INVOLUTION OF THE UTERINE MUCOSA IN THE EWE

THESIS FOR THE DEGREE OF M. S.

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Uterus

Tube

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IN THE EWE

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THESIS

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THESIS

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Review of Literature

Detailed descriptions of the histological changes taking place in the mucosa of the bovine or ovine uterus during involution are lacking in veterinary literature. Statements on this important subject in our early veterinary literature are based on observations of the involution of the uterus in the human.

Our knowledge concerning involution of the uterus can be said to start with the work of Friedländer (1) on the uterus in women, followed by Kundret and Engelman (2) and Leopold (3). These early investigations have been followed by a long list of articles by different workers dealing with the subject in women.

The uterus in woman is of the decidual type in that a part of the mucosa of the uterus, which has undergone certain changes to fit it for the implantation and nutrition of the ovum, is cast off after labor. A thin layer of decidual tissue is cast off with the foetal membranes immediately after birth. The remaining mucosal cells become differentiated into two layers; the one adjoining the uterine cavity is decidual, becomes necrotic, and is cast off in the lochia, while the other layer adjoining

the muscularis and containing the fundi of the glands, remains in situ and constitutes the matrix from which the new endometrium is regenerated.

In 1931 there appeared an article by J. Whitridge Williams (4) on a series of uteri taken from women who had died from causes other than puerperal infections, and uninfected uteri amputated during the puerperium from women suffering from chronic nephritis, serious heart diseases, etc. His material was thus not complicated by lesions associated with infections or the uterus and therefore meets the often made complaint that unless the studies were made on normal uteri, the conclusions would probably be incorrect.

Williams (4) shows the intricate changes involved in the regeneration of the uterine mucosa following delivery. In doing so he advances some new contentions concerning the process. He states, "It seems to me that the evidence thus far adduced makes three points clear: first, that the process is in no way connected with inflammatory change; second, that there is no indication of any extensive necrotic process; and third, that all of the specimens show unusual proliferation of endometrial tissue, which does not merely cover the surface of the placental site, but invades it in all directions, but particularly extends between it and the underlying muscularis, so that in a general way it undermines the placental site

and ultimately leads to its extrusion or exfoliation."

He further states, "Regarded from another point of view, such a process of exfoliation should be regarded as very conservative, and as a wise provision on the part of Nature; otherwise great difficulty might be experienced in getting rid of the obliterated arteries and organized thrombi, which if they remained in situ would soon convert a considerable part of the mucosa into a mass of scar tissue, with the result that after a few pregnancies it would not longer be possible for it to go through its usual cycle of changes, and the reproductive career would come to an untimely end."

While the ewe has the multiple type of placenta and is not a deciduate in the sense that there is discarded along with the chorion a portion of the endometrium, the ewe is a deciduate in that the cells that proliferated to form the crypts or maternal placenta of pregnancy are disposed of postpartum in a somewhat similar manner to that described by Williams (4).

Fleming (5) does not describe the changes that occur in the uterus postpartum. He merely states that after the foetal villi are withdrawn after birth the cotyledons are shed or disappear in some obscure manner.

DeBruin (6) does not describe the complex changes that take place in involution. He states, "The uterine mucosa after parturition also suffers considerable change.

The cotyledons become smaller, lose their peduncular identity and undergo regressive fatty metamorphosis. Fourteen days later cotyledons proper do not exist. After three weeks the mucosa has returned to its original state. Puerperal processes - for instance, septic metritis - do not influence the regressive changes of the cotyledons; that is they do not retard them."

In 1908 appeared the comprehensive article of Hilty (7) the third part of which, dealing with the changes in the mucosa of the uterus of the cow during the puerperium, is of interest to us. He states, "With cessation of the blood circulation in the maternal and foetal placentae and the loosening of the afterbirth, and onset of postpartum pains, the regenerative processes in the uterine mucosa and caruncles begin."

"The caruncle undergoes throughout its entire extent a fatty degeneration, setting in at its periphery. Crypts and crypt walls vanish. The maternal placenta becomes a stnuctureless mass of cellular debris which disappears between the tenth and fourteenth day postpartum, that is to say, it forms an essential component part of the lochia, consisting of uterine epithelia, leucocytes, and fat droplets."

Hilty (7) goes on to explain that after the maternal placenta has been cast off in the lochia, the cellular stratum or subepithelial tissue develops by intensive cell

proliferation into cap-shaped, melon-like puerperal caruncles, towering above the mucosa. These caruncles are then covered by epithelia spreading over the caruncle from the inter-caruncular epithelium. The puerperal caruncle then corresponds to its original juvenile caruncle.

In 1924 appeared Hallman's (8) article on diseases of the reproductive organs of cattle. He describes the histological changes occurring in the cotyledon of pregnancy. His conclusions agree with Hilty's in that the maternal placenta is eliminated down to the connective tissue band or cellular stratum at the base of the maternal placenta. In Hallman's series of cases sufficient material unfortunately was not available to cover the full period of involution. The latest case studied was twelve days postpartum, and the involution was not complete.

Williams, W. L. (9) wrote an article in 1929 on "The Significance of Utero-chorionic Lesions in the Cow," in which he reviews a group of papers by Hallman and his colleagues, and Williams and his colleagues. In describing the involution of the maternal placenta or cotyledon of Hilty (the crypt mass) Williams states, "After the termination of pregnancy the mass of crypts constitutes a useless tissue which is eliminated. Having lost their epithelial covering, an extensive denuded surface results, freely exposed to any bacterial or other irritants present. The tissue of the crypt walls consists to an unusual degree of blood, lymph and other liquid, and immediately the

afterbirth comes away the healthy uterus contracts with great rapidity; the unnecessary fluid and movable cells are abruptly withdrawn and the cotyledon of Hilty (the crypt mass) is very largely returned to the body as a whole. Inevitably, as in a wound, some of the exposed superficial cells perish but the amount is very small in typically healthy cows and no clinically visible discharge follows the expulsion of the afterbirth. The line of demarcation between health and disease can not be accurately drawn, but the Williams group, from the clinical standpoint, locates that line far nearer to an absence of recognizable discharge than does the Hallman group from the laboratory standpoint.

