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AUDITORY OSSICLES FROM ARCHAEOLOGICAL FINDS

ABSTRACT — A total of 75 auditory ossicles, obtained during archaeological excavations from the latène period (Praha) and from the Middle Ages (Beroun) were subjected to scanning electron microscope and osteometric examinations. In both groups, normal and pathologically changed auditory ossicles were found and described according to previously published classification of damage of auditory ossicles due to a benign (inflammatory) destructive process. The suitability of archaeological ear ossicles for scanning electron microscopy was also demonstrated on 2 mallei, found in skeletal remains from Nové Dvory, dating back to the time of the „Únětice culture", being thus more than 3,000 years old. Finally, some osteometric differences between the latène and medieval groups were evaluated statistically in order to compare them with those on other skeletal parts of these individuals after necessary measurements.

KEY WORDS: Ear ossicles — Archaeological finds — Scanning electron microscopy and osteometry.

After previous experiences with necroptic auditory ossicles or ossicles extracted during operations we have followed up the possibility of using the scanning electron microscope to study also normal and intravitally damaged ear ossicles found in graves discovered during archaeological research.

MATERIAL AND METHODS

A total of 77 auditory ossicles belonging to three different groups have been acquired:

1. The first group of ossicles belonged to the skeletal remains of important citizens found in the monastery burial ground in Beroun (1340—1421): 23 mallei, 22 incudes and 8 stapedes.

2. The second group was obtained from the skeletal burial remains in Praha (Prague) 6, Ruzyně-Jiviny (the late and middle latène periods, i.e. 100 to 300 BC: 10 mallei, 9 incudes and 3 stapedes.

3. The rarest findings are two mallei found in skeletal remains from Nové Dvory, dating back to the time of the "Únětice culture", being thus more than 3,000 years old.

After necessary processing the scanning electron microscope Tesla BS 300 was used; after these examinations the ossicles were subjected to osteometry.

RESULTS AND DISCUSSION

The high degree of preservation of even the fine superficial structures enabled a number of interesting observations: though e.g. more than 3,000-year-old hammers belonging to the "Únětice culture" displayed flattened heads and above the site of attachment of the anterior process a well preserved nutrient foramen (*Fig. 1* on the left).

On the Beroun hammers (Middle Ages) a prominent lump or tubercle is seen on the anterolateral aspect of the head (Fig. 1 on the right): in one hammer (*Fig. 2* on the right) the tubercle is developed to such a degree that it is likely to have contributed to the concretion of this portion of the hammer with the wall of the tympanic cavity (probably so-called primary fixation of the hammer, which causes hypacusis in vivo).

FIGURE 1. *A hammer dating back to the time of the "Únětice culture" (= —3,000 years) with a large nutrient foramen (the black horizontal bar is equivalent to 0,5 mm). On the right — a medieval hammer with a prominent tubercle on the anterolateral aspect of the head.*

The incudes are also intersting: the occurrence in the anvils of a well-preserved lenticular process proves (for osteometry) the fact that their long crus is complete: otherwise (*Fig. 3*) it is just in the vicinity of the lenticular process that the lesions of the auditory ossicles due to an inflammatory process in the middle ear first appear; these lesions were defined in the classification by Navrátil and Lisoněk, 1966. With the utmost importance of this site in mind, we would like to demonstrate the three possible forms of the terminal portion of the long crus, which has not a continuous compact surface:

The end of the long crus in *Fig. 4* (on the left = latène) displays a hollow space opening wide in the crurolenticular angle; it is lined with an intact bone surface so that it is the orifice of the central vascular canal of the long crus.

