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POROUS HYPEROSTOSIS AND SIGNS OF CANNIBALISM AT THE BLUCINA LOCALITY IN SOUTHERN MORAVIA (CZECHOSLOVAKIA) IN THE EARLY BRONZE AGE

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SUMMARY

In a storage pit dating from the 17th century B.C. at Blucina in southern Moravia (Czechoslovakia) bone fragments were found of 11 humans showing signs of cannibalism. In eight out of eleven fragments of the orbits of 4-5 children (aged 2-6 uears) cribra orbitalia were found. Some of these fragments were processed histologically and under SEM. Morphological investigation excluded anaemia from B12 deficiency, and at the same time the mechanism of bone cribrification was elucidated.
The most probable cause of the occurrence of orbital cribra in southern Moravia in the Bronze age seems to be : lack of folic acid and iron due to diet (drinking goatsmilk, eating unleavened wheat bread) or other causes (malaria). A discussion is made of the role of parasites and vitamin C deficiency.

Key words : porotic hyperostosis - cribra orbitalia - early Bronze Age cannibalism.

INTRODUCTION

Porous hyperostosis consists of hyperplasia of the bone marrow with bone changes in various forms on the occipital and parietal bones and the roof of the orbits. The result is that the tabula externa grows thinner, sometimes holes even appear in it. The tabula interna is not affected. These bone changes indicate a haematological condition in the subject, and indirectly point to pathological environmental factors. Individual forms of porotic hyperostosis have been described throughout the world, with different degrees of seriousness and different causes of the anaemia responsible for the bone changes (Hengen, 1971).
It is necessary to determine the specific factors which might induce porous hyperostosis in central Europe, and especially the most common form in the region of the roof of the orbit - cribra orbitalia.
We should like to draw attention to the determination of cribra orbitalis in fragments of children's orbits found under extraordinary circumstances at an early Bronze Age site in southern Moravia.

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LOCALITY AND SITE

During systematic excavation of a Bronze Age hill settlement at Cezavy, near the village of Blucina in the rural district of Brno (cf. Müller-Karpe 1980, 813-14 and lit.) a pit (no. 5) with unusual contents was discovered in 1985.
According to the characteristic shape of the pit, with a narrow, cylindrical neck, widening markedly at the sides, with a sharp transition to a flat bottom at a depth of 1.25 m (Fig. 1), the primary purpose may be supposed to have been that of a larder.
Over 290 carbonified grains were recovered from the grey to dark grey clayey loam spoil. Preliminary determination has identified them as mainly wheat (determined by F. Kühn, Brno Agricultural University). This suggested that the pit had originally been used as a grain store. There was clear corroboration of this fact by further finds, such as an 8.6-cm-long horn blade polished like a sickle, and part of a stand for grinding grain made of conglomerate, which was decidedly not of local origin (petrography by A. Prichystal, natural science faculty of Brno University).
The most important find in the pit was a large quantity of human bones and to a smaller extent animal bones, which were concentrated in the neck and mouth of the pit (Fig. 2). At a depth of over 0.8 m there were occasional additional bones, all from animals. The osteological material at the top of the pit did not fall into any pattern. All the bones were in a very fragmentery condition, distributed at random, even chaotically, with occasional small stones, lumps of daub and the shells of malacofauna, mainly of the genus Unio (determined by I. Flasar, Teplice district museum). Practically none of the human bones was intact, and some parts or fragments of the same bone were even found at different depths. The fragments of human and animal bones were frequently singed or even burnt, including the fracture surfaces, so that they must have been smashed before they were burnt. Some of the breaks in the human bones have the character of spiral fractures, such as might have occurred only in fresh bones still relatively rich in organic substances. On some bones, both human and animal, there were the marks of short, fine cuts with a sharp implement.
According to the preliminary anthropological findings the bones belonged to 10 to 12 individuals, only 2 to 3 of whom were adults. The age of the children was mainly in the range from two to six years, only one being an individual of around fifteen (evaluated by J. Jelinek, Anthropos, Brno).
The animal bones are mainly from domestic oxen (Bos taurus, 4-5 specimens), along with sheep and goats (Ovis seu Capra, 3-4 specimens), with only occasional pig bones (Sus scrofa), and bird bones (Aves)(determined by L. Seitl, Anthropos, Brno).
According to the fragments of ceramic vessels the site was reliably datable to the early Bronze Age, probably the latter period of the Unetician culture, i.e. the 17th century BC.