"The caruncle of Hilty does not disappear after healthy parturition, the cellular layer, 2, in Fig. 7, remains intact, prepared fully to provide new crypts in the next pregnancy. While histologists have not yet discovered the structural basis of the observed phenomenon, there is apparently some fundamental arrangement and function of the cells in the cellular layer, 2, Fig. 7, which preordains the arrangement and character of the uterine crypts and these fix the character of the chorionic villi or tufts. The exact extent of injury required to disturb the symmetry of the crypts in the next pregnancy is unknown, but the evidence indicates that the lesions need not be very profound."

Williams first says that the mass of crypts constitutes a useless tissue which is eliminated, and then goes on to say that the cotyledon of Hilty (the crypt mass) is very largely returned to the body as a whole. These statements contradict each other We do not believe there is any histological evidence to show that there is apparently some fundamental arrangement and function of the cells in the cellular layer of the caruncle which preordains the arrangement and character of the uterine crypts, and that these fix the character of the chorionic villi or tufts. In fact, there is evidence to the contrary, which will be cited in the short description of the evolution of the uterine mucosa.

Non-pregnant Uterus

The uterus because of its variability is one of the most interesting, as well as the most difficult, organs to study.

As the shape and topographical relations are sufficiently described in the standard texts on anatomy, this paper will be confined principally to the histology of the mucosa.

Some confusion exists in veterinary literature in regard to the use of the terms caruncle and cotyledon. The terms have been applied by some writers to the mass of

cells that constitute the raised circumscribed areas in the non-pregnant uterus, and to the much larger mass that develops in the gravid uterus from these raised areas.

In this paper the raised areas in the mucosa of the non-pregnant uterus will be called caruncles or placental matrices. We prefer the term "placental matrices" since the raised areas are composed of permanent cells which do not remain grouped in a caruncular shaped mass in the cotyledon of pregnancy.

The term cotyledon will only be applied to the semi-spherical shaped bodies that develop in the gravid uterus and are composed of the permanent placental matrix cells, which spread out into a band of cells in the cotyledon, and the decidual cells that proliferate from the matrix forming the crypts.

The terms crypt mass and maternal placenta will be used synonymously and will designate only the decidual cells of the cotyledon.

The term foetal placenta, or chorionic villi will be used to designate that part of the chorion which is lodged in the crypts of the maternal placenta during pregnancy. The chorionic villi in conjunction with the decidual cells of the crypt walls that lodge the villi during pregnancy effect the passage of waste products from the blood of the foetus into the blood of the mother, and of

oxygen and nutritive materials from the blood of the mother to the blood of the foetus.

The term glandular mucosa will be used to designate all of the mucosa containing glands - namely that which is not occupied by the caruncles in the non-pregnant uterus, and all of the mucosa that is not occupied by the cotyledons in the pregnant or involuting uterus.

Histology of the Mucosa of a Non-pregnant Uterus

Ewe 8041 Non-pregnant

This ewe, a non-pregnant, five or six-year old animal, was killed May 18, 1932. All of the generative tract was removed as soon as possible after death and placed dorsal side up on a piece of cardboard. The internal os of the cervix was located by palpation through the wall of the uterus and measurements taken of the length of the horns from the internal os around the greater curvature of the horns to their tips. The diameters of the horns were always measured at their greatest diameter.

The right horn measures 115 millimeters in length and 12 millimeters at its greatest diameter.

The left horn measures 120 millimeters in length and 12 millimeters at its greatest diameter.

An incision was made through the dorso-median line of the vagina, cervix, and around the greater curvature of the horns, thus exposing the epithelial surface. The edges

of the incision were pinned down to the cardboard which flattened out the hollow organ into one plane. Data were taken on the gross appearance of the mucosa and a photograph of the uterus was made.

The whole genital tract was then fixed in Bouin's solution for twelve hours, when it was possible to cut blocks of tissue without disturbing the relationship of parts. The blocks of tissue were labeled and fixed longer if necessary. They were then run through the alcohols, cleared in cedar wood oil, embedded in paraffin, sectioned and stained in hematoxylin and eosin.

Macroscopically the endometrial surface of the mucosa is differentiated into two parts, i.e., the caruncles and the glandular mucosa.

One hundred and twelve caruncles are present in this uterus. The caruncles are arranged in four symmetrical rows in each horn; the rows running parallel with the long axis of the horns. In the middle and lower part of the horns the caruncles are elliptical in shape but become circular toward the ovarian end of the horns (Fig. 1). The caruncles project about two millimeters above the glandular mucosa.

During the resting period when the uterus is not subject to the cyclic changes of estrus the epithelium has a greyish white translucent color. During the rutting season when the uterus is going through the cyclic changes of

estrum the caruncles may be black in color, due to a pigment formed under the epithelium, Marshall (10), Casida and McKenzie (11). We have also noted the black pigment under the epithelium in the glandular mucosa in some of the non-pregnant uteri examined during the rutting season. Hilty mentions the pigment occurring around the edges of the caruncles in the involuted uterus of the cow. Hammond (12) also mentions an amorphous brownish pigment that appears around the caruncles seventy-two hours to eight days after the beginning of heat in the cow.

Macroscopically there is nothing to distinguish the glandular mucosa from the caruncles except that the caruncles are elevated above it.

