UNION OF SOUTH AFRICA

PRENATAL GROWTH

in the

MERINO SHEEP.

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C O N T E N T S .

CHAPTER 1.

INTRODUCTION.

OBJECT OF WORK.

That growth during the foetal period does not differ qualitatively from that subsequent to birth, is the view generally accepted. It is maintained, that, in spite of its greatly varying rates, and its change of direction from progressive during the developmental period to regressive during senescence, growth is one continuous process, starting with fertilization of the ovum and ceasing with death of the individual. The progressive part of the cycle is "divided by the incident of birth into pre-and postnatal periods," (Arey, 1931,). When it is considered how readily the latter period lends itself to investigation, it is not surprising to find that much work has been carried out in this connection. Reference to Brody et al (1926) or to Hammond (1932) will give an idea of the extent of the available literature.

In direct contrast to this wealth of material is the paucity of information regarding the prenatal phase of development. What knowledge does exist has been gained mostly in studies on small laboratory animals, such as the rat (Stotsenberg, 1915), the mouse (MacDowell et al, 1937) and the guinea-pig (Draper, 1920). In general the results of this work have confirmed the thesis of continuity of the growth curve. However, MacDowell and his associates believe that, on account of qualitative differences in growth during the earliest stages, age for the purpose of growth curves should be calculated from the time of formation of the "embryo proper."

For man and the domestic mammals there is a lack of extensive and reliable data. That such work on the human being presents well-nigh insurmountable difficulties is only too readily understood. A brief indication of the complexity of the problem is given by Mall (1910,). Not being bound by the same ethical laws as his medical colleague, the worker in the veterinary field encounters but one major obstacle - the brake of economic considerations. To

expand on the seriousness of this problem would merely be labouring the point. Therefore, it is apparent that any work which aims at making available additional material advances greatly the facilities for the investigation of prenatal growth.

Scattered throughout the veterinary literature are isolated references to weights and dimensions of small numbers of foetuses of known or assumed ages. Due to the diversity of conditions under which the observations were made and the almost general lack of accurate definition of procedure, these figures cannot be employed in the compilation of one comprehensive table.

In this field most workers have avoided committing themselves as to the age of their material. Invariably they have relied upon either length or weight as an indication of age-sequence. Consideration of breed and individual variability will show that such criteria are apt to give misleading results. Especially would this be the case where the material is obtained from such an uncontrolldd source as a public abattoir. A further disadvantage of this procedure, exposed by Lowrey (1911,), is that,in the absence of data regarding age, absolute growth rates cannot be given. The worker has to content himself with expressing growth of systems and organs relative to body weight.

The existence of adequate ageing standards would make available for studies on prenatal growth the abundance of material always obtainable at large abattoirs. As a result of the work to be reported in this paper, there is now available at Onderstepoort a complete series of ovine foetuses. By direct comparison with this standard unknown foetuses are aged with a fair degree of accuracy.

The very nature of this standard, excellent as it is, militates against the extension of its sphere of usefulness beyond local limits. The primary object of this paper is to place this standard at the disposal of workers farther afield. It is hoped that this aim will be achieved by the publication of a partly descriptive and partly statistical study of those features of the collection which appear to be of importance in age determination.

As the development of the foetus is intimately connected with changes in the maternal genitalia, organs of lactation and endocrine glands, all these aspects of the reproductive process have received attention and will be considered in this paper. In some instances, it is felt, the numbers of observations are too limited to allow of definite conclusions. Nevertheless, the figures are given in the hope that, with appropriate additions by other investigators, eventually a large mass of data will be accumulated.

In connection with the literature it must be pointed out that every effort has been made to avoid what may be termed "second-hand" quotations. However, where it has been impossible to obtain the original article in this country, it is felt that recourse to such quotation is preferable to losing entirely a useful reference.

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vast amount of data collected.

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CHAPTER 2.

REVIEW OF LITERATURE.

A search of the literature has emphasised the meagreness of authoritative knowledge of prenatal growth of domesticated mammals. Much of the available knowledge is contained in works of which foetal development was not the primary consideration. In such cases the information, being merely incidental, received but scant attention. This literature is, to some extent, supplemented by studies on small laboratory mammals, in which the general principles of growth are apparently similar to those in larger mammals.