MATERIAL AND METHODS

The pit in the settlement contained 11 fragments of children's orbits. In eight of these there were signs of cribra orbitalia over an area of 10 x 15 mm, localised on the outer edge of the roof of the orbit, approximately at the site of the lacrimal gland. All cribra were flat, in three cases of the porous type, in 4 cases of the cribrotic type, and in one case of the trabecular type, according to the classification of Nathan and Haas (Nathan and Haas 1966). After sorting according to colour and shape of the margins the orbits were assigned to 4 to 5 individuals. Orbital cribra thus occurred in 4-5 children aged 2-6 years (age determined anthropologically by Dr. Jelinek), i.e. 80 to 100%, a figure which is, of course, very approximate in view of the small numbers involved.
The edge of one fragment of orbit was dark red in colour, and seemed to have been burnt, as if it had lain on the edge of a fireplace. Part of the bone with cribrification in the case of one fragment each from two individuals was subjected to histology and SEM microscopy. For histological processing the tissue was fixed in 10% neutral formaline, decalcified with a mixture of chromium dioxide, nitric acid and alcohol, dehydrated with glycerine, saturated with celoidine and then embedded it. Using a sliding microtome 10 m sections were cut, and stained by routine methods. For SEM investigation the fragments were dehydrated with increasing concentrations of acetone, vacuum-plated with a layer of around 59 § gold, and scanned at a voltage of 30 kV.

RESULTS

In the histological material the cribrified bone retained its structure remarkably well. The bone matrix was filamented, with irregular, grainy, evidently organic components in the bone cavities, which were in almost all places lined with membranose structures. In some places on the bone surface, at the sites of membranes, there were the outlines of cell structures with the cytoplasmic zone and the remains of the nucleus discernable. There were also outlines in the matrix reminiscent of vascular canals, and the structure of the whole matrix was unhomogeneous here, which can be interpreted as signs of an area in various phases of remodelling.
Under the SEM it was possible to observe uneven surfaces of mineralised bone matrix with more or less dense cribrification, comprising canals penetrating from the surface to the interior of the bone, whose mouths were usually usurated. On the surface there were on the one hand distinct crystals, on the other globules of organic material whose origin could not be determined. At higher magnification occasional fibrous impregnated structures can be seen, corresponding to the course of the collagen fibres. Apart from distinctly cribrified bones there are in the vicinity of individual orifaces submicroscopic openings on the periphery of the matrix representing quite minor cribrification of bone. Their closing and opening apparently cause macroscopic cribrification.

DISCUSSION

From the homogeneous filling of the pit and from the scattered but related bone fragments, one can surmise that the events in question took place on a single occasion. One can scarcely suppose that around eleven humans died of natural causes. Their bodies must have been brutally dismembered, in the course of which breaking, hammering, splitting and chopping were used to smash the skull and postcranial skeleton. Some of the broken bones got to the edge of a fireplace, or directly into a fire. The concrete significance of the deed cannot be determined ; we do not know the circumstances, or what happened to the soft tissues. Ritual cannibalism is only one of the possible explanations, which can neither be proven nor disproven. In the final phase of the ritual the bones of men and animals were tipped into the pit, which must have been quite near the place of the ritual, and which had already been filled approximately half full. Thus the whole find can be considered the remains of a bloody ritual, a hecatomb, which in view of the clear evidence of grain-growing was probably connected with some agricultural cult. The placing, or rather the tipping, of the remains of the ritual into the empty grain pit was perhaps intended to assure the next harvest (cf. Bouzek-Koutecky 1980, 412-18, 424-28).
The reason for the cannabalistic ritual might be sought in the state of disease found in the population, and especially in the "sacrificed" victims. We therefore tried to elucidate the probable factors responsible for orbital cribra in Blucina.
For the central European region and the population living there in the Bronze age the following factors seem most likely to have caused the anaemias which have the main effect on the development of these forms of porous hyperostosis :