Histology of the Glandular Mucosa

The whole surface of the mucosa is covered by an epithelium of columnar cells which is continuous over both the glandular mucosa and the caruncles. This epithelium dips down in the glandular mucosa, at frequent intervals, to form the uterine glands which are much branched toward the fundus of the glands. The epithelium of the mucosa is but one cell in thickness. These cells have large oval nuclei that are situated near their bases.

Just below the epithelium is a shallow layer of connective tissue densely crowded with nuclei which are

elongated and lie parallel to the epithelial surface. Numerous leucocytes may be scattered through this layer. This connective tissue layer is richly supplied with capillaries and small blood vessels.

Beneath this layer is a much thicker layer of looser connective tissue which reaches to the inner surface of the muscular wall of the uterus. This layer of loose connective tissue is continuous with the whole inner muscular wall of the uterus as there is a layer of this tissue between the caruncles and the muscular wall. The connective tissue cells of this loose layer are similar to the cells in the layer under the epithelium except that the nuclei are farther apart and the cells have branching processes which anastomose with one another.

The whole layer is penetrated by capillaries with the larger blood vessels lying in the deeper parts. Ramifying throughout the layer are the uterine glands, the fundi of which reach to the inner surface of the muscular wall. The fundi of some of the glands ramify in the layer of loose connective tissue below the caruncles. The excretory ducts from these glands do not pass through the stroma of the caruncles in reaching the lumen of the uterus, but pass to the side of the caruncles and open on the epithelium of the glandular mucosa between the caruncles.

The epithelial cells lining the glands are continuous with the epithelial cells covering the mucosa. No histo-

logical difference can be seen between the epithelial cells lining the glands and those covering the mucosa.

Histology of the Caruncles

The caruncles are local thickenings of the layer of densely cellular connective tissue found just below the epithelium in the glandular mucosa. As already mentioned, they are covered with a single layer of columnar epithelial cells which are continuous with the epithelium covering the glandular mucosa.

The dense cellular tissue of the caruncles is composed of cells with elongated nuclei similar to the cells under the epithelium in the glandular mucosa. It is traversed with numerous capillaries which usually run at right angles to the epithelial surface.

Immediately below the caruncle, in the layer of loose connective tissue that is interposed between the caruncle and the muscular wall, is a group of large blood vessels which ensure a rich blood supply to the caruncle should pregnancy take place (Fig. 2).

The Pregnant Uterus

The observations reported in this paper are limited to the processes taking place in the involuting mucosa of the ewe's uterus. It would be impossible, however, to make clear the changes that take place during involution without an understanding of the changes that occur in the mucosa during evolution.

Assheton (13) in 1906 published an important article on "The Morphology of the Ungulate Placenta, particularly the Development of that organ in the Sheep, and notes upon the Placenta of the Elephant and Hyrax." Most of the discussion of the changes occurring in the mucosa of the ewe's uterus is based on Assheton's article.

The fertilized ovum in the ewe does not reach the uterus until the fourth or fifth day after coition. On the ninth day the zona radiata ruptures and the blastocyst for the first time lies in direct contact with the epithelium of the uterus. The wall of the blastocyst from the time expansion begins on the tenth day until the sixteenth day is of two layers, the trophoblast (ectoderm) and hypoblast (entoderm) each of one cell in thickness. The mesoderm soon makes its appearance growing out between the ectoderm and entoderm, and the wall of the blastocyst soon consists of trophoblast and mesoblast.

The first attack upon the epithelium of the uterus

occurs about the eighteenth day. The trophoblast, where it comes in contact with the epithelium of the caruncles, becomes slightly thicker. Certain binucleate cells of the trophoblast migrate to the surface where they are in contact with the uterine epithelium. These cells insinuate themselves between the cells of the uterine epithelium and pass down to their bases where they then force themselves between the epithelium and the sublying matrix. The epithelial cells are cut off from nutrition and soon degenerate. Other phagocytic cells of the trophoblast engulf and remove the dead epithelial cells. The matrix of the caruncles is now in contact with the trophoblast.

The allantoic splanchnopleure makes its appearance about the fifteenth day and grows very rapidly. It fuses with the wall of the blastocyst about the twenty-third to twenty-fourth day.

The trophoblast, soon after the destruction of the epithelium over the caruncles, forms into ridges over the caruncles. Furrows are formed in the stroma of the matrix opposite the ridges of the trophoblast.

The future villi of the foetal placenta are formed as buddings along the crests of the ridges, first of the trophoblast which is followed quickly by the mesoblast. The mesoblast forms the core of the villi and carries the branches of the allantoic blood vessels. The villi grow by their own interstitial growth and the cells of the caruncle proliferate new cells which grow up around the villi.

The walls of the crypts are not lined by epithelial cells of the uterus but by cells from the trophoblast. Assheton names the layer lining the crypts plasmodi-trophoblasts.

The growth of foetal villi from the chorion with the corresponding growth of crypts from the matrix is a continuous process from the time villi first appear until pregnancy is terminated, as reported by Assheton (13) in the ewe, Hilty (7) Hallman (8) and Hammond (12) in the cow.

As pregnancy advances and more villi develop on the chorion, calling for the development of more crypts to lodge the villi, the placental matrix cells do not remain grouped in a caruncular shaped mass but spread out into a thin band of cells to provide for the large number of crypts that form in the cotyledons.