For the sake of clarity the literature will be treated under headings corresponding with those to be employed in the consideration of the experimental data.

(a) GENITAL TRACT & PLACENTA.

1. VAGINA.

Anatomists differ as to the nomenclature of that portion of the female genital tract situated posteriorly to the cervix. The English school refers to the portion between the cervix and the external urethral opening as the vagina, Everything posterior to this is called the vulva. In German works this latter part is further divided into the vestibulum vaginae, which constitutes the major portion, while the term vulva is restricted to the external opening of the urogenital sinus. In this work the German teaching will be followed, except for the fact that vestibulum and vagina will be taken together and will be referred to as "vagina."

Sisson (1927) found that the vagina of the sheep has a length of between 10.5 and 11 cm. He states that the labiae of the vulva are thick and firm and that the ventral commissure is prominent.

From a consideration of the anatomical situation of the vagina it would appear that, after having served as a portal of entry for the sperm, this structure does not again participate in the reproductive process until the approach of parturition, when it

dilates to allow of birth. On account of its relative unimportance this organ does not receive attention in embryological texts. However, it seems obvious that during the period of pregnancy certain changes must occur and that the purport of these must be to render the vagina a larger and more easily distensible organ.

It has long been noted that with the approach of term there is an enlargement and a relaxation of the vulva. Craig (1912) and Williams (1917) refer to the soft and flabby nature of this organ prior to parturition. Hammond (1927) states that "just prior to parturition the vulva and the vagina become red and swollen." While studying parturition in the mare, (Holzgruber, 1925), ~~it is~~ observed that these changes are recognisable as long as three weeks prior to the birth of the foal.

Hammond (1927) states that the vaginal pregnancy changes resemble closely those of the oestral cycle. They are mostly of a microscopic nature. In the anterior half of the vagina the changes are similar to those of the adjacent portion of the cervix. In this portion of the vagina is found a fair amount of sticky mucous material. Oppermann (1922) states that during pregnancy the vaginal wall has a dry and sticky feel.

2. CERVIX.

In the ruminant the cervix is an extremely well-developed structure, with walls that are thick, dense and inelastic (Ellenberger & Baum, 1921.) The cervix of the sheep has a length of about 4 cm. and its lumen is practically obliterated by reciprocal prominences and depressions of the mucous membrane (Sisson, 1927). Besides giving a good description of the structure of the ovine cervix, Trautmann (1917) also indicates that in this species the uterine seal is well developed. The presence of such a seal during pregnancy is mentioned by many authors. For the cow, Williams (1917) gives details of the cranio-caudal development of the mucous plug. Woodman & Hammond (1925) show how in the bovine the actual quantity of mucous material increases steadily throughout pregnancy. There can be no doubt that this accumulation of mucus effectively closes the uterine canal during the major part of the gestation period.

In dealing with the physiology of parturition Craig (1912) states that there is a softening and a loosening of the cervical walls "a few days prior to parturition." Zeiger (1908) shows that there is also an enlargement of the cervical canal towards the end of pregnancy. In the bovine he finds that by the end of the seventh month the canal is sufficiently open to allow of the introduction of one finger. Hammond (1927) is of opinion that, apart from sealing off the uterus, the steady accumulation of mucus in the cervix assists in the dilation of this structure.

3. UTERINE BODY & HORNS.

The uterus of the sheep is bicornuate. According to Sisson (1927) each horn has a length of from 10 to 12 cm. As a result of the gradual tapering of the anterior extremities of the cornua there is no definitely discernible external landmark indicative of the exact point of junction of the horn with the Fallopian tube. Posteriorly the two horns unite to form the body. The arrangement of the peritoneal covering makes this undivided portion appear longer than it is. The approximate length of the body is 2 cm.

Roux (1936) gives the weight of the uterus of the non-gravid Merino sheep as varying between 15.5 and 77.5 gm. He deals with eight groups of sheep, some of which, having been fed on low level rations, were in very poor condition. In these latter sheep the extremely low uterine weights were encountered. Although he does not find it possible to demonstrate a definite correlation between the weight of the ewe and the weight of its uterus, Roux nevertheless concludes that nutrition does exert an influence on uterine development. It is not possible to determine to what extent previous pregnancies might have affected his figures.

