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EUGEN STROUHAL, MOHAMMAD FAWZI GABALLAH, GEORGES BONANI,
WILLY WOELFLI, ALENA NĚMEČKOVÁ AND SHELLEY R. SAUNDERS

RE-INVESTIGATION OF THE REMAINS THOUGHT TO BE OF KING DJOSER AND THOSE OF AN UNIDENTIFIED FEMALE FROM THE STEP PYRAMID AT SAQQARA

ABSTRACT: Human remains found in the granite chamber beneath the Step Pyramid at Saqqara by B. G. Gunn in 1926 and J.-P. Lauer in 1934, together with the skull and two postcranial bones of an unidentified female found at another place in the Step Pyramid, were re-examined macroscopically, radiologically, histologically, histomorphometrically and by radiocarbon dating. The embalming technique of the fragments alleged to be those of Djoser did not conform with that of the Old Kingdom. Histology showed a remarkable preservation of soft tissues. Macroscopic examination and histomorphometric analysis revealed different ages for individuals represented by single fragments. Radiocarbon tests demonstrated various dates, in no fragment, however, corresponding to the Third Dynasty date. On the other hand, the defleshed bones of the unidentified female gave a date some hundred years earlier than the range of 2700 – 2600 yrs B.C. accepted for the Third Dynasty. The supposed remains of Djoser can be considered as belonging to Saite, Late Period or Early Ptolemaic secondary burials inside the Pyramid. The bones of the unidentified female were either from a burial deposited before the Third Dynasty or, if they belonged to the period of construction of the pyramid, then the dating of the Third Dynasty should be put back about 300 – 500 years earlier.

KEY WORDS: King Djoser – Unidentified female – 1st – 2nd and 3rd Dynasty – History – Archaeology – Anthropology – Histology – Histomorphometry – Radiocarbon dating.

KING DJOSER: A HISTORICAL NOTE

King Djoser was one of the most famous Ancient Egyptian rulers. He occupied the Egyptian throne as the second king of the 3rd Dynasty (2700 – 2600 B.C.). His architect Imhotep built the King's burial complex, the Step Pyramid at Saqqara, the first monumental stone structure ever built in human history. The King's "Horus name" Netjerikhet was perpetuated in this and his other buildings.

Not many details of Djoser's activity have survived. He left his Horus names on the walls of temples at Heliopolis and Gebelein. A nameless mastaba at Beit Khallaf near Abydos has been considered to be his Upper Egyptian tomb. On the basis of inscriptions and reliefs with his name at Wadi Maghara his rule over the Sinai has been presumed (Beckerath 1975). According to the Turin canon Djoser reigned 19 years, but according to Manetho 29 years (Gardiner 1961:75, 433). Beckerath (1971) dated his reign be-

tween 2620 and 2600 B. C. It is not known if he survived until his thirtieth regnal year to celebrate the *sed* festival, for which a large court was built in his pyramid complex. Representations depicting him performing the ritual race during the festival could have been designed for a posthumous celebration of it (Beckerath 1975). If we accept a duration of his reign in the range of 19 to 30 years and add at least 15 years prior to his ascension to the throne, his age at death could be a minimum of 34 years. 45 years or more may be the upper estimates.

ARCHAEOLOGICAL FINDS

Djoser is one of the few kings of the Old Kingdom whose supposed remains were found in his pyramid. The report concerning the discovery was published by J.-Ph.Lauer and D. E. Derry (1935) and has been generally accepted by Egyptologists (Edwards 1961:51, Fakhry 1961:21 – 22, Stadelmann 1985:43). Recently Germer (1991:34 – 35) expressed doubts about the authenticity of these remains and recommended an anthropological re-examination of them.

At the bottom of a large square shaft (side length 7 m) in the centre of the pyramid, at a depth of 28 m under the original surface of the terrain, the builders of the pyramid constructed an oblong burial chamber with great blocks of Aswan red granite. It is oriented north-south and its inner dimensions are: length 2.96 m, breadth 1.65 m and height 1.65 m (Lauer 1936:32, 1962:75). A complicated system of corridors descending from the temple north of the pyramid enabled the transport of the royal mummy (Firth and Quibell 1935 – 36: 99, Lauer 1936: 32 – 33). After the deposition of the mummy inside the granite chamber, the circular access in its roof was blocked by a huge granite stopper (diam. 1 m, height 1.75 m). Later grave robbers, unable to remove this heavy obstacle weighting 3 tons, cut away the edges of the blocks adjacent to the stopper, thus creating a crevice through which a slim man could enter the granite chamber. This happened several times (Lauer 1936: 32 – 33).

The first historical record concerning the investigation of the northern descending corridors was made by the Prussian consul general Heinrich von Minutoli (1824). He found in one of the corridors fragments of a "precious mummy", among which were "a strongly gilded skull and two, also gilded soles", which he considered "remnants of the prince buried there". Together with other findings he sent them to Europe, but the ship sailing to Hamburg went down in the estuary of the Elbe. Fragments which were later found in the granite chamber were considered by Fakhry (1961:21) to be parts of the mummy found by Minutoli and he assumed that they all belonged to Djoser. On the contrary, Germer (1991) recalled the fact that the habit of gilding the surface of mummies was characteristic of the Ptolemaic Period.

The corridors searched by Minutoli were cleared by J. S. Perring, a collaborator of the English Colonel Howard Vyse in 1837, who found in them "heaps of mummies". They penetrated through the robbers' crevice into the granite chamber as well, but did not find there any human remains. Vyse (1842:45 – 46) commented: "At all events, it did not appear to have been used as a tomb, for, had a body been placed within it, some remains would probably have been found, as it could not have been conveyed away through the present forced entrance, unless it had been broken into small pieces." The failure to find the fragments which were discovered later was explained by Lauer and Derry (1935) by the supposition that Perring and Vyse had sent into the chamber only their workmen who – not seeing a coffin or mummy – could have easily overlooked mummified fragments in the then insufficient light.

Perring found some additional 30 mummies dated to the Late Period deposited in the great access corridor, which was excavated horizontally from the southern foot of the pyramid during the Saite Period (664 – 525 B. C.). The corridor is about 41 m long, ending at the southern edge of the upper part of the central shaft.

Further research on the pyramid was carried out by other Egyptologists, but none of them left a record that he entered the granite chamber. During the time of C. M. Firth, who directed work at Saqqara between 1924 – 31, it was B. G. Gunn who, while recording marks incised inside the granite chamber in 1926, surprisingly found in it part of a human spine and an incomplete hip bone. He considered them to be the remains of Djoser, but Firth disagreed, pointing to the possibility that they were parts of some of the Saite or Late Period mummies from the South Gallery which had fallen down the shaft and broken. They may then have slipped through the robbers' entrance into the granite chamber. The fragments found by Gunn were, therefore, deposited in a storeroom without being anthropologically investigated.

In 1926 the young architect J.-Ph. Lauer joined Firth and began reconstructing Djoser's pyramid complex. After Firth's death in 1931, J. E. Quibell took over directorship of the work at Saqqara. At that time Lauer decided to enter the granite chamber, in May 1934. He was rewarded by a finding which he described as follows: "After removing a layer of dust which covered the floor, I found... several human bones among which I discerned an especially well-preserved mummified foot". He decided to leave the bones in place until November of the same year, when he returned, lifted them up and handed them over – together with those found by Gunn – to D. E. Derry, Professor of Anatomy of the Cairo Medical Schooll (Lauer and Derry 1935:25).

After examination of the material Derry concluded that all the fragments from both finds came from the same individual, a male of advanced age. Concerning their dating, he focussed on the foot, in which the tendons of the extensors of the toes were moulded

in linen soaked in an adhesive material, "probably resin". This was, in his opinion, a feature typical of Old Kingdom embalming techniques. As analogies he mentioned three cases dating, however, from the 4th – 6th Dynasties, rather than the 3rd Dynasty. He also did not discount the hypothesis that these fragments were remnants of the mummy found by Minutoli, perhaps not realizing that Minutoli mentioned "both soles" (Derry 1935, Lauer and Derry 1935:27).