In Fig. 3, the dark band of closely packed cells around the periphery of the crypts are the placental matrix cells indicated at (c). The crypts that result from proliferation of the matrix cells are indicated by the (brace b). As the number of crypts increases and the cotyledon grows larger it projects into the lumen of the uterus. The caruncular matrix spreads out into a thin band of cells in the cotyledon by an invagination of the caruncular mass of matrix cells. This results in the adjacent glandular mucosa and its epithelium being carried up the sides of the cotyledon as it increases in size because of its attachment around the edges of the matrix of the caruncle. These statements are made clearer by referring to

Fig. 2. The epithelium between the points (a) and (b) over the caruncle is denuded by the chorion and crypts begin to form on its surface. In Fig. 3 the points (f & f) correspond to (a & b) in Fig. 2. If the epithelial surface of the glandular mucosa is followed down the wall of the cotyledon from (f & f) on each side, the cotyledon will be found to be attached to the mucosa by a narrow short stem indicated by the (brace g). The chorion is indicated in Fig. 3 at (a, a_1, a_2, and a_3). The villi of the chorion enter the cotyledon at (a_1). The muscular wall is indicated at (d & d_1), and the uterine glands at (c). The lacunae of extravasated blood formed between the bases of the villi and tips of the crypt wall are indicated at (h).

The changes taking place in the glandular mucosa of a pregnant uterus are shown in Fig. 4.

There has been an enormous increase in area of the lumen of the uterus. This increase in area has called for a great increase in the number of epithelial cells because the cells have not increased in size. They are still columnar with oval nuclei, (Fig. 4, c).

Just beneath the epithelium is the shallow layer of dense connective tissue with elongated nuclei lying parallel to the surface.

There has been a great change in the uterine glands that ramify in the loose connective tissue layer of the mucosa. They have increased enormously in size and occupy

nearly all the area in the mucosa (Fig. 4). Here too there has been an enormous increase in the number of secreting epithelial cells to account for the increase in size of the glands because the cells have not increased in size. (Fig. 4, e).

The loose connective tissue of the area appears to be relatively reduced in amount. It is found only between the glands and around the blood vessels. The nuclei are fewer and farther apart than in the non-pregnant uterus, (Fig. 4, f). At (a) can be seen a portion of the chorion overlying the glandular mucosa, and at (b) the epithelium of the chorion is indicated. The muscular wall of the uterus is indicated at (g).

Hilty (7), 1908, Hellman (8), 1924, and Hammond (12) 1927, have reported on the evolution of the uterus in the cow.

In the cow the crypt mass does not invaginate as in the sheep to form a cup-like cotyledon. The cells of the matrix become modified into a connective tissue band at the base of the crypt mass. The cotyledons have long stems which are covered by epithelium.

Hilty, in describing the formation of the cotyledon in a six-weeks pregnant bovine uterus, compares the stroma of the placental matrix to the serotina in the human. The crypts are formed by new cell growth from the matrix.

Hallman, in his description of evolution of the bovine uterus, shows that the formation of crypts in the cow is due to the stimulation by the chorion in somewhat the same way Assheton describes the ewe. Hallman points out that the cellular connective tissue of the maternal cotyledon (placental matrix) becomes modified to form a continuous band of densely arranged fibres at the base of the cotyledon (crypt mass) beyond which the chorionic villi do not penetrate.

Hammond's description of the evolution of the uterus in the cow agrees with Assheton's description in the ewe. He states there is not room below the surface of the cotyledon (placental matrix) for all the development which goes on after pregnancy begins and that the tissue of the cotyledon (placental matrix) develops by growing up into the cavity of the uterus.

In Hammond's opinion the cotyledon (placental matrix) causes greater pressure on the foetal membranes over the caruncles, because they are raised above the glandular mucosa and in addition are gland free, so there is no secretion to float off and prevent close apposition of the chorion with the caruncles. This allows the phagocytic cells of the chorion to function over the caruncles or even in the glandular mucosa if pressure of the foetal fluids becomes great enough.

Hammond states, "From a comparison of the number of

cotyledon attachments in the pregnant and non-pregnant horns of the uterus, it is apparent that the power, not only of developing the dormant cotyledons of the uterus, but also of initiating the formation of new adventitious cotyledonary growths rests with the foetal membranes."

Involution of the Mucosa of the Ewe's Uterus

The material for this investigation was collected from a group of eighteen ewes killed at various intervals of a few hours up to thirty days following parturition (See Table I).

Technique Used

The whole genital tract was carefully removed from the ewe as soon as she was dead and placed dorsal side up on a piece of cardboard. All measurements of the length of the horns were taken from the internal os of the cervix around the greater curvature to the tip of the horn. The width of the horn was taken at its greatest diameter.

The lumen of the vagina, cervix and horns was exposed by making an incision through the dorso-median line of the vagina, cervix and around the greater curvature of the horns. The organs were flattened out and

the edges of the uterine wall pinned down to the cardboard.

Data were taken of the gross features and photographs made of some of the uteri.

The whole genital tract was then fixed in Bouin's solution until the tissue was hard enough to cut blocks without disturbing the relationship of parts. Twelve to fourteen blocks of tissue containing a cotyledon or a portion of a cotyledon were taken from each uterus. The blocks were labeled and fixed further if the fixative had not penetrated through the block.

The blocks of tissue were then run through the alcohols, cleared in cedar wood oil, imbedded in paraffin, sectioned, and stained with hematoxylin and eosin.

Ewe 24, Approximately 12 Hours after Parturition

This ewe was killed at 1:25 P.M. on January 26, 1932. She had dropped twin lambs between 11:00 P.M. on January 25, and 7:00 A.M. on January 26. The foetal membranes had been passed before she was killed.

There is no evidence of any retained foetal membranes in the uterus. A small amount of watery bloody fluid is present in the lumen of the horns, cervix and vagina.

The cotyledons are arranged in four parallel rows in each horn. They are farther apart in the middle of the uterus, where the size of the horns was greater during pregnancy, than at the ovarian ends.

The crypt mass is visible in the circular-like depressions on the summits of the cotyledons which project into the lumen of the uterus. The empty crypts in the cotyledons are plainly visible.

The uterine epithelium is bright, wrinkled in appearance, and covers the sides of the cotyledons up to where the crypt formation is visible.

Histology of the Glandular Mucosa

After parturition several involutionary processes are going on in different parts of the mucosa.