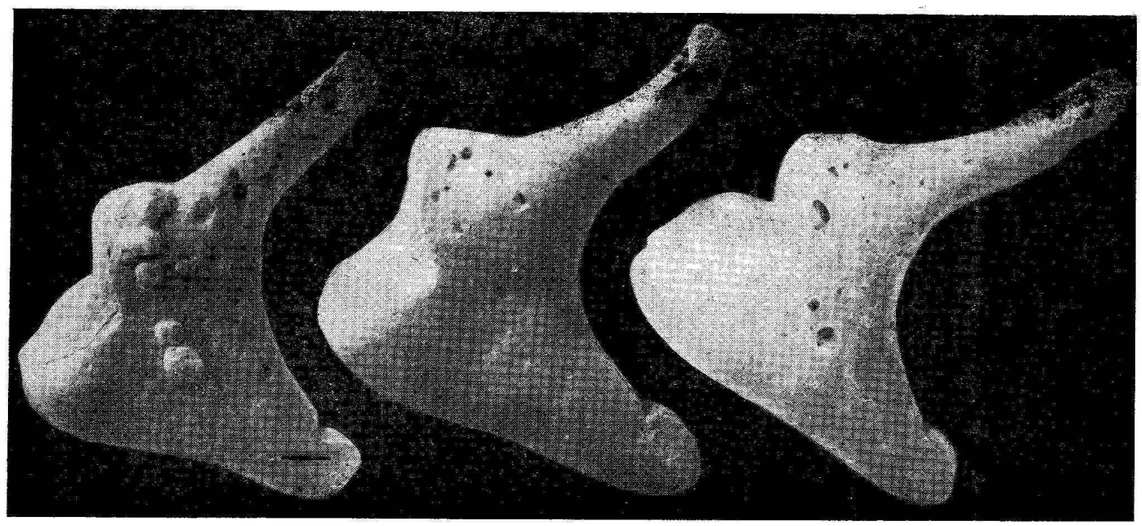
In contrast, the middle of *Fig. 4* (Middle Ages) shows a deep defect in the crurolenticular angle, which has penetrated ruthlessly into deep layers of the bone, usurating it in acute edges, as is characteristic of an inflammatory process of the first degree of the classification.

The right picture of *Fig. 4* (latène) shows a fine, shallow and thus mainly flat and rather extensive defect in the surface beneath the lenticular process — this defect is of post mortem origin.

Following complete inflammatory destruction of the lenticular process (*Fig. 3* on the right — Middle

FIGURE 2. ◀ *A latène hammer with a similar tubercle. On the right — a concretion of the bone tubercle on the anterolateral surface of the head of the hammer with the wall of the middle-ear cavity. Bar = = 0,5 mm.*

FIGURE 3. ▼ *Three medieval anvils: bone pearls as a probably residuum of a previous inflammation; in the middle — the anvil with the first grade damage on the end of the long crus (above); on the right — the second grade damage of the long crus of the anvil (= the whole destruction of the lenticular process). Bar = 0.5 mm.*



Ages), the residue of the long crus assumes the form of a blunt stump, which — according to our classification — shows the second degree of damage.

Observed on another anvil of the latène period (*Fig. 3* on the left) are numerous appositions in the shape of bone pearls, probably due also to an inflammatory process.

Because of the fixation of otosclerotic stapedes in the oval window (fenestra vestibuli), we could only observe normal stirrups: the medieval one with tiny vascular openings in the head (*Fig. 5* on the left); the head of another medieval stirrup has a shell-like construction — a pillar in the middle supports the vault of the shell, thus limiting its flutter. *Fig. 5* (on the right) shows a latène foot-plate with the sites of attachment of both cruia.

As late as in 1923 Heron insists that there are relatively sporadic studies dealing with the gross anatomy of the auditory ossicles and considers Urbantschitsch (1876) to have been the first to subject these ossicles to an osteometric examination.

From the point of view of osteometry, the average maximum length of the malleus (*Scheme 1*-A) in the adults of the Beroun (medieval) group (8.02 $\pm$ $\pm$ 0.30 mm) was shorter than the average maximum length in the sets of Heron or Masali. In the Prague group (latène), the average value of this dimension was still shorter (7.96 $\pm$ 0.23 mm). It is noteworthy that the latter group (Prague) with shorter hammers had, on the contrary, longer handles than the Beroun group.