According to current knowledge the embalming technique of the Old Kingdom was characterized by the application of a layer of plaster over the wrappings. This layer was modelled to conform to the contours of the body, and some anatomical details were indicated by paint (Strouhal in press).

Quibell already expressed his doubts concerning the fragments found by Lauer. Their dark colour reminded him of mummies of "late date" (Firth and Quibell 1935 – 36: 99).

It seems probable that Djoser's funerary monument was built over the dismantled tombs of his predecessors. This was attested to by the finding of about 40,000 stone vessels, some of which contained names of kings of the 1st and 2nd Dynasties, in six galleries below the eastern half of the pyramid (Beckerath 1971). A further five galleries are considered to be burial places of members of Djoser's family. Thus in the burial chamber adjoining the 3rd gallery two or more coffins were deposited, one of which contained the burial of the queen, according to Lauer (Stadelmann 1985: 44, 46). In the 5th gallery two alabaster coffins were found, one empty, the other containing the remains of a child, who, according to Derry, was 8 – 9 years old and allegedly of male sex (Firth and Quibell 1935:44).

On fragments of boundary stelae found in the Step Pyramid complex, names of Djoser's daughters were inscribed: Inetkaus named first and therefore probably the oldest, followed by Hetephernebti, possibly younger. The name of the third daughter was illegible.

ANTHROPOLOGICAL RE-EXAMINATION

In 1988, while searching for the remains of Djedkare Isesi in the Department of Anatomy of the Qasr el-Aini Medical Faculty, Cairo University (Strouhal and Gaballah 1993), we also found in Batrawi's anthropological collection, catalogued the same time by the kind support of Mrs. Roxie Walker of the Bioanthropology Foundation, two small carton boxes containing finds from the Step Pyramid at Saqqara. One of the boxes included a card inscribed: "Foot and other human remains from the granite chamber under the Step Pyramid", and was signed by J. E. Quibell on November 15, 1934. Recently it was numbered A. I. 490. The second box was labelled "Skull of a young woman, Princess of 3rd dynasty (?) from Djoser's Pyramid, also an iliac bone and a humerus. Intrusive?". It was assigned as no. A. I. 446. The same labelling was also found written in pencil on the three anatomical specimens.

SUPPOSED REMAINS OF KING DJOSER
A) FINDS BY B. G. GUNN IN 1926

1. *Part of the thoracic spine* (*Figs. 1 – 2*) has been preserved from T4 to T9 with articulated intervertebral discs in place. The vertebrae are firmly joined by the discs, ligaments and remains of the spinospinal and transversospinal muscles. Vertebrae T7 and T8 are partly damaged, while the left half of T9 has been broken off. Short parts of ribs adjoining the vertebrae have also been preserved.

The vertebrae are large and of medium robusticity (*Tab. 1*). The spongiotic bone of T9 is rather dense, thus revealing the relatively young age of the individual (*Fig. 1*). The edges of the vertebral bodies are devoid of osteophytes. The bodies have normal shapes and the intervertebral spaces are of usual height (*Fig. 3*). Only the left intervertebral joint T8/9 has been exposed, showing no lipping (*Fig. 1*).

2. *The right os coxae* consists of the acetabulum, ischium and lower third of ilium (max. height of the fragment 150 mm, breadth of the ilium 95 mm, *Fig. 4*). The bone is of medium robusticity. The acetabulum is medium to large (*Tab. 1*). The surface of the facies lunata lies 2 mm above the fossa acetabuli and no signs of beginning erosion could be detected. Around the acetabulum remains of the articular capsule have been preserved. About 15 mm from the edge of the acetabulum a rather massive tuberositas glutea (breadth 28 mm) projects, with remnants of insertion of the musculus gluteus maximus.

The upper part of the superior ramus of the pubis (thickness 7 mm) has been broken off. The incisura ischiadica maior in the preserved anterior part was arched in a semi-circular shape ending on an outstanding spina ischiadica. The preserved anterior lower edge of the facies auricularis is smooth without lipping and there is no sulcus praeauricularis.

Fragments nos. 1 and 2 belonged either to a single or to two young adult males.

TABLE 1. *Measurements of Gunn's finds (mm).*

Vertebrae:	1. Anterior vertical diameter	T4	19
	– " –	T5	18
	– " –	T6	21
	– " –	T7	21
	– " –	T8	20
	– " –	T9	22
Right coxae:	22. Maximum diameter of the acetabulum		52
	15. Height of the ischium		76
	– Thickness between the centre of the acetabulum and the interior side of the coxae		10

FIGURES 1 – 3. *1 – Part of the thoracic spine in left lateral view. 2 – Part of the thoracic spine in dorsal view. 3 – Radiograph of the thoracic spine in lateral projection.*

FIGURE 4. *Right hip-bone in lateral view.*

B) FINDS BY J.-P.LAUER IN 1934

3. *Manubrium sterni with upper part of corpus* (1st sternebra, *Fig. 5*) is covered in the upper half of the anterior side by remnants of brown skin penetrated by resin, on the posterior side by islets of blackened soft tissues. At the posterior edge of the incisura jugularis insertion of both musculi sternocleidomastoidei has survived.

The manubrium is totally fused with the corpus without any remnant of fissure (*Fig. 6*). At the same time, the shape of the edges of both parts is asymmetrical. Also, the dimensions, shape and position of articular facets for the 2nd rib differ on both sides. These features suggest the congenital origin of the synostosis. All articular facets are relatively large, concave and smooth, without osteophytes.

A free but closely fitting part of the described fragment is also the *first right rib* of the same individual (*Fig. 6*). It is relatively small (*Tab. 2*), but anteriorly broad (20 mm) and its cartilagineous part is calcified. The medial ends of similarly calcified cartilages of the 1st and 2nd left ribs have survived as well (*Fig. 6*).

4. *Proximal half of the right humerus* (preserved length 150 mm) lacks a major part of the tuberculum maius and the posterolateral part of the head. In the anterolateral quarter of the head the compact layer has been broken off (*Figs. 7*). The bone is medium robust, the head medium large (*Tab. 2*). The cristae of

5

6

FIGURES 5, 6. *5 – Manubrium with upper part of corpus sterni in anterior view. 6 – Radiograph of the manubrium with part of the corpus sterni in postero-anterior projection showing complete fusion.*

both tubercula majus and minus do not bulge. They are smoothly arched, lacking roughness. The sulcus intertubercularis is shallow. The well-preserved tuberculum minus is smooth, without projecting edges. The upper edge of the tuberositas deltoidea cannot be found on the fragment.

Through a break in the posterolateral part and in the place of the broken-off compact layer of the head small trabeculae of spongiotic bone are apparent. We noted by sounding that the marrow cavity of the bone reaches the level of the surgical neck

TABLE 2. *Measurements of Lauer's finds (mm).*

Sternum:	– Length of the manubrium with preserved part of the corpus	94
	4. Maximum breadth of the manubrium	79
	7. Thickness of the manubrium	23
	– Breadth of the incisura jugularis	13
	– Breadth of the right incisura clavicularis	26
	– Breadth of the left incisura clavicularis	23
1st left rib:	3. Length of the arch (along external face)	
	without ossified cartilage	130
	with ossified cartilage	150
Humerus:	7. Minimum circumference of the diaphysis	69
	8. Circumference of the caput	146
	9. Maximum transverse diam. of the caput	43
	10. Maximum sagittal diameter of the caput	46
Left foot:	– Preserved length	164
	– Maximum breadth (at metatarsophalangeal joints)	67
	– Transverse diam. of proximal joint surfaces of the naviculare and cuboideum	50

FIGURE 7. *Right humerus in anterior view.*

(= grade 2 according to Nemeskéri et al. 1960, age range 44 – 60 years).

5. *Left foot* has been preserved intact from the proximal joints of the navicular and cuboid bones (*Figs. 8 – 9*). Their joint surfaces for articulation with the talus and calcaneus are covered by a thick layer of resin which had to have been poured on the foot in a liquid state in order to penetrate into the joint. The skin, exposed on the posterior half of the dorsal side of the fragment and in the posterior and middle thirds of the plantar side, was also permeated by resin. It formed an especially thick layer (up to 7 mm) on the plantar side, where it cracked transversally. In places tiny remnants of the innermost layers of yellowish, finely woven linen have been preserved.