The excess epithelial cells are being destroyed by what appears to be a vacuolar degeneration or hydropic degeneration. The vacuoles are formed in the protoplasm of the cells and the nuclei are crowded to one side (Fig.7). Vacuolar degeneration of the excess epithelial cells is a gradual process that keeps pace with the decrease in size of the uterus.

Involution of the uterine glands is a rapid process and is about complete at the end of the fourth or fifth day postpartum. The excess glandular cells that are destroyed by vacuolar degeneration are not absorbed in situ but are exfoliated into the lumina of the glands (Fig 7, (c). The lumina of the glands are less than half the diameter of those found in the pregnant uterus.

In Fig. 4 of the pregnant uterus the glandular mucosa consists almost entirely of glands. In Fig. 5, approximately twelve hours postpartum uterus, the glands occupy much less of the mucosa and connective tissue is becoming relatively more abundant in the area between the glands.

Histology of the Cotyledon

The cotyledon approximately twelve hours after parturition is illustrated in Fig. 5.

The decidual crypt mass or maternal placenta with the empty crypts still visible is indicated at (c), Fig.5. The permanent placental matrix cells surround the decidual crypt mass and are indicated at (a & b). There is a line of hyaline degeneration on the inner edge of the placental matrix band indicated by the arrow at (d). The muscular wall of the uterus is marked (E) with the peritoneum at (F). The epithelium covering the glandular mucosa is indicated at (h).

Some of the cells in the wall of the crypts are necrotic and a few pyknotic nuclei are present. All of the blood vessels in the area of hyaline degeneration on the inner edge of the placental matrix band, and in the crypt mass, are thrombosed. The formation of this line of hyaline degeneration and the thrombosing of the blood vessels that traverse it may be suggestive of the way the on-

set of labor is started. There is no evidence of hemorrhages from the maternal blood vessels in the crypt mass, which is additional evidence that the blood vessels are thrombosed.

Ewe 8044 Second Day Postpartum Uterus

This ewe lambed at 11:30 A.M. on May 7, 1932. The foetal membranes were passed but were not recovered. The ewe was killed at 10:00 A.M. on May 9, 1932.

The right horn measures 390 millimeters in length and 68 millimeters at its greatest diameter.

The left horn measures 300 millimeters in length and 47 millimeters at its greatest diameter.

Fig. 6 is a photograph of the endometrial surface of the uterus soon after it was opened.

There is no evidence of any retained foetal membranes in either horn. A small amount of the characteristic thick, tenacious, chocolate-brown exudate is lying on the epithelium.

The total number of cotyledons in the uterus is eighty-two, arranged in four parallel rows in each horn and parallel with the long axis of the horn.

All of the endometrial surface of the uterus, except the circular opening on the summits of the cotyledons, appears to be covered with epithelium. The mater-

nal placenta can be seen in the cup-like depressions of the cotyledons.

The epithelial surface of the glandular mucosa is of pinkish red blood color, while the crypt mass in the cotyledons is of a pale whitish bloodless color. The glandular mucosa between the cotyledons is fluffy and wrinkled due to the numerous rugae formed in the mucosa.

Most of the cotyledons are spherical in shape and project from one to one and one-half centimeters above the glandular mucosa. In Fig. 6 the crypt mass of the cotyledon is indicated at (E).

Histology of the Glandular Mucosa

No pronounced change is noted in the glandular mucosa of the second day postpartum uterus from that already described in the approximately twelve hour postpartum uterus.

The excess epithelium covering the glandular mucosa is being destroyed by vacuolar degeneration (Fig. 7). Vacuolar degeneration of the secreting epithelial cells in the uterine glands is not as pronounced as in the previous uterus but the lumina of the glands contain more cellular debris and pyknotic nuclei (Fig. 7, c). As the excess epithelial cells of the glands are destroyed the lumina of the glands decrease in diameter and in this

uterus the lumina of some of the glands are about the diameter of glands in the non-pregnant uterus.

Histology of the Cotyledons

Sections through the cotyledons do not show any marked changes from those found in the twelve hour postpartum uterus. As the cells in the walls of the crypts are necrosed the lumina of the crypts collapse and the crypt walls becomes a mass of coagulated cells and thrombosed blood vessels. Fig. 8 shows the condition of the cotyledon in the second day postpartum uterus.

Nearly all the cells in the crypt walls near the lumen of the uterus are necrosed (Fig. 8, a). Some of them are pyknotic, others show karyolysis, while in others the chromatin of the nuclei has broken up in irregular deeply stained granules, karyorrhexis.

Necrosis of the cells in the crypt walls does not progress from the line of hyaline degeneration on the inner surface of the placental matrix band,(Fig. 8, c), toward the lumen of the uterus, but progresses from the tips of the crypts bordering the lumen of the uterus toward the matrix band.

Fig. 9 is a higher magnification of a portion of a cotyledon showing the permanent placental matrix cells at (A) in the lower right hand corner. The line of hyaline

degeneration on the inner edge of the matrix cells is indicated at (b), and the deciduel crypt cells in the upper left hand corner at (c). Some of the lumina of the crypts are still open. The necrotic tips of some of the chorionic villi that broke off during the expulsion of the chorion, and remained in the crypts, are indicated at (d).

Fig. 10 is a still higher magnification of the central portion of Fig. 9. (A) indicates the placental matrix cells, (b) the line of hyaline degeneration, (c) the cells in the walls of the crypts in various stages of degeneration, (d) the necrotic tip of a chorionic villus.

Ewe 8035 Third Day Postpartum Uterus

This ewe lambed on May 6, 1932 at 1:00 P.M. The foetal membranes were passed at 4:30 P.M. The ewe was killed on May 9, 1932 at 10:00 A.M.

The right horn measures 360 millimeters in length and 65 millimeters at its greatest diameter.