Favilli (1928) gives the weight of the ovine uterus as varying between 40 gm., in virgin ewes, and 65 gm., in previously pregnant sheep. His observations, having been made in the slaughter-house, are not likely to represent poor conditioned sheep. This might explain the absence of figures as low as those ~~given~~ mentioned by Roux. Favilli gives the weight of the uterus at the end of the period of gestation as 1010 gm. This figure appears somewhat high, and in a

later publication (Favilli, 1929) it is stated that such a figure is obtained in cases of twin pregnancies. With a single foetus the figure is about 600 gm. Favilli (1928) quotes figures to show that similar increases in uterine weight occur in the bovine. Malan & Curson (1937) give figures for the weight of the empty uterus at the end of each month of pregnancy. These show that there is a steady increase in the weight of the organ from about 60 gm. up to about 700 gm.

Rorik (1907) shows that in the bovine there is a definite increase in the weight of the uterus during pregnancy. During the first half of pregnancy this increase is most marked. What few figures are given by Hilty (1908) seem to support this view. Hammond (1927) obtains his figures from heifers pregnant for the first time, thus eliminating the effects of previous gestations. These figures show that by the end of the period the non-gravid weight of the uterus has increased almost twentyfold.

Figures for the pig (Stegmann, 1923) show that by the end of the thirteenth week of pregnancy the non-gravid weight of the uterus has been doubled.

Draper (1920) ~~gives~~ presents a complete series of weights for the guinea-pig uterus throughout pregnancy. These figures indicate that the growth curve of the uterus is of a double ~~hyper~~para bolic nature i.e. first slow, then increasing rapidly and later slowing down again. This type of curve had already been suggested by the figures quoted above for the bovine and the sheep.

In all these cases it is the weight of the empty uterus that has been considered. This figure is the sum of the weights of the uterine wall and of the placenta. As will be seen later, the placenta undergoes a great deal of growth during pregnancy and it exhibits its own type of curve. It is evident, therefore, that the weight of the empty uterus is influenced greatly by the placenta. In the ruminant it is an easy matter to separate the placenta from the uterine wall and thus obtain the weight of the latter alone. However, no such figures appear to be available.

As might be expected, the increase in weight of the uterus is accompanied by an increase in size. For the sheep Favilli (1928) shows that the area of the uterus increases from less than 100 sq.cm. in the non-gravid state to almost 1600 sq.cm. at the end of gestation. He also demonstrates (1929) that there is a steady daily increase of the volume of the uterus. Stegmann (1923) shows that in the pig the length of the uterine horn becomes increased during pregnancy.

Favilli (1928) maintains that the increase in size of the uterus is brought about not only by a multiplication of muscle fibres, but by the enlargement of existing fibres. He gives measurements in support of this view. Hammond (1927) also mentions this point and indicates that during pregnancy the uterine muscle appears sparsely nucleated - an indication of the enormous increase in the cytoplasm of the cells.

Favilli (1929) draws attention to the decrease of the thickness of the uterine wall during pregnancy. From the fact that the greatest reduction occurs fairly early during gestation,he concludes that passive stretching is not the sole cause of the thinning. He states that, due to the even distribution of pressure in the liquid contents of the uterus,the thinning is spread evenly throughout the uterine wall. In the goat the non-gravid thickness of 8 mm. is reduced to 1.5 mm. near term, (Zeiger, 1908.) This author maintains that the reduction is greater in the pregnant horn "where the pressure is higher." Hilty (1908) demonstrates similar reductions in the case of the bovine.

Further information regarding the effects of pregnancy upon the uterus may be obtained from comparisons between virgin and involuted uteri. For the sheep Behne (1929) finds that the effect of pregnancy is to increase enormously the blood and lymph vessels. Not only is there an increase in size, but also in number. The elastic coats of these vessels are greatly thickened. For the goat similar results are reported by Hackeschmidt (1920). The changes in the structure of the bovine uterus, observed by Kraft (1923), resemble closely those of the sheep (Behne). Kraft finds that the microscopic picture of the involuted uterus is so typical as to