On the anterior half of the dorsal and anterior thirds of the plantar side thick wrappings consisting of several layers of linen, which originally encircled the whole foot, remained in situ. Single layers are apparent on its proximal edge, running from above the protruding head of the 5th metatarsal obliquely and distally above the distal half of the hallux. Deeper layers of these wrappings stained black by penetrated resin cover the middle third of the dorsum pedis. In these, while the resin slowly stiffened, the tendons of the extensors of the toes and the depressions between them were moulded. These artificial "tendons" are regularily arched, cylindrical, widening proximally, well-preserved except the first, whose proximal two thirds have been broken off (breadths 9, 6, 5, 5 and 7 mm). Depressions between the "tendons" are 7 – 8 mm deep, regularily cylindrical, widening distally (lengths 35, 42, 29, 27 mm, prox. breadths 7, 7, 3, 1 mm, dist. breadths 14, 7, 7, 5 mm).

The longitudinal and transversal vaults of the foot, enlarged probably by antemortem cramp, are very deep. Radiograms did not reveal any lipping or other pathological changes (*Fig. 10*).

The described fragments nos. 3 – 5 conform to the male sex, but their estimated individual ages revealed differences, being older than 50 years (no. 3), 40 – 60 years (no. 4) and 20 – 40 years (no. 5).

6. *Two fragments of wrappings* consisting of several layers of linen permeated by resin appear homogenous and stiff (69 × 48 × 21 mm, 43 × 43 × 29 mm). Remains of soft tissues, however, were found in them by histological examination (see below).

C) CONCLUSION

While the general robusticity and some other features do not exclude the probability of male sex in any of the preserved fragments, estimations of their individual ages contradict the original hypothesis of Derry that they all came from a single individual. Embalming techniques revealed by the fragments, especially the copious use of resin in some of them,

FIGURES 8 – 10. *8 – Left foot in dorsal view. 9 – Left foot in plantar view. 10 – Radiograph of the left foot in dorso-plantar projection.*

and the well preserved remains of soft tissues, do not correspond with the supposition of their dating to the Old Kingdom.

REMAINS OF AN UNIDENTIFIED FEMALE

State of preservation. The whole calvarium (*Figs. 11 – 13*), left humerus and left os coxae without pubis are available. These are completely skeletalized remains, without remnants of soft tissues.

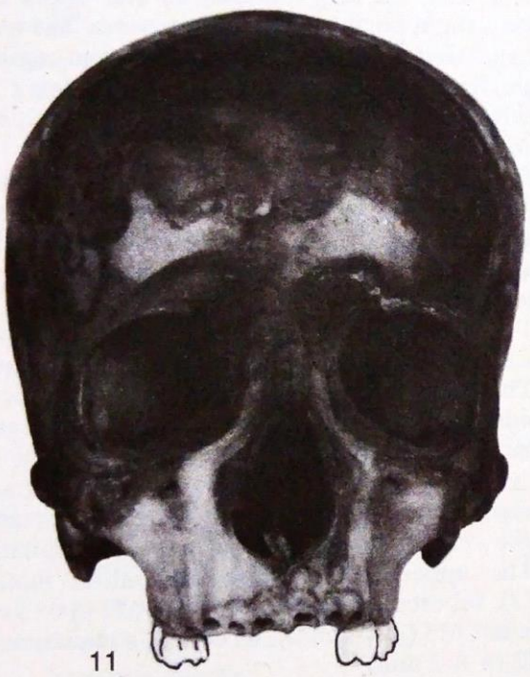
Age. The synchondrosis sphenooccipitalis is still open (fissure 1 mm), and no cranial suture has begun to fuse. In the upper jaw the permanent dentition was fully erupted, except the 3rd molars whose crowns are still deep in their sockets, being turned about 30 degrees posteriorly by their occlusal surfaces. Over them were large openings (left 10 × 8 mm, right 9 × 8 mm). The first molars show the very beginning of abrasion of the top of their cusps, while the other teeth are almost not abraded. The development of the ossa tympanica was completed. The occipital condyles bear no traces of fusion. The upper humeral epiphysis had not yet begun to fuse with the diaphysis, while the distal epiphysis had already joined it, leaving no trace of fusion. The lateral epicondyle fused smoothly with the diaphysis, while the medial one retained a deep fissure after fusion.

The acetabulum was smoothly fused except for a round hole in its centre (diam. 8 mm). The crista iliaca, tuberositas ischiadica and the surface of the facies auricularis had not yet begun to fuse.

All this indicates an individual aged 16 – 17 years, eruption of the third molar appearing belated, while fusion of the epicondylus medialis was accelerated. The surface character of the preserved bones and their identical individual age do not leave any doubt that all the remains belonged to a single individual.

Sex. All bones are gracile and relatively small (*Tabs. 3 – 7*). The incisura ischiadica major forms a widely vaulted arch. The sulcus praeauricularis is still slightly marked. The humerus has only slightly developed tuberositas deltoidea, the septum between the fossae coronoidea and olecrani is perforated (7 × 5 mm). In conformity with these features indicating the female sex are also the secondary sexual features of the skull which follow.

Descriptive features of the skull. The calvarium is gracile. In the frontal norm, medium developed, slightly merging tubera frontalia can be observed.



11

12

FIGURES 11 – 12. *11 – Calvarium in frontal view. 12 – Calvarium in right lateral view.*

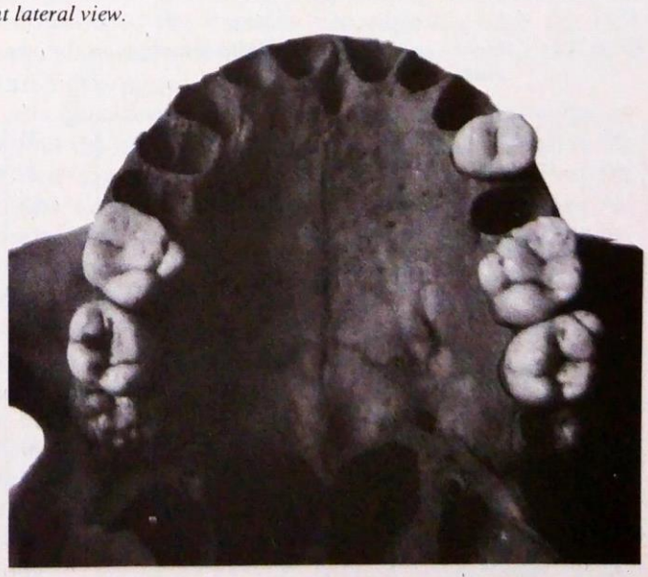


FIGURE 13. *Upper dentition with tubercula Carabelli and a paraconus.*

There is no metopic suture. There are notches in the place of the foramina supraorbitalia. No foramina frontalia accessoria developed. The upper orbital margin is thin and acute and the orbits are rectangular with slightly slanting axes. The foramina ethmoidea are double. The internasal suture lies in the midline, the nasal bones are of shape 3 after Hovorka (in Martin and Saller 1957). The piriform aperture is almost rhombic, narrow, with protruding edges. The processus marginales are only slightly marked. The zygomatic bones are medium prominent and have no anomalous sutures. The foramina zygofacialia and infraorbitalia are not increased in number. The fossae caninae are shallow, the subnasal region markedly wavy.