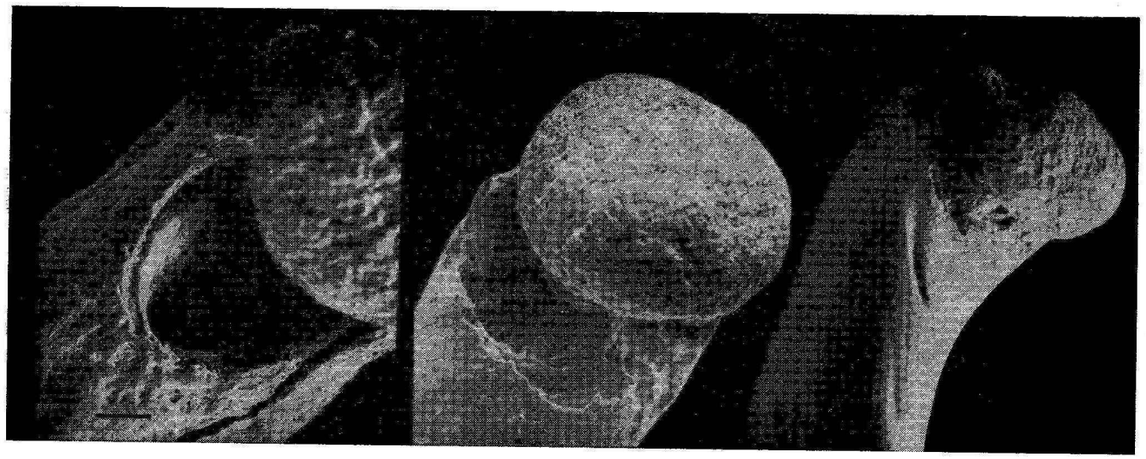


FIGURE 4. *Three ends of long crura of anvils: a) a shallow depression in the crurolenticular angle is lined with intact cortical lamina — it is the natural orifice of the central vascular canal of the long crus of the incus (Latène; the bar is equivalent to 0.1 mm). b) inflammatory usuration with acute edges in the crurolenticular angle (= the first grade damage, Middle Ages). c) post mortem superficial defect in the vicinity of the lenticular process of a latène anvil.*

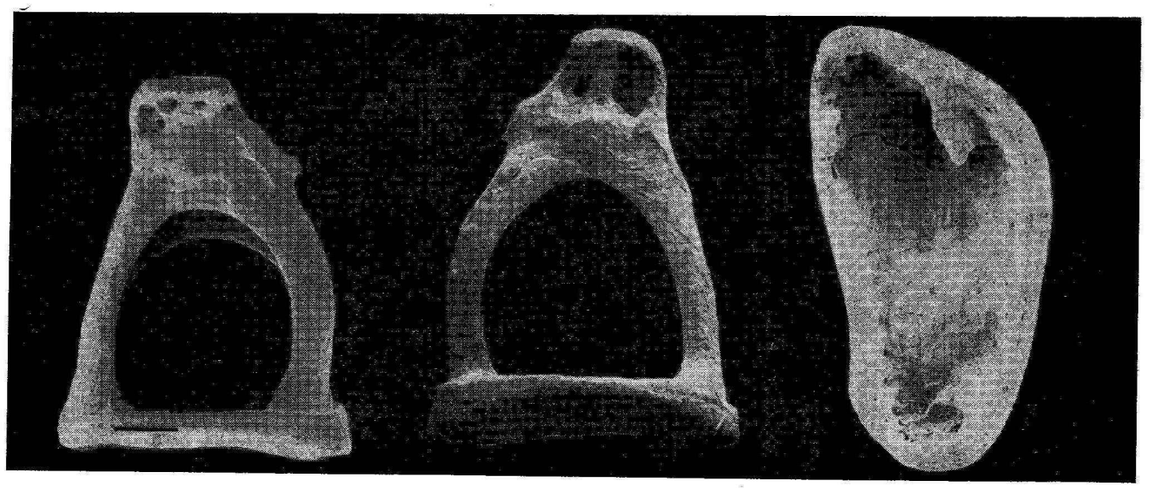


FIGURE 5. *Two normal medieval stapedes: one with tiny vascular openings in the head (the bar represents 0.5 mm) and the other showing the shell-like construction of the head with a supportant pillar. On the right—the foot-plate of the latène stirrup with well-defined sites of attachment of both crura.*