The left horn measures 290 millimeters in length and 50 millimeters at its greatest diameter.

There is no evidence of any retained foetal membranes in the uterus. A small amount of chocolate-brown exudate is lying on the epithelial surface of the uterus (Fig. 11).

The cotyledons are arranged in four rows in each horn as in the previous uterus. The total number of cotyledons in the uterus is eighty-six. The cotyledons project above the glandular mucosa from one-half to one centimeter.

The glandular mucosa has the wrinkled, fluffy appearance noted in the previous uterus.

Histology of the Glandular Mucosa.

The involutionary processes as described in the second day postpartum uterus are in progress in this case. A few of the uterine glands have involuted to the size found in the non-pregnant uterus. Vacuolar degeneration is active in the larger uterine glands. Nearly all of the glands contain cellular debris in their lumina which are remains of the exfoliated epithelial cells (Fig.12,c).

The lumina of the blood vessels show reduction in size by proliferation and thickening of the intima as described by Hilty (7). (Fig. 12, d).

Histology of the Cotyledons

Sections through the cotyledons show that the involutionary changes described in the previous uterus are progressing. Nearly all of the cells in the crypt walls

are necrosed and the lumina of the crypts have collapsed except near the fundi of the crypts, (Fig. 13). In Fig. 13 the placental matrix cells are indicated at (a) with the line of hyaline degeneration indicated by the (brace b). The necrotic and degenerating cells of the crypt mass are indicated at (c).

Ewe 8043 Fourth day Postpartum

This ewe lambed on May 3, 1932 at 9:30 A.M. The foetal membranes were passed at 2:00 P.M. She was killed on May 7, 1932 at 9:30 A.M.

The right horn measures 420 millimeters in length and 54 millimeters at its greatest diameter.

The left horn measures 500 millimeters in length and 65 millimeters at its greatest diameter.

The cotyledons are arranged in four parallel rows in each horn as in previous uteri. The total number is 84. A greater quantity of exudate is in the lumen of the uterus than in the third day postpartum uterus. The exudate is cherry red in color instead of the characteristic chocolate brown color usually found. Projecting from the circular opening on the summits of the cotyledons is the decidual crypt mass which is also cherry red in color. The epithelium of the glandular mucosa is white in color instead of having the reddish color found in previously

examined uteri.

The orifices of the crypts which were visible in the crypt mass in previously described uteri are not visible in the crypt mass projecting from the summits of the cotyledons.

Histology of the Glandular Mucosa

The exudate lying on the mucosa contains necrotic cellular debris and portions of thrombosed blood vessels that have been exfoliated from the decidual crypt mass of the cotyledons. The exudate shows invasion by leucocytes from the mucosa. Rugae formation on the epithelial surface of the glandular mucosa is still pronounced (Fig. 16, e). The excess epithelial cells are being destroyed by vacuolar degeneration. Most of the uterine glands have undergone involution to the size of the glands found in the non-pregnant uterus. In the lumina of the glands can be seen cellular debris. Vacuolar degeneration is seen here and there in the uterine glands that are not completely involuted. Proliferation of the intima of the blood vessels shows further reduction in the size of their lumina.

The glandular mucosa is not as edematous as in previous uteri. As the glands decrease in size there is an apparent increase in the connective tissue between the

glands. The mucosa also appears to be more firmly attached to the muscular coat, (Fig. 16, h),

Histology of the Cotyledon

Fig. 14 shows a section through one of the cotyledons. The decidual crypt mass marked (a) can be seen projecting out of the summit of the cotyledon. All of the crypts are collapsed except where a portion of a chorionic villus has broken off and remained in the crypt, (Fig. 14, g). All of the cells that composed the walls of the crypt are necrosed, except a few around the periphery of the crypt mass where it comes in contact with the placental matrix band. The placental matrix band is indicated by braces at (b and c), Fig. 14. The dark area around the periphery of the crypt mass and on the inner edge of the placental matrix band indicated by the (brace d) in Fig. 14 is the part of the crypt mass which shows invasion by leucocytes.

The fact that the necrotic decidual crypt mass is being invaded by leucocytes only in the area bordered by the placental matrix band is further evidence that the blood vessels in the crypt mass are thrombosed,(Fig.14,h). Otherwise the leucocytes would be inveding all parts of the necrotic crypt mass from the blood vessels that traverse all parts of it.

Fig. 15 is a higher magnification of a portion of the cotyledon. The placental matrix cells are indicated at (a). In the upper part of the photomicrograph is the crypt mass (b) with some of the crypts still visible where a portion of a chorionic villus has been retained. in the crypt indicated at (c). The heavy infiltration of leucocytes can be seen at (d).

Previous to fixing the uterus in Bouin's solution, the crypt mass projecting from the summit of one of the cotyledons was grasped with a thumb forceps and with gentle traction pulled out. This was done to determine how firmly the decidual crypt mass is attached to the permanent placental matrix cells. Fig. 16 is a photomicrograph of the cotyledon. The cavity left by the portion of the crypt mass that was removed is indicated at (a). All of the crypt mass in the center of the cotyledon came away down to the permanent placental matrix cells, leaving a clean surface. A small portion of the crypt mass which was not grasped by the forceps remained attached to the placental matrix cells as indicated at (i).

This uterus is one of three in the series of eighteen uteri studied in which a heavy infiltration of leucocytes was observed.

Ewe 8027 Fifth Day Postpartum

This ewe lambed on April 25, 1932 at 3:45 P.M. The foetal membranes were passed at 6:45 P.M. She was killed on May 30, 1932 at 10:00 A.M.

The right horn is 350 millimeters in length and 60 millimeters at its greatest diameter.

The left horn is 490 millimeters in length and 76 millimeters at its greatest diameter.