TABLE 3. *Measurements of the neurocranium of the unidentified female (mm).*

1	Maximum length	177
5	Length of the base of the skull	95
7	Length of the foramen magnum	32
8	Maximum breadth	130
9	Minimum frontal breadth	86
10	Maximum frontal breadth	112
11	Biauricular breadth	107
13.1	Maximum bimastoid breadth	102
BC	Maximum bicristal breadth	113
16	Breadth of the foramen magnum	24
17	Basion-bregma height	123
23	Horizontal circumference	495
24	Transverse curve	292
25	Sagittal curve	360
26	Frontal arch	119
27	Parietal arch	125
28	Occipital arch	116
29	Frontal subtense	105
30	Parietal subtense	110
31	Occipital subtense	98
ML	Length of the mastoid process	28
MT	Thickness of the mastoid process	12

TABLE 4. *Measurements of the splanchnocranium of the unidentified female (mm).*

40	Length of the face	93
43	Breadth of the upper face	95
44	Biorbital breadth	92
45	Bizygomatic breadth	114
46	Bimalar breadth	89
48	Height of the upper face	65
48.1	Height of the alveolar part	12
50	Anterior interorbital breadth	21
51	Orbital breadth	38
52	Orbital height	32
54	Nasal breadth	24
55	Nasal height	50
60	Maxilloalveolar length	51
61	Maxilloalveolar breadth	58
MH	Malar height	14

In the lateral norm glabella is of grade 2 after Broca (Martin and Saller 1957), while arcus superciliares are not developed at all. The nasofrontal transition runs in a very open blunt angle. The posterior half of the nasal bridge is straight, the anterior one slightly convex, their prominence medium. The spina nasalis anterior is of grade 3 after Broca (Martin and Saller 1957), the lineae temporales are slightly marked solely on the frontal scale. The pterya are of type a (Martin and Saller 1957), the cristae supramastoideae are weak. The profile of the forehead slants somewhat in its lower half, curving abruptly in the upper one. There is a slight postbregmatic depression. The vertex is flat and slightly ascending, the lambdoic region is medium flattened, the occiput slightly bulging and smoothly arched, the protuberantia occipitalis externa almost absent.

In the vertical norm the shape of the skull is ovoid (after Sergi in Martin and Saller 1957) with medium prominent tubera parietalia. The lambdoid suture contains numerous tiny wormian bones. No foramen parietale developed.

The occipital norm is house-shaped, narrow at the base, with a hint of sulcus sagittalis on the vault.

The basal norm reveals medium thick processi mastoidei and narrow incisurae mastoideae. Foramen Hushke and tuberculum praecondylicum are not developed. The upper dentition forms an elliptic arch, the palate is medium deeply vaulted. The occipital muscular relief is feeble, without a torus occipitalis.

The upper molars show anomalous features (*Fig. 13*): tubercula Carabelli on both M1 (5 × 3 mm) and on left M3 (3 × 2 mm), as well as a paraconus on left M2 (4 × 2 mm).

Dimensions of the skull are both in the neurocranium (*Tab. 3*) and in the splanchnocranium (*Tab. 4*) relatively small, corresponding with the female sex as well as, to a lesser extent, with the young age of the individual.

In the indices (*Tab. 5*) the neurocranium is dolichocranic, under the upper limit of chamaecrany, metriocranic, on average medium high with a low positive value of the acroplatic index. The forehead is globular, above the lower limit of metriometopy or mesosemy. The relations between the dimensions of the single bones of the cranial vault are harmonious. The index of the foramen occipitale magnum indicates its narrow form. The cranial modulus has a lower value than would be expected in a grown-up female.

The index of the upper face after Kollmann is lepten, after Virchow medium (*Tab. 6*). Other facial indices show mesoconchy, mesorrhiny, mesurany and the upper limit of orthognathy. The modulus of the upper face is still low, owing to the adolescent age of

TABLE 5. *Indices of the neurocranium of the unidentified female.*

1	Cranial i. (8:1)	73.4
2	Basion height-length i. (17:1)	69.5
3	Basion height-breadth i. (17:8)	94.6
HK	Mean height i. (Hrdlička-Kóčka, 17: 1+8:[2])	80.1
AC	Acroplatic i. (Benington, 8-17:1)	4.0
AB	Biauricular b.-maximum breadth i. (11:8)	82.3
MB	Bimastoid b.-maximum breadth i. (13.1:8)	78.5
CB	Bicristal b. – maximum breadth i. (BC:8)	86.9
10+	Sagittal i. of skull vaulting (1:25)	49.2
11	Transverse i. of skull vaulting (11:24)	36.6
12	Transverse frontal i. (9:10)	76.8
13	Transverse fronto-parietal i. (9:8)	66.2
16	Sagittal fronto-parietal i. (27:26)	105.0
17	Sagittal fronto-occipital i. (28:26)	97.5
18	Sagittal parieto-occipital i. (28:27)	92.8
19	I. of frontal sagittal arch (26:25)	33.1
20	I. of parietal sagittal arch (27:25)	34.7
21	I. of occipital sagittal arch (28:25)	32.2
22	Sagittal frontal i. (29:26)	88.2
24	Sagittal parietal i. (30:27)	88.0
25	Sagittal occipital i. (31:28)	84.5
33	Foramen magnum i. (16:7)	75.0
PM	Mastoid thickness i. (MT:ML)	42.9
37	Cranial modulus (1+8+17:[3])	143.3

TABLE 6. *Indices of the splanchnocranium of the unidentified female.*

39	Upper facial i. (Kollmann, 48:45)	57.0
39.1	Upper facial i. (Virchow, 48:46)	73.0
41	Jugomalar i. (46:45)	78.1
42	Orbital i. (52:51)	84.2
46a	Interorbital (50:44)	22.8
48	Nasal i. (54:55)	48.0
51.1	I. naso-facialis transversalis (54:45)	21.1
51.2+	I. naso-facialis verticalis (55:48)	76.9
54	Maxillo-alveolar i. (61:60)	113.7
60	Gnathic i. (40:5)	97.9
61+	Upper facial modulus (40 + 45 + 48 : [3])	90.7
69	Longitudinal craniofacial i. (40:1)	52.5
70+	Vertical craniofacial i. (48:17)	52.8
71	Transverse craniofacial i. (45:8)	87.7
72	Frontobiorbital i. (9:43)	90.5
73	Jugofrontal i. (9:45)	75:4

In Tabs. 1 – 6 numbers according to Martin and Saller 1957, letters according to E. Strouhal.
+ = calculation of the index modified

the individual. The craniofacial indices are harmonious.

Dimensions of postcranial bones reveal unfinished growth and epiphysation (*Tab. 7*). Stature can be roughly estimated according to tables by Trotter and Gleser (1952) using the humeral length and adding 8 mm as compensation for the missing unfused humeral head. It comes to 155 cm according to tables for Europid females or 154 cm according to tables for Negrid females, both low values resulting from the unfinished growth.

Also the height of coxae and ischium were still low, while the breadth-height index of the ilium expressed its relatively larger breadth, as conforms with the female sex.

Pathological changes were not found in any of the preserved bones.

TABLE 7. *Measurements (mm) and indices of the postcranial skeleton of the unidentified female.*

Left humerus		
1	Maximum length	282+
4	Lower epiphyseal breadth	50
7	Min. circumf. of the diaphysis	46
Right coxae		
1	Pelvic height	179 ? ++
9	Height of the ilium	121 ++
12	Breadth of the ilium	131 ++
15	Height of the ischium	76 ++
22	Max. diameter of the acetabulum	49
–	Breadth-height index of the ilium (12:9)	108.3

+ diaphysis with lower epiphysis without head
++ without apophyses

Conclusion. The features, form and dimensions of the skull fit well into the range of Egyptian population, not revealing any foreign genetic influence. The secondary sexual features, smaller dimensions and gracility of the remains express the female sex and the juvenile age of the individual. The total skeletalization of the remains corresponds with the still imperfect state of embalming techniques in the first three dynasties.

Question of identification. Because information about the origin of these remains was not found in the Cairo Department of Anatomy and none of the authors of archaeological reports on the Step Pyramid mentions the finding of a skeleton of a juvenile female, no support for her identification is available. The possibility that these remains were erroneously considered to belong to an 8 – 9 year-old child found in an alabaster coffin in one of the eastern corridors of the pyramid seems improbable. However, the remains of a child of that age from the Step pyramid were not found in Batrawi's anthropological collection either. Regarding the origin of these remains in the Step Pyramid, as attested to by a written document and by positive proof of their antiquity according to radiocarbon dating (see further), we might consider them as being related to a royal burial, either of Djoser, or of some of his predecessors.

HISTOLOGICAL EXAMINATION

(Alena Němečková)

Introduction. In July 1989 we obtained some specimens designated as the tissues of King Djoser's mummy. These were taken from Lauer's finds, item no. 6. Macroscopically these tissues were dessicated, brittle and of light brown colour. We present here the results of a study of them using a light and an electron microscope.

