Basion-Bregma Height (ba-b)</td>
<td>137</td>
</tr>
<tr>
<td>ML Mastoid Length</td>
<td>25</td>
</tr>
<tr>
<td>MB Mastoid Breadth</td>
<td>25</td>
</tr>
<tr>
<td>Maxillo-Alveolar Breadth (ecm-ecm)</td>
<td>61</td>
</tr>
<tr>
<td>Palatal Length (sta-ol)</td>
<td>62</td>
</tr>
<tr>
<td>Palatal Breadth (enm-enm)</td>
<td>63</td>
</tr>
<tr>
<td>Bicondylar Breadth (cdl-cdl)</td>
<td>65</td>
</tr>
<tr>
<td>Bigonial Width (go-go)</td>
<td>66</td>
</tr>
<tr>
<td>Chin Height (id-gn)</td>
<td>69</td>
</tr>
<tr>
<td>Maximum Ramus Height</td>
<td>70</td>
</tr>
<tr>
<td>Minimum Ramus Breadth</td>
<td>71</td>
</tr>
</tbody>
</table>

The relationships of jaws to each other falls into Angle’s Class I occlusion, in which the posterior teeth, and specifically the first molars, are in normal antero-posterior relation. The dentition has revealed severe pathological conditions. The anterior and posterior teeth of the maxilla and mandible were severely worn. The anterior teeth were worn up to large coalesced dentinal areas, though rim is still complete and in some cases up to full dentin exposure and loss of rim (estimated at 8 scores in the anterior teeth and up to 10 score in the posterior teeth).

In the maxilla, osteomyelitis condition was found. This is a serious and potentially lethal lesion because of its frequently-associated bacteremia. The severe dental-related abscesses extended considerably beyond the tooth regions and destroyed the entire cortical area covering the roots of the right premolars and right first molar in the maxilla. This was the most probable cause of death of this individual. In the right maxilla, the canine, M2 and M3 were antemortem lost. The left third molars were antemortem lost in both jaws.

The thoracic vertebrae, tenth to twelfth, showed osteophyte development of vertebral bodies indicating degenerative changes in the spine. Foramen olecrani was present in the right humerus.

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APPENDIX 2
Étude anatomopathologique du contenu des quatre paquets
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Des échantillons de chacun des quatre paquets ont été examinés :

EXAMEN MACROSCOPIQUE

– Paquet N°1 : poudre brunâtre et quelques fragments solides, de 0,8 X 0,5 X 0,2 cm.
– Paquet N°2 : poudre uniquement
– Paquet N°3 : un peu de poudre et fragments, le plus grand 1,5 cm de diamètre.
– Paquet N°4 : poudre et quelques petits débris.

EXAMEN EN LUMIÈRE DIRECTE ET EN LUMIÈRE POLARISÉE

– Présence de débris minéraux, réfringents en lumière polarisée, et de débris amorphes.
– Très rares fragments allongés de fibres végétales, de très petite taille.

EXAMEN MICROSCOPIQUE

**Technique**
Les fragments se sont tous révélés très friables sous la pince, c’est pourquoi certains échantillons du paquet N°3 ont été directement inclus en paraffine.

D’autres échantillons, provenant des paquets N°1 et 3 ont fait l’objet d’une réhydratation au tampon PBS pendant 15–30 et 60 minutes. Tous les fragments solides flottaient initialement à la surface du tampon.

Les échantillons qui ont été réhydratés une heure sont devenus entièrement pulvérulents, sans aucun fragment solide résiduel. Les fragments réhydratés une demi-heure étaient encore partiellement conservés, mais très friables. Ceux qui n’ont subi la réhydratation uniquement pendant 15 minutes avaient conservé leur forme, et ne flottaient plus dans le flacon, traduisant une bonne imprégnation.

Les fragments ont été coupés sur microtome standard à une épaisseur de 5 microns, puis les coupes colorées par l’hématoxyline-éosine et l’acide périodique de Schiff (P.A.S.).