1. Iron deficiency - this was stated as the main factor inducing orbital cribra at the PPA congress in Detroit in 1976 (in Janssens 1981).
In our case in Blucina the population was an agricultural one, probably consuming in the main wheat in the form of gruel and bread. In Egypt, for instance, Grüße was able to date pure yeast back only as far as 1500 B.C. (Darby 1977). A large amount of phytates and wholemeal unleavened bread might retain the elements Zn, Sr, Cu and Fe, as has been shown in the 3rd century A.D. in wadi Qitna in Nubia, Egypt (Smrcka, Jambor, Salas, in press). Our conclusions were confirmed by a similar situation in the province of Far in Iran (Sarram et al. 1969). The retention of minerals in the gastrointestinal tract might under the influence of this type of diet induce premature osteoporosis and the occurrence of orbital cribra.

2. A lack of folic acid - may be induced by various forms of malabsorption. In the area of southern Moravia, in a population in the Bronze Age the shortage may have been due to : serious diarrhoea, frequent pregnancy, unsuitable diet, including drinking goatsmilk, lack of iron and malaria.
The lack of folates in children may give rise to megaloblast anaemia given predisposing risk factors such as low birth weight, short lactation and frequent infection. The most common time for anaemia to occur is around the eighth month (in the range 2-22 months).
Given a lack of folic acid, serum folates fall in 3-6 weeks, those in

the red blood cells within 18 weeks ; in the twentieth week megaloblast anaemia develops.
The normal function of folic acid is tied to the presence of vitamin B12. Megaloblast anaemia due to lack of vitamin B12 in the diet is usually combined with a lack of folic acid, with anaemia due to folic acid deficiency more common, since its deposits in tissue are considerably lower than in the case of vitamin B12. The normal consumption of folic acid is 100 g, while that of vitamin B12 is only 2 g. Apart from this cooking destroys 70-100% folic acid, while the loss of B12 is only 10-30%.
Under the electron microscope B12 anaemia is characterised by a bizarre pattern of membranes (Donner 1985), which was not present in the orbital cribra from Blucina, so that this type of anaemia is excluded here.
a. drinking goatsmilk
Lack of folic acid may arise due to the drinking of goatsmilk, which has correctly been pointed out with regard to prehistoric populations by Janssens. Goatsmilk contains less folic acid than cows' milk, and was probably the children's most frequent food. Janssens backs up his assertion by means of the occurrence of this type of anaemia during World War II, in the Bronze Age by the frequent finding of sheep and goat bones (Janssens 1981).
b. malaria
The folate mechanism can also be disturbed by malaria. This region of lowland forests, with oxbows of the river Morava and many marshes, was an ideal breeding-ground for mosquitoes. The endemic occurrence of malaria might be supported by the finding of "brush" skulls in Mikulcice dating from the Great Moravian Empire (nos. 748, 420a, 771 - 9 years, 3 years, 12-18 months). This need not have been a case of congenital spherocytosis (congenital haemolytic icterus), as was determined by L. Vyhnanek (Stloukal and Vyhnanek 1976). The accounts of inhabitants are also important - in the Hodonin area malaria acquired its own local nickname - "hodonka" (Daniel 1985).