Methods. At first we processed the specimens by classic histological methods. Small pieces of tissue were fixed in 10 % formaldehyde and transferred over metacrylate into paraffin. The following staining methods were used on the tissues: haematoxylin and eosin, orcein and Verhoeff's haematoxylin method (Wolf 1954).

Then we carried out special processing to get the preparations ready for observation in an electron microscope. Having softened the tissues according to Sandison (1955), we transferred the specimens in glutaraldehyde solution in a 0.05 M phosphate buffer. Minute particles of the tissues were postfixed in 1 % osmium dioxide in a 0.1 M phosphate buffer and in 0.1 M saccharose, prior to being dehydrated and embedded in EPON 812. Ultrathin sections made on an ultramicrotome were contrasted with uranylacetate and lead citrate (Mráz, Polónyi 1988).

Results. Distinct histological qualities of the skin were seen on the sections prepared with classical histological methods. Identical specimens, embedded in EPON and stained with the toluidine blue, demonstrated a better quality of tissue processing (*Figs. 14, 15, 16*).

No epidermis layer was found on the sections. A layer of dermis was preserved containing the bundles of collagen fibres (*Fig. 14*). Elastic and reticular fibres were also noted. It was possible to determine a hypodermis by the presence of the adipose tissue separated by bundles of collagen fibres (*Fig. 16*). At the boundary between dermis and hypodermis some blood vessels were found. They probably represent the rete cutaneum, which supplies the hypodermis, skin glands and parts of hairs. We did not find any degenerative atherosclerotic changes in vessel walls. In sections we could observe the hair, placed at various depths of the hypodermis. We were successful in finding hairs in longitudinal and transversal sections (*Figs. 14, 16, 17*).

A well-formed cellular matrix as well as hair cortex was diagnosed in longitudinal sections of the hair bulb (*Fig. 14*). The cells on the top of the hair papilla contained pigment granules. We found cells of elongated shape, which move along the hair axis and consecutively take the shape of cuticular cells. The inner and outer epithelial sheaths were damaged, the outer sheath of connective tissue was preserved.

The cells on the top of the papilla were observed in an electron microscopic image. It was possible to observe a decomposition of the cellular nucleus, numerous cellular vacuoles and well-preserved cellular membranes (*Fig. 15*). There was no hair medulla on the transversal sections (*Figs. 16, 17*). The hair cortex was made of cells without nuclei (*Fig. 17*), and was covered with a cuticula which consisted of flat cells, superimposed in tile-like fashion (*Fig. 18*), loosened in some places. We found melanin pigment in the form of granules and rods in the outer layer of the cortex (*Fig. 18*).

Another specimen represents the remains of an elastic cartilage. The ground substance is interwoven by a network of elastic fibres, which reacted positively on the orcein dye. The cells are missing, only empty lacunes remaining (*Fig. 19*).

In several specimens we observed peripheral nerves, enveloped by a connective tissue sheath. The individual nerve bundles were covered by this perineurium (*Fig. 20*), which represents a tough sheath that remained preserved for a long time. The individual nerve fibres appeared very distinctly.

We compared our light microscopy results with that of Giacometti's paper (1968), in which the author studied skin specimens from about 4,000 B. C., and our electron microscopy results with that of the Lewin's papers (1967, 1968), in which the author described skin tissue from about 600 B. C.

FIGURE 14. *Skin in horizontal section. A = hair bulb, B = collagen fibres, C = adipose tissue.* × *63.*

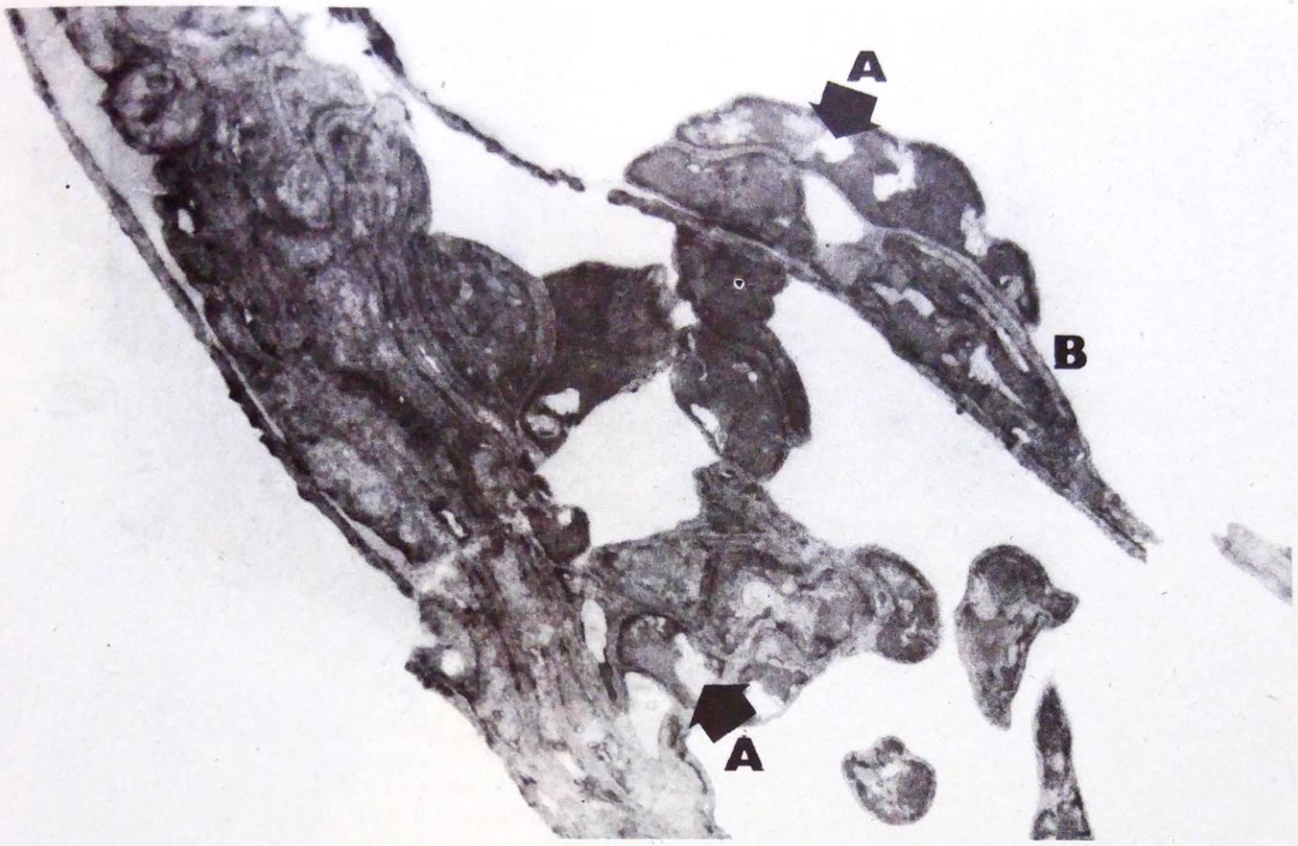


FIGURE 15. *Cells on the top of a papilla in an electron microscope. A = cellular vacuoles, B = well-preserved cellular membranes. × 6000.*