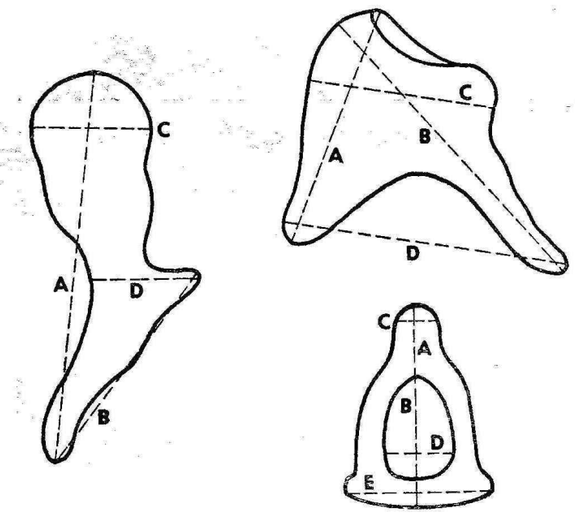
The greater average length of the manubrium of the malleus as seen in the latène group did not contribute to the total length of the hammer probably due to a smaller angular value of the hammer (axial angle of Masali). This smaller angle makes our latène hammers more broken, while the medieval hammers are straighter.

The average length of the incus (*Scheme 1* — dimension B of the anvil) was almost the same in both groups. On the contrary, there was a difference of 0.3 mm in the average width of the incus (dimension C) between the two sets ($P = 0.025$). This difference influenced the average somatic index of the anvil — 79.49 in the medieval group, 75.58 in the latène group. The value of this index in the latter group was thus almost identical with the values reported by Masali for Man and anthropomorphic apes. In the medieval group, however, the values of this index approached those given by Masali for Macacus and Cercopithecus.

On account of the small number of preserved stirrups we have not so far used the average values to differentiate the two groups.

Scheme 1.

	Praha (N = 10) IIIrd—Ist cent.		Beroun (N = 19) XIVth cent.	
MALLEUS (adults)	n:		n:	
A — length of the hammer	9	7.96 ± 0.23	16	8.02 ± 0.30
B — length of the handle	9	4.92 ± 0.30	15	4.83 ± 0.34
C — width of the head	9	2.33 ± 0.09	16	2.33 ± 0.14
D — width at the level of the lateral process	10	2.01 ± 0.14	16	2.01 ± 0.20
INCUS (adults)	n:		n:	
A — width of the anvil	9	4.91 ± 0.32	19	5.21 ± 0.34
B — length of the anvil	6	6.62 ± 0.28	13	6.60 ± 0.23
C — width of the body	9	3.61 ± 0.11	19	3.58 ± 0.11
D — bicrural distance	6	6.02 ± 0.47	13	6.04 ± 0.43
STAPES (adults)	n:		n:	
A — height of the stirrup	2	3.35	4	3.40 ± 0.07
B — height of the window	2	1.85	3	1.90 ± 0.16
C — width of the head	3	1.03 ± 0.19	5	0.98 ± 0.15
D — width of the window	2	1.75	3	1.77 ± 0.05
E — length of the footplate	3	2.77 ± 0.12	3	2.87 ± 0.05



SCHEME 1. Dimensions meassured on individual auditory ossicles.
Malleus: A — the maximum length of the hammer; B — the length of the manubrium; C — the width of the head; D — the width of the hammer at the level of the lateral process.
Incus: A — the width of the anvil; B — the length of the anvil; C — the width of the body of the anvil; D — the bicrural distance.
Stapes: A — the height of the stirrup; B — the height of the window; C — the width of the head; D — the width of the window; E — the length of the foot-plate.

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