3. Lack of vitamin C. Lesions of the eye in scurvy vary from fine conjuctival haemorrhage to serious subconjunctival haemorrhage and subperiostal bleeding in the area of the frontal bone and the roof of the orbit. These haemorrhages are said to be capable of causing orbital cribra with vertical cribrification (Ortner 1981).
Vitamin C deficiency would have been most apparent in winter. It is interesting that, according to the observations of archaeologists, in similar burials in grain pits skeletons are always found at the bottom, which would indicate that they occurred at the end of the winter, or in spring, when there was little or no grain left in the pits.

4. Inflammation of the lacrimal gland. This is also said to be a possible cause of orbital cribra (Steinbock 1976). This would be supported in our case by the localisation of the cribra. But it would have to be a infection, probably or viral origin, in order to affect almost all the children.

5. Parasites. A lack of minerals and anaemia may have been inducec in the period of developing agriculture in southern Moravia by Ascariasis.
The Blucina population kept pigs, as was evident from the grain pit in question. After an outbreak of A. suum in pigs, it may have adapted to

man. In view of the fact that the eggs of A. lumbricoides and A. suum are practically indistinguishable, it is not possible for us to ascertain the extent of infection with A. suum in the human population (Sery 1979). Threadworm infection in children may have meant a deterioration in nutrition. The first phase of the development (larval stage) is characterised by coughin and lung infiltrates due to migration of the larvae through the lungs. In two months, at the end of the cycle, the threadworms appear in the stools. Adult threadworms live in the small intestine. They cause diaorrhea, which menas a loss of minerals.
A fatal blockage of the intestines can be caused by infestation with 1000 - 5000 threadworms. Metabolites may cause allergies and anaphylactic reactions. Hepatal abscess and perforation and inflammation of the peritoneum may occur.
Under favourable circumstances threadworm eggs may survive up to 8 years. The marshy ground around the settlement, with no sewerage system, might have contained a large number of threadworm eggs, and repeated infection may have occurred, especially in children.

CONCLUSION

Investigation of orbital cribra dating from the 17th century B.C. from Blucina showed that the histological surface of the cribra corresponds to the surface of the endostal bone with the remains of cell and membrane structures, the bone matrix shows brisk remodelling of the walls between individual orifices. Under the SEM the histological findings were confirmed. In addition an artificial usuration of the mouth of the cribra was found, probably associated with the age of the bone. The origin of the organic component represented by the surface globules cannot be more closely explained. The submicroscopic cribrification on the peripheries of the orifices, by whose fusion and the disintegration of the septa the actual cribra apparently occur, is a significant contribution. According to the remains of cell and membrane structures one can suppose that cribrification arises through the activity of surface bone cells, especially as part of bone remodelling. The most probable cause of orbital cribra in Blucina in southern Moravia in the Bronze Age seems to be a lack of folic acid and iron, though the factors responsible may be various.

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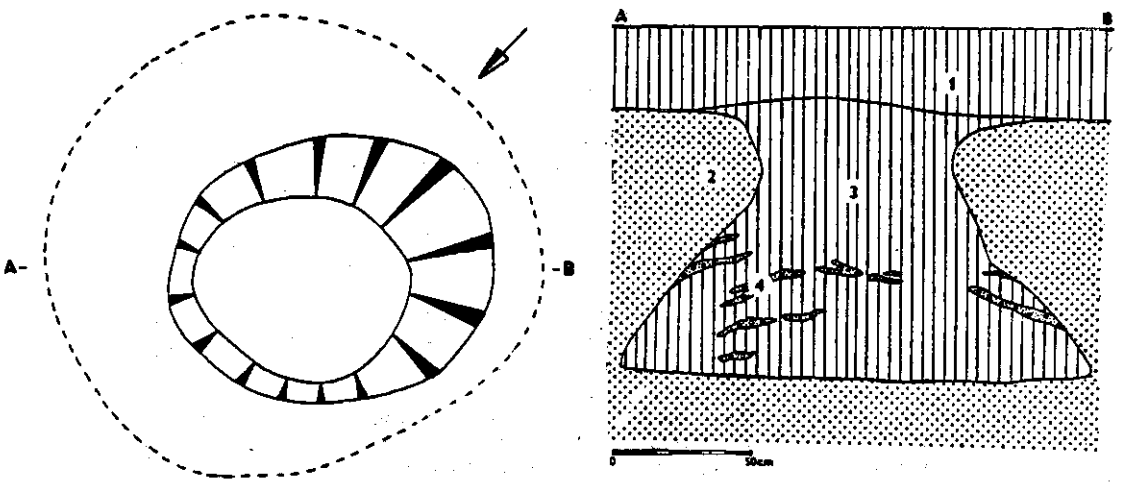