FIGURE 16. *Skin in transverse section with hairs. × 25.*

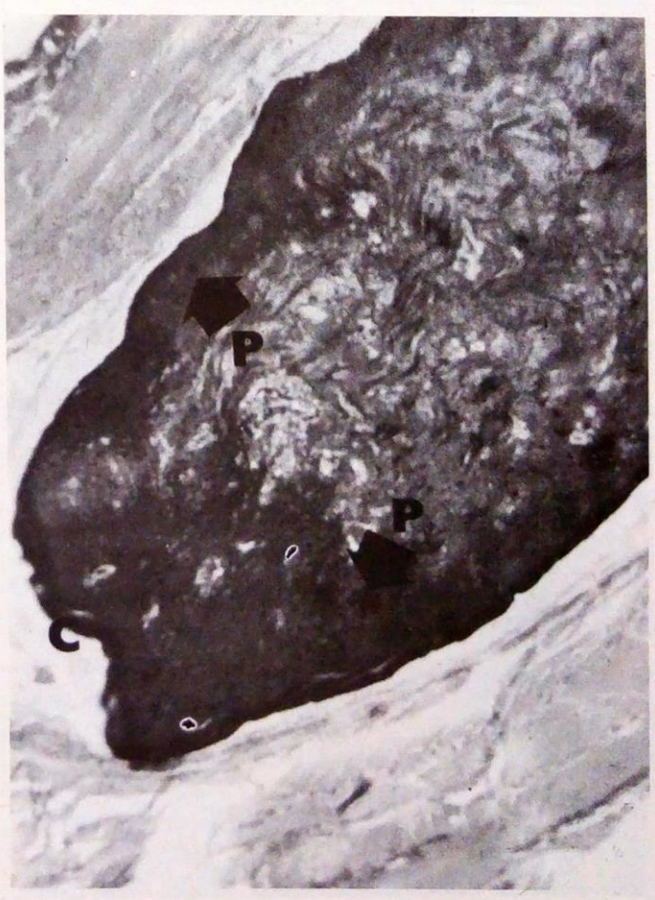


FIGURE 17. *Detail from a transverse section of a hair. C = cuticula, P = pigment granules. × 160.*

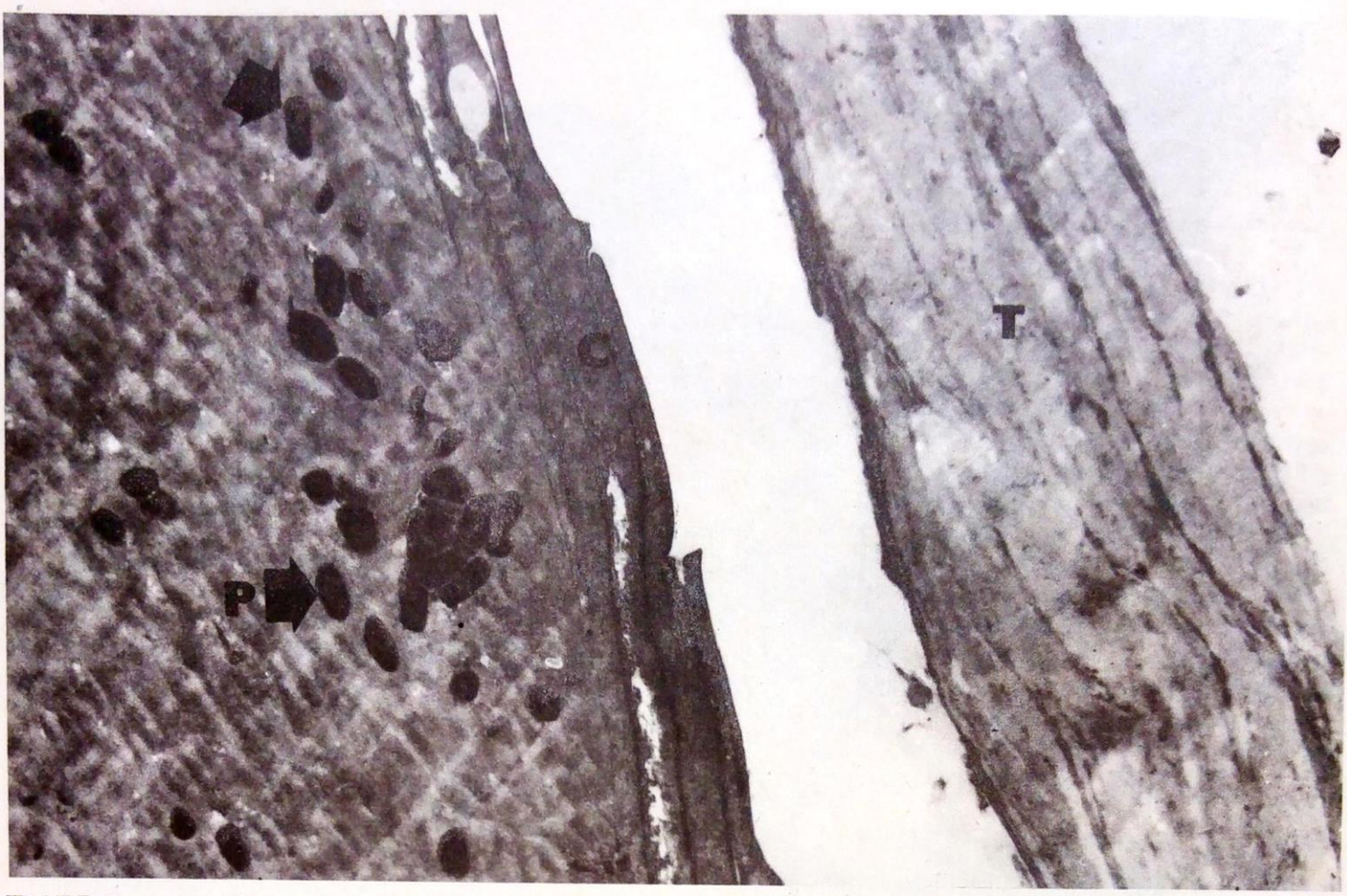


FIGURE 18. *Section of a part of a hair in an electron microscope. P = pigment granules, C = cuticular cells, T = connective tissue. × 4000.*

FIGURE 19. *Elastic cartilage with stained bundles of elastic fibres in the matrix between the cells. × 120.*

FIGURE 20. *Peripheral nerve in horizontal section. Fibres of the endoneurium collagen. × 160.*

Considering the presumed age of our specimens, we found them in extraordinarily good histological condition. We had not met with such well-preserved tissues as these in Old Kingdom specimens we studied previously (Němečková 1993). The cellular preservation is surprising, especially in the structure of the hair bulb.

Conclusion. The mummified material studied proved to be quite comparable with normal, present-day tissues. In the specimens of the mummified tissues we did not observe any pathological changes. We diagnosed a very well-preserved structure of skin and hair bulb. Semi-thin sections, stained by toluidin blue, proved to be the best histological method for the study of mummified tissues.

HISTOMORPHOMETRIC ANALYSIS
(Shelley R. Saunders)

Introduction. There are a number of histological methods that have been developed for estimating age at death from skeletal remains. These methods are based upon observations, made in the first half of this century, that the number of osteons in any given sample of bone increases with age as a result of continuous remodelling activity. Researchers have also known for some time that histological structures are often preserved in excavated skeletal remains, so that histological aging methods might be applied to earlier human populations.

The great advantage of these methods is that they can be applied to extremely fragmentary remains, or applied in cases where only small bone tissue samples are available for analysis. The accuracy rates for these methods are reported to be high (Thompson 1979; Singh and Gunberg 1970). However, there are still a number of attendant problems with histological aging, because of considerable physiological variance within microscopic bone sections and because of methodological problems of section preparation and quantification (Stout 1989).

Material. The author was provided with two samples purported to belong to the mummy of King Djoser. One came from the transition between the posterior and middle third of the 7th left rib (Gunn's find, no. 1, sample taken on Dec. 21, 1988); the other was a mid-section of diaphysis of the humerus (Lauer's find, no. 4, sample taken March 7, 1991).

Methodology. Age at death was estimated from the samples according to the method of Thompson (1979) for the humerus and the method of Stout (Stout and Paine 1992; Stout et al. 1994) for the rib.

Two undecalcified sections from 7th left rib (part of Gunn's find, no. 1) and a humerus section (from Lauer's find, no. 4) were prepared. The bones were soaked and cleaned in Sandison's fluid. The samples were then dehydrated in three successive solutions (50 %, 70 %, 95 %) of ethylalcohol, and then embedded in an epoxy resin. One cross-sectional surface of each specimen was cut, ground and polished. The polished surfaces were glued to glass slides using epoxy, and final thin sections were prepared by cutting off the excess embedded blocks. The resultant thin sections were then ground, polished and covered with glass cover-slips.

Cortical area, intact osteons and fragmentary osteons were counted from the total area of each of the two cross sections of the rib sample. Counting the entire section avoids problems of field location. Counts of intact and fragmentary osteons were made using a Zeiss Videoplan imaging programme with digitizing board, which maintains orientation and reduces the chance of intraobserver error.