Upon opening the uterus the endometrial surface is found covered with hundreds of retention cysts, (Fig. 17, a). These cysts vary in size from 1 to 8 millimeters in diameter.

Eighty-three cotyledons are present in the uterus. They are arranged in four parallel rows in each horn. Most of the cotyledons contain the cup-like depression on their summits. Hanging from the crypt mass in the cotyledon is what appears to be fragments of chorionic villi.

The general appearance of the endometrium gives the impression in this case that involution is not as far advanced as in the fourth day postpartum uterus.

Histology of the Glandular Mucosa

The involutionary processes are not as far advanced as in the fourth day uterus. This may be due to the large

number of retention cysts in the mucosa.

The uterine glands are larger and a greater number of them contain cellular debris in their lumina than in the previous uterus. The formation of the retention cysts is probably caused in the following manner: Involution of the uterine glands is very rapid, resulting in the accumulation of large quantities of cellular debris in the lumina of the glands. The remains of the destroyed cells are not absorbed in situ but are exfoliated into the lumina of the glands where they are either liquified by the enzymes of the dead cells or are washed into the lumen of the uterus by the secretion from the glands. The cellular debris may occlude the orifices of the glands, stopping the flow of secretion and causing the formation of a retention cyst. Further evidence that this is probable may be adduced from the fact that cellular debris is found in the lumina of the cysts, (Fig.18,b).

The area between the glands does not appear to contain as many connective tissue fibres as the previous uterus and the mucosa is loosely attached to the muscular wall.

Histology of the Cotyledon

Nearly all the crypts in the cotyledons contain portions of chorionic villi which were retained at the time the chorion was passed. The cells of the villi are ne-

crosed as are all the cells in the crypt walls except at the fundus of the crypts next to the line of hyaline degeneration. The necrotic crypt mass is not protruding from the summits of the cotyledons as described in the fourth day postpartum uterus.

Soon after the foetal membranes were passed a portion of the chorion with chorionic villi on it was fixed in Bouin's solution. Fig. 19 is a photomicrograph of a section cut through the villi. All but a few of the cells of the villi are necrotic. Several large thrombosed blood vessels can be seen.

Ewe 8040 Sixth Day Postpartum

This ewe lambed on April 23, 1932 at 3:45 P.M. The foetal membranes were not recovered. She was killed at 10:00 A.M. on April 29, 1932.

The right horn is 470 millimeters in length and 60 millimeters at its greatest diameter.

The left horn is 330 millimeters in length and 43 millimeters at its greatest diameter.

There is no evidence of any retained foetal membranes in the lumen of the uterus showing that the membranes were passed but not found.

The cotyledons are arranged in four parallel rows in the right horn but are scattered in the left horn.

Ninety-one cotyledons are present in the uterus. There is a small quantity of thick, sticky chocolate-brown exudate in the lumen of the uterus.

Histology of the Glandular Area

Vacuolar degeneration of the glandular epithelium is still going on. Rugae formations of the mucosa are not as numerous as in previous uteri, and the rugae are not as long.

Involution of the uterine glands is about complete. No vacuolar degeneration of gland cells could be found and cellular debris is found in the lumina of only a few of the glands.

The area between the uterine glands appears to have less connective tissue than was found in the fourth day postpartum uterus, (Fig. 20, b). The mucosa does not appear to be as firmly attached to the muscular wall as in the previous uterus.

The edematous appearance of the glandular mucosa or relatively less dense appearance of the connective tissue gives one the impression that involutionary changes have not been as rapid in this uterus as in some of the previous uteri.

Histology of the Cotyledons

Nearly all of the cells in the decidual crypt mass are necrosed, (Fig. 20, a). A large number of crypts are still visible, due to the retention of a great many chorionic villi in the crypts, (Fig. 20, d). In Fig. 21, which is a higher magnification of a portion of a cotyledon, the portions of retained chorionic villi are more distinct. In Fig. 21 the line of hyaline degeneration on the inner edge of the placental matrix cells is indicated at (b).

There is no infiltration of leucocytes into the necrotic mass of the cotyledons or into the exfoliated cellular debris that constitutes part of the exudate in the lumen of the uterus. The lack of leucocytes is hard to understand in view of the fact that each cotyledon has a large mass of necrotic tissue consisting of the decidual crypt mass.

There is no evidence that the necrotic crypt mass is being invaded by capillaries or fibroblasts from the placental matrix cells that surround it.

The necrotic crypt mass is evidently being liquified by autolysis and also reduced in volume by exfoliation into the lumen of the uterus.

Ewe 8034 Seventh Day Postpartum

This ewe lambed on April 22, 1932 at 8:45 A.M. The foetal membranes were not recovered. She was killed on April 29, 1932 at 10:00 A.M.

The right horn is 370 millimeters in length and 44 millimeters at its greatest diameter.

The left horn is 280 millimeters in length and 33 millimeters at its greatest diameter.

Upon opening the uterus no evidence of any retained membranes can be seen, showing that the membranes were passed but not found.

Covering the glandular epithelium is a large quantity of the characteristic sticky chocolate-brown exudate.

One hundred and thirty-four cotyledons are present in the uterus. The cotyledons are arranged in four parallel rows in each horn.

In this uterus the decidual crypt mass of the cotyledons is projecting from the openings on their summits as previously described in the fourth day postpartum uterus. Hanging or projecting from a large number of cotyledons is what appears to be portions of the decidual crypt mass (Fig. 22, e).

Histology of the Glandular Mucosa

Rugae of the surface of the glandular mucosa are not

nearly as numerous or long as in previous uteri, (Fig. 22, d). Vacuolar degeneration of epithelial cells is still in progress. Involutionary changes in the uterine glands appear to be complete. Connective tissue fibres are relatively more abundant in the area between the glands. The mucosa has the appearance of being firmly attached to the muscular wall except directly under the cotyledons. The lumina of the blood vessels are being reduced or obliterated by proliferation of the intima, (Fig. 22, h).