**Résultats**
– Aucune des coupes examinées n’a montré de tissu humain ou animal.
– Aucune cellule n’a été repérée.
– Aucun matériel végétal en quantité significative n’est présent.
CONCLUSIONS

– Les fragments communiqués sont constitués de débris minéraux et de très rares restes végétaux.
– Absence de toute structure tissulaire, en particulier humaine, dans la limite des prélèvements communiqués.

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APPENDIX 3
Fourier Transformation Infrared Spectrometry (FTIR) Analysis of Four Wrapping Samples
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METHOD

Fourier Transformation Infrared Spectrometry (FTIR) is one of the basic techniques for analysing and identifying organic compounds. It helps determine not only the functional groups present in the compound, but also its structure. Furthermore, it serves as a useful tool in the study of particle interaction.

Every chemical compound generates a characteristic infrared spectrum that helps in its identification. Absorption bands typical of particular structural fragments usually occur in the same band waves, regardless of molecular structure. Extensive experimental study results allow to attribute specific functional groups to strictly defined areas of characteristic absorption bands. A full spectrum of the compound provides information for determining the identity of analysed substance with the model. Two substances are identical only if their infrared spectra are exactly the same. The infrared spectra of organic compounds are complex and their interpretation is often very difficult. Infrared spectroscopy measures electromagnetic radiation spectra in the 2–50 μm range. The so-called ordinary infrared in the 2–15 μm (corresponding to bands at 5000–667 cm) has been studied most fully and is widely applied in research on the structure of organic compounds.

The FTIR analysis in KBr pastilles was carried out on samples from the objects. After selecting the samples, a mixture of dissolvents was used to extract the organic compounds, which were subsequently distilled, and in such form analysed using the FTIR method.

RESULTS OF SAMPLES’ INVESTIGATION

Sample No. 1 (extract)
The following bands were identified in the infrared spectrum for this sample:

– bands at 3416 cm corresponding to the amide and hydroxyl groups derived from polysaccharides and proteins;
– bands at 2921 and 2852 cm corresponding to the single and double bonds stretching vibrations in aliphatic molecules;
– band at 1734 cm typical of the oil ester group;
– drop at 1699 cm corresponding to resin carboxyl group;
– bands at 1653, 1635, and 1559 cm characteristic of amide groups of protein and polysaccharides;
– strong bands at 1112 and 1058 cm characteristic of ether bonds, sulphates, and silicates.
Sample composition: probably traces of oil and resin, protein, polysaccharides (plant gums). Additionally, non-organic compounds, such as sulphates (gypsum) and traces of carbonates, were present.

Sample No. 2 (extract – dry residue)
The following bands were identified in the infrared spectrum for this sample:
– bands at 3411 cm corresponding to the amide and hydroxyl groups from polysaccharides and proteins;
– bands at 2925 and 2852 cm corresponding to the single and double bonds stretching vibrations in aliphatic molecules;
– drop at 1699 cm corresponding to resin carboxyl group;
– bands at 1653, 1603, and 1560 cm characteristic of amide group of protein and polysaccharides;
– bands at 1112, 1061, and 1016 cm typical of ether bonds, sulphates, silicates, and polysaccharides.
Sample composition: protein, traces of polysaccharide resin (plant gums); additionally, non-organic compounds, such as small amount of sulphates (gypsum) and carbonates (band at 1406 cm), were present.

Sample No. 3 (extract – dry residue)
The following bands were identified in the infrared spectrum for this sample:
– bands at 3421 cm corresponding to the amide and hydroxyl groups from polysaccharides and proteins;
– bands at 2928 and 2850 cm corresponding to the single and double bonds stretching vibrations in aliphatic molecules;
– band at 1701 cm corresponding to resin carboxyl group;
– bands at 1653 and 1559 cm characteristic of amide group of protein;
– strong band at 1031 cm typical of ether bonds, sulphates, silicates, and polysaccharides.
Sample composition: protein, traces of polysaccharide resin (plant gums). Additionally, non-organic compounds, such as sulphates (gypsum) and carbonates (band at 1419 cm), were present.