Figure 1 : Blučina-Cezavy, item 5/1985. 1 - ploughed field, 2 - clayey substrate, 3 - filler of grey clayey loam, 4 - strata of clay in secondary horizons.

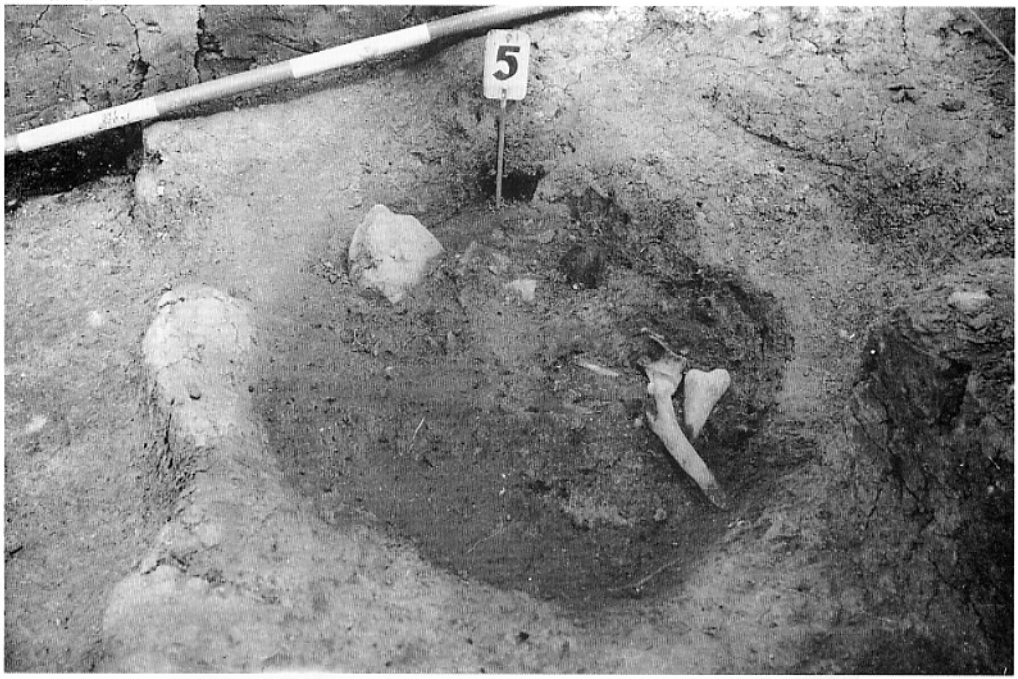


Figure 2 : Blucina-Cezavy, item 5/1985. Filler of pit with human and animal bones on the level of the clayey substrate.

