CXCVIII. THE METALLIC CONTENT OF TISSUES FROM GOAT FOETUSES AND KIDS.

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TISSUES from human foetuses were examined for mineral content by Sheldon and Ramage [1931; Ramage *et al.*, 1933], and it is desirable that the method used by them should be extended to other foetuses in order to make a comparative study of the quantities of metals present at various stages of development and to learn something further of the functions of the common metals. The tissues of the goat foetuses and kids forming the subject of the present paper were obtained through the kindness of Prof. J. Barcroft, Cambridge, and Prof. H. A. Harris, University College, London, who studied the animals before dissection of the tissues. The specimens included the kidneys, spleen, liver, meconium, gall bladder and bile from each of eight animals, the ages and approximate weights of which were as follows:

	No.	Weeks	Days	g.	
Foetus	18	12	5	240	A twin
"	19 M	14	5	{562	"
"	19 F }			{538	"
"	21	19	3	833	One of triplet
"	22	20	4	2600	A twin
Kid	23	21	4	{2300	"
"	24			{1850	"
"	20	22	2	4800	"

The gall bladders were tied up and sent green, the other tissues were partially dried and, on receipt here, each was powdered in an agate mortar and dried in a steam-oven to constant weight. The gall bladders were washed on the outside with water, dried on filter-paper, slit open and the bile removed. Weighed or measured quantities of the bile were put on pieces of ashless filter-paper and dried ready for spectrographic analysis by the flame method [Ramage, 1929]: the bladders were dried and powdered.

The wet weights of the bodies and the livers and the dry weights of the other tissues were taken and plotted against the ages. The most noticeable feature observed was the rapid growth of the kidneys up to 14 weeks 5 days, the kidney then weighed 82 % of the kidney of kid No. 20, whereas the body was only 11.5 %, the spleen 32 %, and the liver 30 %, of the weights of the body, spleen and liver of that kid, respectively.

The mineral content of the dried tissues was determined by burning 0.025 g. of the powder of each in rolls of ashless filter-paper in an oxy-coal gas flame before the slit of a spectrograph as described in previous papers. Smaller quantities only of some of the gall bladders and bile were available, and in those cases the whole of the specimens were used in the analyses. The elements studied were potassium, rubidium, magnesium, calcium, manganese, copper and iron.

The rate of growth of the foetuses and kids varied from case to case; No. 21, for instance, one of a triplet, was much below par in almost every particular studied, both in weight and percentages of the mineral contents. While, therefore, it would be unwise to attempt to draw deductions from minute differences, there are points of a more general character which may be regarded as typical of average development.

There is distinct evidence of a marked shortage of mineral elements, especially copper, potassium, and, to a less extent, of iron towards the end of foetal life. It is known that in the newly born child, calf and piglet, the percentages of copper in the livers are six to ten times as high as in the mothers' livers, but in these goat foetuses and kids the percentage was only 0.002 in Nos. 21, 22, 23 and 24, whereas it was 0.02, 0.015 and 0.01 in Nos. 19 M, 19 F, and 20 respectively. The percentage of copper in the human liver nearly doubles during the last three months of foetal life, rising from 0.016 to 0.03 [Ramage *et al.*, 1933].

The shortage of metals was seen in every tissue except the kidney in which the iron rose from 0.012 to 0.03 %, and, as noted above, the growth of the kidney is very slow after about the fourteenth week.

Fig. 1.

The livers and meconia of the foetuses Nos. 19 M and 19 F were remarkable, as the percentages of iron and copper in the livers were higher than in any other of all the tissues analysed and the meconia contained more copper than that of

any other foetus or kid. Only three meconia contained manganese. No. 19 M contained 0.006, No. 19 F contained 0.001 and No. 20 contained 0.0006 %. These features do not appear to be accidental. The kid No. 20 lived for a day, receiving some milk, and the "meconium" contained far more calcium and less magnesium than any other.

There was distinct evidence also of correlation between iron, calcium and copper in the livers (see Fig. 1), as was found to be the case in children's livers [Ramage *et al.*, 1933], the only exception being that copper in No. 22 was relatively low, but this again may be accepted as further evidence of the shortage of copper towards the end of foetal life in these goats.

The human infant, the calf and the piglet are all born with a reserve stock of copper in their livers but these kids had no reserve, the percentage in fact being extremely low.

Manganese, as in children's livers, followed an independent line, the percentage in the livers and gall bladders was highest about birth, and there were merest traces in the kidneys of Nos. 23 and 24, but in no other kidneys, and no manganese was detected in the spleens.

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