Sample No. 4 (extract – dry residue)
The following bands were identified in the infrared spectrum for this sample:
– bands at 3400 cm corresponding to the amide and hydroxyl groups from polysaccharides and proteins;
– bands at 2930 and 2850 cm corresponding to the single and double bonds stretching vibrations in aliphatic molecules;
– band at 1734 and 1717 cm corresponding to the oil ester and resin carboxyl groups;
– bands at 1653 and 1559 cm characteristic of amide group of protein;
– strong band at 1034 cm typical of ether bonds, sulphates, silicates, and polysaccharides.
Sample composition: traces of oil, protein, traces of the fossil-type resin, and polysaccharides (plant gums). Additionally, non-organic compounds, such as sulphates (gypsum), were present.
28. Infrared spectra charts for samples of the wrappings Nos. 1 (the upper chart) and 2 (the lower chart). Strong band at 1734 cm⁻¹ indicates presence of oil in wrapping no. 1. Both samples showed presence of carboxyl resin (bands at 1699 cm⁻¹), as well as amide groups of protein and polysaccharides (bands at 1653, 1635, 1559 cm⁻¹).
29. Infrared spectra charts for samples of the wrappings Nos. 3 (the upper chart) and 4 (the lower chart). Strong band at 1734 cm\(^{-1}\) suggests presence of oil in wrapping No.3. Additionally, both samples contain carboxyl resin (wrapping No. 3 - bands at 1701 cm\(^{-1}\); wrapping No. 4 – 1734 cm\(^{-1}\) and 1717 cm\(^{-1}\)), as well as amide groups of protein and polysaccharides (bands at 1653 cm\(^{-1}\), 1559 cm\(^{-1}\)).
CONCLUSIONS

Spectroscopic analysis of the above samples suggests that the objects were executed in similar technique, using the same technology. The complex spectra point to the possible presence of contaminants form the excavations.

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APPENDIX 4

Microscopic and Microbiological Analysis of Four Wrapping Samples

IWONA PANNEKO

OBJECT OF STUDY

Four samples were examined:
- No. 1 – powder with varied size of particles.
- No. 2 – brown powder with infrequent small textile fragments.
- No. 3 – brown powder of little structural variety.
- No. 4 – powder containing a small fragment of textile and its isolated yarns.

RESEARCH METHODOLOGY

Microscopic, microchemical, and microbiological examination was performed on the analysed material.

Microscopic examination

Microscopic observations in reflected, transmitted and ultraviolet light, in up to 600x range were employed to test the samples. Material under study was observed in the form of samples made in: water, lactophenol, and solution of absolute alcohol and glycerol.

1. Reflected light was used in the analysis of the content and granularity of the samples, and the spatial structure of the textile fragments; additionally, basic biological examinations were carried out, such as the microscopic analysis of microbiological growths describing shape, colour, structure of the grown microorganisms, as well as the identification of various biological structures observed in the samples, such as large spores, plant pollens, or fragments of biological tissues.

2. Transmitted light was used in the identification of elementary fibres, deposits occurring on threads, and specially grown microorganisms.

3. Observations in ultraviolet light were used to determine the degree of textile degradation, the depolymerisation of cellulose in flax fibres, as well as the identification of deposits occurring on threads.

The analyses were conducted in order to determine the following characteristics of the yarn and textile:

1. identification of the yarn’s component fibers;
2. twining direction determining arrangement of the elementary fibre strands in a thread;
3. textile weave.
**Microchemical examination**

Microchemical reactions with two reagents, Kuoxam and ClZnJ, were carried out to identify the component fibers. Microscopic analyses were performed in transmitted light in up to 600x range.