For the humerus sample, four grid units of approximately 1 mm^2 (the grid size matches that of Thompson exactly) were used to count the density of osteons. The counts were averaged, and this value compared to the regression formula for age estimation supplied by Thompson for the male humerus.

The estimated morphological age of the specimens was not known at the time of the histological analysis.

Results. The histomorphometric counts of the two sections of the rib and of the section of the humerus are reported in *Table 8*. It can be seen that the range for the estimated ages from the rib sections is 19 – 25 years, while for the humerus section the estimated age is 48.3 ± 9.5 years. While it has been shown that different bones of the body remodel at different rates (Stout and Stanley 1991), this large discrepancy in estimates precludes the possibility that both bones belonged to the same individual. The appearance of one of the rib sections can be judged from *Fig. 21*. Although there was a minimal amount of drying and cracking during preparation, this did not appear to affect the quantification of histomorphometric features.

TABLE 8. *Histomorphometric calculations.*

Rib sample	Section 1	Section 2
1 Total area of the section	61.1	61.1
2 Cortical area of the section	29.4	28.4
3 C/T Ratio	0.481	0.464
4 Intact osteons	261	313
5 Fragmentary osteons	57	75
6 Intact osteon density (Pi) (4:2)	8.88	1.02
7 Fragmentary osteon density (Pf) (5:2)	1.94	2.64
8 Total visible osteon creations Pt = Pi + Pf	10.82	13.66
Age predicting equation: Age = – 2.3168 + 1.9794 (Pt)		
Age estimate	19.10 yrs	24.72 y
Humerus sample		
Grid counts	68 55 65 46	
Total count	234	
Age estimate	48.3 + 9.5 yrs	

FIGURE 21. *Histomorphometric section from the rib.* × *40.*

RADIOCARBON DATING

(Georges Bonani, Willy Woelfli, Eugen Strouhal)

Sample provenance. Samples for AMS (accelerator mass spectometry) ^{14}C-dating were taken from the remains designated as King Djoser's during three different working sessions of two of us (E. S. and M. F. G.) in Egypt. Respecting Derry's identification of the fragments as belonging all to one and the same individual (Derry 1935, Lauer and Derry 1935), only one small piece of textile wrapping from Lauer's find (no. 6, ETH-5333) was at first collected on December 21, 1988.

Since the result of this ^{14}C-dating did not turn out as expected (see *Tab. 9a*), two other samples were taken on March 7, 1991, namely a small fraction from the 7th left rib of Gunn's find (no. 1, ETH 8008) and a minute amount of tissue from the compact layer at the middle part of the diaphysis of the right humerus of Lauer's find (no. 4, ETH-8009).

Although the dating of these two samples essentially confirmed the first result, the number of dated samples was still too small to exclude the possibility that both finds might be a mixture of fragments from different individuals. Such a possibility was first indicated by our macroscopic and radiological investigations of the fragments. The existence of such a mixture could finally be proven by means of a histomorphometric analysis finished on September 3, 1991.

For this reason the following four additional samples were collected on February 22, 1994: a sample of soft tissue adhering to the inner side of the right hip bone from Gunn's find (no. 2, ETH-12195), and from Lauer's find a sample of soft tissue from the posterior side of the sternum (no. 3, ETH-12194), as well as two samples from the left foot. One of them was removed from the tuberositas ossis navicularis with a part of the adhering ligamentum talonaviculare (no. 5a, ETH-12198), and the other from the middle of the posterior edge of the preserved textile wrappings over the anterior third of the sole (no. 5b, ETH-12193).

During this last stage of investigation two samples from the remains of the unidentified female were also taken. The first one was the left concha nasalis inferior (ETH-12197) and the second one was a part of the damaged medial edge of the right ischion (ETH-12196).

Experimental procedure. Samples were prepared for AMS-dating according to the ETH-standard procedure. Tissues and textiles were cleaned first mechanically (in an ultrasonic bath) and then chemically, by applying the traditional acid-base-acid (HCl-NaOH-HCl) treatment. The bone samples were slowly dissolved in 10 % HCl until its organic component

(the collagen) could be fully removed. The available material was rinsed to pH 7 with distilled water between each step. The strength of the solution, temperature and length of time of each step were adjusted according to the ability of the material to withstand the treatment. Following this treatment, the material (a few milligrams in each case) was dried and then combusted to carbon dioxide in evacuated and sealed quartz tubes, with copper oxide and silver wire. The CO_2 was finally reduced to filamentous graphite over a cobalt catalyst, using the method described by Vogel et al. (1987).

For each sample the $^{14}C/^{12}C$ and $^{13}C/^{12}C$ ratios were determined quasi-simultaneously and relative to the respective NBS oxalic acid I and PDB standard values, using the ETH AMS dating facility. Details of this measuring procedure are described elsewhere (Bonani et al. 1987). The conventional radiocarbon ages were calculated according to the evaluation procedure suggested by Stuiver and Polach (1973). They are corrected for natural isotopic fraction, with normalization to $\delta^{13}C = -25\ ‰$ and reported in yr BP (before 1950).

Results. The conventional ^{14}C age and corresponding ^{13}C value measured for each sample, including ETH laboratory identification number, type of dated material and provenance are listed in *Tables 9a* and *9b*. The errors quoted for the ^{14}C ages are at the one-sigma (1σ) level, and represent either the statistical error of the mean or the variance, whichever is larger. The mean and variance (scattered around this mean) were evaluated from the results of at least three independent age determinations performed on each sample.

Discussion. The compilation of the results in *Table 9a* shows that the conventional radiocarbon ages of the 7 samples attributed to the remains of King Djoser all lie in the range of 2185 – 2630 yr BP, yielding a weighted mean value of 2369 ± 57 yr BP. To obtain the corresponding true or calendar age range, this value, including its ± 2σ error range, was calibrated by using the high precision calibration curve based on dendrochronological dating (Stuiver and Pearson 1986). The CalibETH programme was applied to calculate the resulting non-Gaussian probability distribution (Niklaus et al. 1992). The result of this calibration procedure listed in table 10 leaves no doubt that the fragments of Gunn's and Lauer's finds cannot be identified with King Djoser's remains. This pharaoh is supposed to have lived between 2620 – 2600 B. C. (Beckerath 1971) or even a couple of hundred years earlier, if the results of more recent ^{14}C dating of Djoser's Step Pyramid are taken at their net value (Haas et al. 1987).

In spite of this negative result, it is worthwhile to note some interesting features of these seven dates. A simple X^2-test applied to these results (see *Table 10*) immediately tells us that the true scatter of the single dates around their weighted mean is much larger than the scatter allowed by the experimentally-determined errors of each date. The numbers (X^2 and associated probability P) indicate that not all of these seven samples belong to the same time range. A closer examination suggests a division of these results into the two subsets listed in *Table 10*. Their corresponding weighted mean values are, as can be seen, more than 200 radiocarbon years apart. Applying the same statistical test as before to both data sets improves the probability P from zero to 4.7 % for the first and to 30.6 % for the second subset. The latter leaves no doubt that the three data of the second subset form a statistical unit. They are based on a soft tissue sample from Gunn's find (no. 2) and two textile samples from Lauer's find (nos. 5b and 6).

More delicate is the situation in the case of the first subset. Here, the evaluated probability of 4.7 % is below but close to the 5 % limit usually but more or less artificially established, to distinguish between statistical and non-statistical ensembles. The high radiocarbon age obtained for no. 5a, ETH-12198, is responsible for the rather low P-value. Of the members of this group two (rib, no. 1, ETH-8008, and humerus, no. 4, ETH-8009) accidently yielded exactly the same date (*Table 9a*). But it should be remembered that histomorphometrically the first fragment, coming from Gunn's find, belonged to a 19 – 25 year old individual, while the second one originating in Lauer's find to a 48.3 ± 9.5 year old one. The fragment of sternum, no. 3, ETH-12194, belongs to them according to a similar dating. It came from an older individual who could be, but need not be, identical with the one represented by the humerus. The foot, no. 5a, ETH-12198, represents a younger individual who lived about 150 – 200 years earlier than the other ones contained in this "group". Curiously enough, the date for wrappings of the foot, no. 5b, ETH-12193, belongs to the first subset and suggests the possibility that the foot was rewrapped about 450 years later. Thus also this "group" does not come from a single individual, but from a heterogenous collection of three or four individuals.