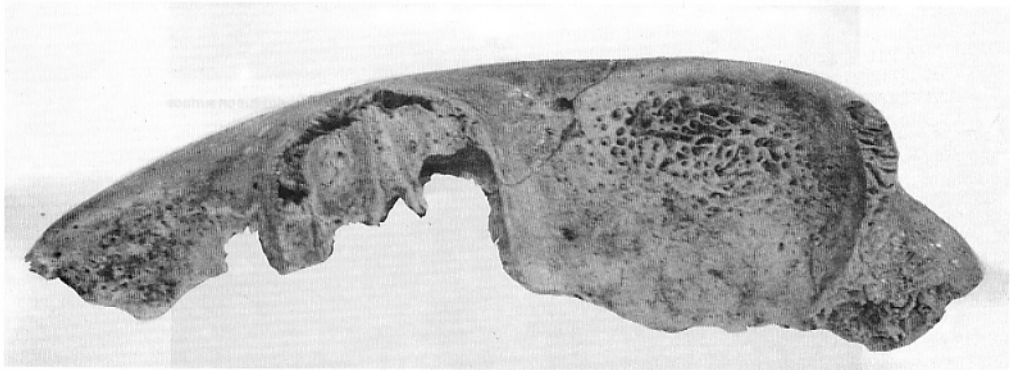
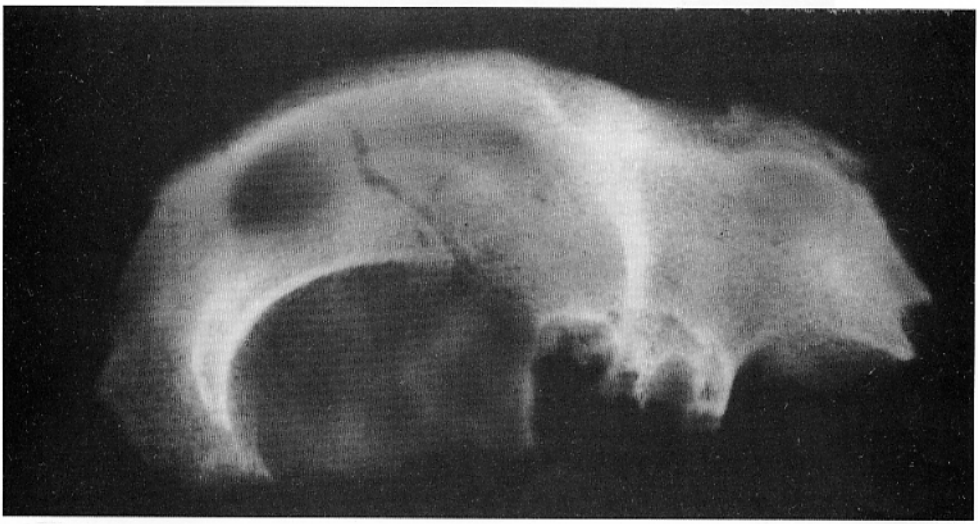


Figure 3 : Blucina-Cezavy. Cribra orbitalia on a fragment of a child's skull from 5/1985.

Figure 4 : Close-up of fragment (see Fig. 3)



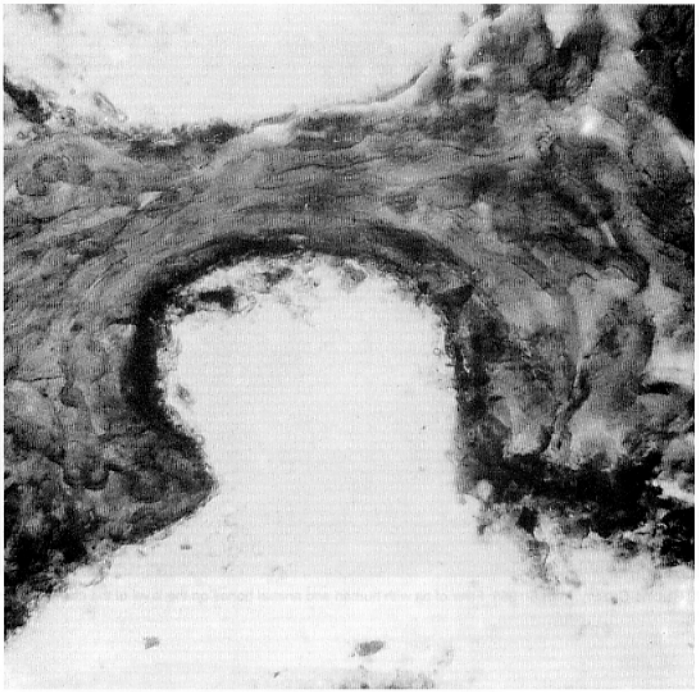


Figure 5 : Part of cribrified bone with membranous lining of cribra and granular and globular detritus on surface (H.E., magn. 200x).