**Microbiological examination**

Microorganisms were grown from the small powder samples on the Czapek-Dox agar and broth, incubated in a thermostat at 29°C for fourteen days. Thus, grown microorganisms and microbiological samples were submitted to microscopic observations in transmitted light.

**RESULTS OF SAMPLES’ EXAMINATION**

**Sample No. 1**

This sample contains powder in which particles with various structures occur as a result of the decay of several fiber types. Several isolated flax fibers of a significantly changed appearance were identified (Fig. 30), along with minute fragments of a timber tissue in an advanced stage of degradation.

Traces unidentifiable due to the extremely advanced decay (Fig. 29) constitute the majority of elements observed in the sample. It is likely that they represent a mammal tissue (human).

Spherical microorganisms varied in size have been observed in the tissues, and, considering their appearance, it is quite possible that the tissues had been contaminated with microorganisms belonging to the subphylum Sarcodina of the Kingdom Protista (Figs. 31, 32). A light coloured residue on the tissue fragments is most likely to be identified with the mycelium of Actinomycetales, which showed no activity in the grown microbiological samples (Fig. 33). Furthermore, numerous colonies of one bacterial species were grown from the sample (Fig. 34)

**Sample No. 2**

Sample No. 2 contains a brown powder with infrequent small textile fragments. The fragments are badly damaged, felted, and majority of the yarns present significant structural changes (Figs. 35, 36).

The microscopic and microchemical analyses have demonstrated these are the fragments of linen fabric. The threads are twisted in the S-direction (Fig. 37). Regardless of a great distortion, it has been possible to establish that the textile has a linen-weave texture.

In some places a white residue was observed on the threads (Fig. 38), which most likely can be associated with activity of Actinomycetales; they can possibly be interpreted as chemical deposits. Places where these deposits are located intensively glow in ultraviolet light (Figs. 39, 41 – threads in transmitted light, Figs. 40, 42 – threads in UV light).

The physical stage of the flax fibers disintegration is presented in the microphotographs. Characteristic structures of the elementary flax fibers, the so-called joints, are preserved in spite of a very poor condition of the material (Figs. 43, 44).

The microbiological growth on agar and broth has resulted in three bacterial species.

The microscopic examination has indicated the presence of inactive Actinomycetales mycelia, occurring in the form of a white residue.
Sample No. 3
Sample No. 3 comprises powder of a non-homogenous granularity. Three distinct grain types are observed: mineral grains, small fragments of silt particles, and black opalescent grains, most likely from bitumen or a resinous substance (Figs. 45, 46, 47). Additionally, the powder contains unidentifiable particles; it can be assumed that these are animal (human) tissue fragments (Fig. 48).

Interesting elements observed in the sample are sickle-shaped bodies, built of extremely thin rods. However, their identification requires further examination (Figs. 49, 50).

The microbiological examination has revealed the presence of bacterial colonies, while inactive mycelia of Actinomycetales in the form of a white residue and particles were identified in the course of the microscopic observations.

Sample No. 4
Powder containing a small textile fragment as well as isolated threads (Fig. 52) constitutes sample No. 4. The textile fragment is folded (Fig. 53). Preserved threads are very friable and disintegrate into a powder. The fabric is made of flax fibers. The threads are twisted in the S-direction (Fig. 55). The textile has a linen-weave texture. A considerable distinction has been observed in the density of the warp and weft yarns.

There are two kinds of deposits observed on the fabric: white-grey, resembling the particles present in the powder (Fig. 56), and white threadlike sediments, which most likely result from nitrogen compounds affecting the textile (Fig. 57). Additionally, resinous substances were identified on the threads (Fig. 55). The structure of the sediments was analysed microscopically and microbiologically.