The dating of the two bone samples taken from the remains of the unidentified female yielded two results with a disturbingly large scatter (*Tab. 9b*). Since the two samples were taken from remains of one single individual and no fault was detected in the experimental procedure, we have to consider here the weighted mean together with the large error as determined by the variance of this two data. The calibration of this result (see *Tab. 10*) shows that the remains of this woman are more than 2000 years older than the fragments from Gunn's and Lauer's finds. She died somewhere between 3532 and 2878 B. C., a couple of hundred years before the chronological range for the 3rd Dynasty accepted by Egyptologists (2700 – 2600 B. C., Hayes 1971). This discrepancy leaves the way open for two possible explanations: the woman either died long before the beginning of the 3rd Dynasty and her burial was deposited in a monument preceding the Step Pyramid, or, if she belonged to Djoser's family, then the time range presently attributed to this Dynasty is too low.

TABLE 9a. *Results of radiocarbon dating of the supposed remains of King Djoser. Samples 1–2 are from Gunn's find (1926), samples 3–6 from Lauer's find (1934).*

Sample No.	Laboratory No.	Material	Anatomical location	Conv. ^{14}C-age (yrs BP)	^{13}C (‰ 0)
1	ETH-8008	bone	rib	2465 ± 55	−24.3 ± 1.0
2	ETH-12195	soft tissue	hip bone	2220 ± 55	−25.2 ± 1.2
3	ETH-12194	soft tissue	sternum	2410 ± 55	−25.5 ± 1.2
4	ETH-8009	bone	humerus	2465 ± 55	−18.4 ± 1.0
5a	ETH-12198	bone and tendon	os naviculare	2630 ± 60	−20.0 ± 1.4
5b	ETH-12193	textile	wrappings from a foot	2185 ± 55	−28.5 ± 1.2
6	ETH-5333	textile	wrappings not associated with a bony fragment	2290 ± 45	−22.2 ± 2.0

TABLE 9b. *Results of radiocarbon dating of two samples from the unidentified female.*

Sample No.	Laboratory No.	Material	Anatomical location	Conv. ^{14}C-age (yrs BP)	^{13}C (‰ 0)
1	ETH-12196	bone	ischium	4630 ± 65	−20.5 ± 1.2
2	ETH-12197	bone	nasal concha	4355 ± 65	−22.1 ± 1.3

TABLE 10. *Calibration of the radiocarbon dates for the supposed remains of King Djoser and of the unidentified female.*

Sample set	Weighted mean conv. ^{14}C-age (yrs BP)	X^2 and associated probability P	Calibrated ^{14}C-age ranges for 2σ – error (= 95 % c. l.) and corresponding probability
"Djoser" all (1 – 6)	2369 ± 57	7.85 (P = 0.0 %)	762 – 625 B.C. (19.4 %) 598 – 357 B.C. (77.5 %) 287 – 251 B.C. (3.1 %)
"Djoser" (1, 3, 4, 5a)	2487 ± 46	2.65 (P = 4.7 %)	777 – 473 B.C. (91.2 %) 464 – 417 B.C. (8.8 %)
"Djoser" (2, 5b, 6)	2240 ± 32	1.18 (P = 30.6 %)	379 – 331 B.C. (23.7 %) 329 – 208 B.C. (76.3 %)
Unidentified female	4492 ± 137	8.90 (P = 0.0 %)	3620 – 3582 B.C. (1.5 %) 3532 – 2878 B.C. (98.5 %)

There are good arguments for both options. The stone vessels from the 1st and 2nd Dynasties which were deposited in the East Galleries of the Step Pyramid indicate a possibility that older burials could have existed in its place.

On the other hand, the second possibility is supported by a series of radiocarbon dates of 17 monuments built during the 3rd – 6th Dynasties (Haas et al. 1987). The results of this study indicate that all of these monuments are ca. 300 – 400 years older than their Egyptological datings. For instance, a conventional ^{14}C-age of 4280 ± 40 yr BP (mean value of dating of four different samples) was found for the Step Pyramid of King Djoser. The calibration of these results tell us that this Pyramid was built with a probability of 95 % between 3100 and 2700 B. C. Since this range partially overlaps with that found for our unidentified female, we cannot exclude the possibility that she indeed lived during the 3rd Dynasty and – being buried in the Step Pyramid – she could had been a member of Djoser's family.

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CONCLUSIONS

1. The embalming techniques applied to mummified human remains found by Gunn and Lauer in the granite chamber of the Step Pyramid differ from the techniques of the Old Kingdom. Lavish application of resin in wrappings as well as the moulding of "tendons" and spaces between the "tendons" do not correspond to 3rd Dynasty methods, but recall the complicated patterns of wrappings known from the Ptolemaic Period.

2. The fragments described were not parts of the mummy found by Minutoli. Not the slightest traces of gilded wrappings were found on them. The foot exceeds the number of two soles mentioned by Minutoli.

3. The excellent preservation of histological details in Lauer's find (no. 6), comparable with recent tissues, precludes an origin in the first half of the 3rd millennium B.C.

4. Macroscopic features as well as histomorphometric results showed that the fragments did not

belong to a single individual as considered by Derry, but to 3 to 5 persons, all probably of male sex, but of different individual ages at death.

5. Results of radiocarbon dating of all fragments completely excluded the 3rd millenium B. C., and thus the possibility that even a single one of them could have belonged to King Djoser. All fragments originated in burials from the 1st millennium B. C., showing a rather wide time range (777 – 208 B. C.). In combination with the previous point it cannot be excluded that each fragment came from a separate individual. For confirmation of this possibility the determination of blood groups or DNA sequences of the single fragments would be useful.

6. Fragments found both by Gunn and Lauer could have accordingly originated in the Saite, Late Period and early Ptolemaic burials recorded in the Southern Gallery (and perhaps also in the northern descending corridors) of the pyramid. They could have fallen to the bottom of the shaft and, during archaeological activities there, could have found their way probably more than once into the granite chamber. Our re-examination thus confirmed the original view of Firth. This hypothesis also explains why these fragments were not found prior to Gunn's work and why others could have been found eight years after Gunn by Lauer.

7. According to the results of radiocarbon dating a discrepancy was found between the date of the death of the individual represented by the foot (about 2630 BP) and the date of its wrappings (about 2185 BP). This can be explained by a supposition of re-wrapping of an older mummy about 450 years after the death of the individual during the beginning of the Ptolemaic Period.

8. The bones of a 16 – 17-year-old woman show a state of preservation reflecting the poor knowledge of embalming techniques during the first three dynasties. This was proved by their high radiocarbon dating with a wide range from 3532 to 2878 years B. C.

9. Identification of these remains with one of the three daughters of Djoser remains a possibility, if the hypothesis that the Egyptological dating of the 3rd Dynasty is too low were taken into account. But this female also could have been connected with one of Djoser's predecessors and her body could have been buried under the later Step Pyramid, similarly as the Archaic stone vessels found in the 6th – 11th eastern galleries. For this reason we prefere to call her an unidentified female rather than a daughter of Djoser.

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Photographs:
Figures 1 – 13 Eugen Strouhal
Figures 14 – 20 Alena Němečková
Figure 21 Shelley Saunders

Eugen Strouhal
Institute for the History of Medicine,
1st Medical Faculty,
Charles University,
Kateřinská 32, 121 08 Prague 2,
Czech Republic

Mohammad Fawzi Gaballah
Department of Anatomy,
Medical Faculty Kasr el-Aini,
Cairo University,
Cairo, Egypt

Georges Bonani,
Willy Woelfli
Eidgenössische Technische
Hochschule,
Institut für Teilchenphysik,
Zürich, Switzerland

Alena Němečková
Institute for Histology and
Embryology,
Medical Faculty, Plzeň,
Charles University,
Czech Republic

Shelley R. Saunders
Department of Anthropology,
McMaster University,
Hamilton, Ontario, Canada