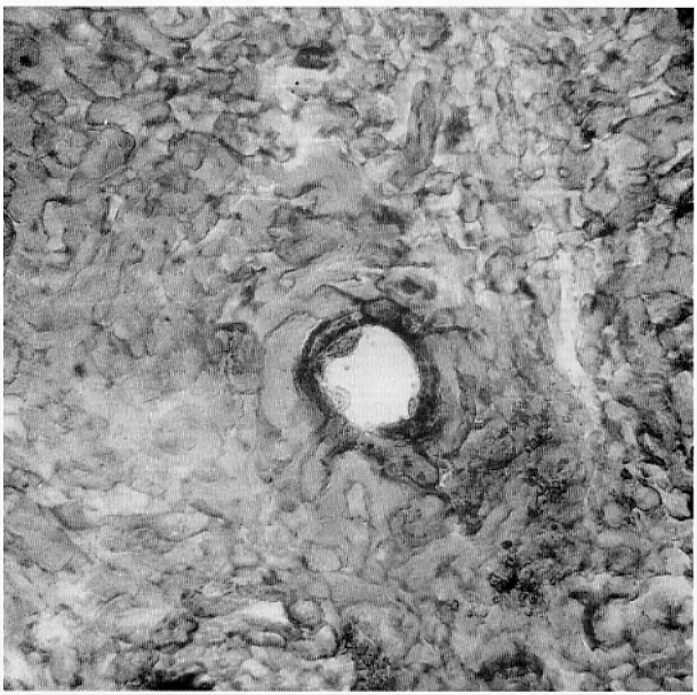


Figure 6 : Relatively well-preserved bone matrix with tiny cribrose orifice (vascular canal?) with membranous lining and outlines of cell-like structures (H.E., magn. 200x).

Figure 7 : Break surface of cribrified lamina with variously-sized and often usurated canal openings (SCAN, magn. 200x).

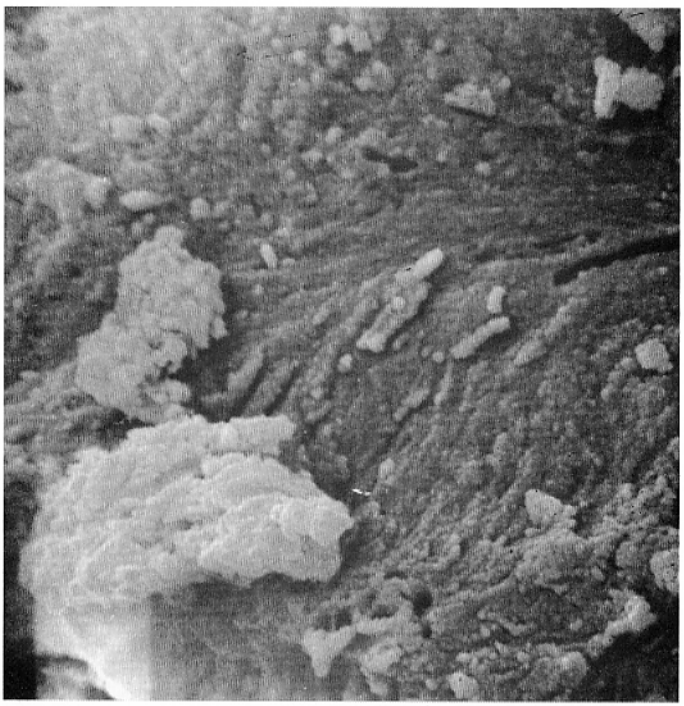


Figure 8 : Detail of surface of cribrified lamina with granular and fine fibrous structure of mineralised bone. On the surface variously large globules of organic material (SCAN, mag. 7800x).