STRUCTURAL ANALYSIS OF ELEMENTARY FIBRES

The microscopic analysis of the material has been carried out on the samples made in water, lactophenol, and solution of absolute alcohol and glycerol. Lactophenol is a staining reagent used in the study of the microscopic anatomy of cells.

Flax fibers in all stages of physical and chemical degradation are present in the material. The microscopic microanalysis has indicated the presence of elementary fibers of the flax plant in the form of tubes with characteristic swellings and shifts, referred to as culm knodes. The tests have shown that the joint is the strongest part of a fiber and is the last to give in to the structural degradation. This indicates a varied rate of depolymerisation of the flax fibres, as well as differences in the location of the chemically distinct elements in a fiber. The varied degree of the depolymerisation of cellulose in the fibers is influenced by enzymes produced by the microorganisms. Additionally, the extent to which the threads are penetrated by, e.g., resinous substances appears to be of a certain significance in the depolymerisation process. Natural flax fibers in particular stages of decay are presented in the microphotographs (Figs. 59–62). All stages of deterioration of the fibrous material have been observed: from fibers with the characteristic flax structure preserved to those in advanced decay stages, where the fibrous structure is absent. The material disintegrates into a powder that consists of hemicelluloses and lignin – the compounds created during degradation of cellulose.
Observations under a fluorescent microscope in ultraviolet light have confirmed an extremely high level of degradation of the elementary flax fibers (Figs. 62, 63).

As the analysed fibers do not show the glow colour characteristic for cellulose, it becomes evident that cellulose, the main constituent of flax fibers, was subject to the advanced depolymerisation.

Only small thread fragments and single elementary fibers show white-blue glow. It is possible that these were attacked by microorganisms.

Observations under an electron microscope are crucial for determining the nature of correlations between the physical and chemical structure of the fibers. The exact degree of degradation of all the natural flax fiber constituents can be ascertained with the help of an advanced analytical equipment.

MICROBIOLOGICAL EXAMINATION

The microbiological growth on broth resulted in one bacterial species and two species of Actinomycetales.

The growth of white-grey-pink-black sediments inoculated from the yarns and, occurring in the powder (Figs. 64, 65), indicated the activity of Actinomycetales in a form of thin threads (Figs. 66, 67).

The deposits on the textiles occurred as a result of an intensive development of hyphae of two Actinomycetales species collectively forming a mycelium, which created the deposits on the fabric.

A particular morphology, physiology, and life cycle of Actinomycetales places these microorganisms on the fringe between bacteria and fungi. According to the latest systematics of plants, Actinomycetales are the Gram positive order of Actinobacteria.

Actinomycetales grow slowly and show a high heat and dryness resistance. Demanding little humidity, they are exceedingly capable of survival. There are several species of Actinomycetales of the Streptomyces genus that produce enzymes which actively decompose cellulose and hemicelluloses.

SUMMARY

The analysed samples contained disintegrated fibers from the linen textiles and most probably decomposed animal tissue fragments. Mineral grains were dominant in one sample.

The cellulosic fibrous material is disintegrated owing to chemical, physical and biological factors. The degree of the polymerisation of cellulose, the main component of the flax fibers, can be determined with the help of an advanced equipment for chemical analyses.

The bacterial organisms, primarily of the Actinomycetales order, have been identified in the samples. Living and active Actinomycetales occurred only in sample No. 6. Par-
ticular physiological characteristics of Actinomycetales enable their survival in severe conditions of the arid desert climate.

Numerous deposits of dead Actinomycetales mycelia give evidence for a significant role of these microorganisms in the biodeterioration of archaeological materials in difficult climatic conditions of the Saqqara region.

Due to their specific habitat demands, bacteria play a lesser role in the biodegradation of the fibrous archaeological material. Their expansion comes, once the fungi and Actinomycetales decompose cellulose into simple compounds and the humidity of the environment is increased. The high number of bacterial colonies grown from the archaeological material indicates an extremely advanced cellulose deterioration.

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