Histology of the Cotyledon

The cells of the decidual crypt mass, Fig. 22 (a), are completely necrosed down to the permanent placental matrix cells indicated by the brace at (b). Nearly all the crypts are collapsed and are visible only where a portion of a chorionic villus has been retained, (Fig. 22, i). The walls of the cotyledons which consist of glandular mucosa and the permanent placental matrix cells are being pulled down toward the bases of the cotyledons. Two purposes are accomplished by the pulling down of the walls of the cotyledon. First, the dedidual crypt mass is turned out into the lumen of the uterus, thereby exposing a larger surface for the exfoliation and liquefaction of the necrosed cells. Second, placental matrix cells which spread out into a narrow band in the cotyle-

don of pregnancy are drawn into a caruncular mass in the mucosa.

There is no evidence of leucocytic infiltration either into the necrotic crypt mass or into the exudate on the glandular mucosa.

Ewe 8026 Ninth Day Postpartum

This ewe lambed on April 10, 1932 at 10:15 A.M. The foetal membranes were passed at 2:00 P.M. She was killed on April 19, 1932 at 2:15 P.M.

The right horn is 235 millimeters in length. Greatest diameter not taken.

The left horn is 315 millimeters in length and 26 millimeters at its greatest diameter.

The endometrial surface of the uterus is covered with a small quantity of the thick, sticky, chocolate-brown exudate. The exudate has a shiny, dry appearance. The cotyledons in the right horn are arranged in four parallel rows. In the left horn the cotyledons are irregularly arranged or scattered.

A total of 92 cotyledons are present in the uterus. The cup-like depression is not present on the summits of the cotyledons and the walls are not covered with glandular mucosa as in previous uteri. The cotyledons do not project as far into the lumen of the uterus as in previous uteri.

Histology of Glandular Mucosa

Rugae on the epithelial surface of the glandular mucosa are rapidly disappearing, (Fig. 23, c). Vacuolar degeneration of the epithelial cells is still in process. The uterine glands are completely involuted. The area between the glands seems to contain more connective tissue and the mucosa appears to be firmly attached to the muscular wall even directly below the cotyledons, (Fig. 23).

Histology of the Cotyledon

The seventh day postpartum uterus was the first uterus in which all the cells in the crypt mass were found necrotic.

In this uterus and in the subsequent uteri of the series all of the cells in the crypt mass are found necrotic.

The greatest change observed taking place in this uterus is the reduction or receding of the glandular mucosal walls of the cotyledon and the drawing together of the permanent placental matrix cells at the base of the decidual crypt mass, (Fig. 23, b). Comparing Fig. 14, Fig. 22, and Fig. 23, which are photomicrographs of cotyledons from the fourth, seventh and ninth day postpartum uteri, the changes that take place are quite evident.

In Fig. 14 the cotyledon projects into the lumen of

the uterus one to two centimeters. The walls of the cotyledon consist of glandular mucosa and placental matrix cells indicated at (e) and by the (brace b). In Fig. 22, the walls of the cotyledon have receded or have been reduced so that they project only a few millimeters above the mucosa that forms the inter-cotyledonary area of the endometrium. In Fig. 23 the sides of the necrotic crypt mass (a) are not covered by glandular mucosa. The mucosal walls and the band of permanent placental matrix cells that covered the sides of the necrotic crypt mass have receded or have been drawn down to its base indicated at (b). As a result of these changes the necrotic crypt mass is everted into the lumen of the uterus.

The necrotic decidual crypt mass is now in the ideal position for its disposal. The disposal of the necrotic crypt mass in the subsequent uteri of the series consists of its elimination by liquefaction and absorption, or by its exfoliation and passing off in the lochia.

Ewe 8032 Tenth Day Postpartum Uterus.

This ewe lambed on April 9, 1932 at 11:45 A.M. The foetal membranes were passed at 4:00 P.M. She was killed on April 19, 1932 at 2:00 P.M.

The right horn measures 250 millimeters in length and 27 millimeters at its greatest diameter.

The left horn measures 200 millimeters in length and 22 millimeters at its greatest diameter.

One hundred and thirty-seven cotyledons are present in the uterus. Some of the caruncular areas at the horn tips had either not produced cotyledons during pregnancy or had completely involuted.

The cotyledons are masses of thick, sticky chocolate-brown material, (Fig. 24, d). Covering the glandular mucosa and in the lumen of the cervix is what appears to be some of the same material that is found on the cotyledons except that it is more fluid in consistency, (Fig. 24, f). At the ovarian ends of each horn there are cotyledons that appear to be almost completely involuted, (Fig. 24, e). The small cotyledons at the horn tips apparently involute more quickly than the larger cotyledons in the middle of the horns. The decidual crypt mass on two of the cotyledons was grasped with a thumb forceps and pulled off, (Fig. 24, c). A moist, glistening white surface with a dark pigment ring circumscribing the caruncular area is found.

Histology of the Glandular Area

Rugae formations on the glandular epithelium are rapidly disappearing or being reduced in size. The uterine glands are completely involuted. The glandular mucosa is firmly attached to the muscular wall and appears to contain rela-

tively more connective tissue than the glandular mucosa in uteri in which the uterine glands were not completely involuted, (Fig. 25, a).

Histology of the Cotyledon

The involutionary changes in the cotyledons of this uterus do not differ materially from those described in the ninth day postpartum uterus.

The necrotic decidual crypt mass is everted into the lumen of the uterus, (Fig. 25, a). The glandular mucosal walls of the cotyledon have receded and the permanent placental matrix cells are gathering into a mass at the base of the necrotic crypt mass, (Fig. 25, b).

The cotyledons are more pedunculated. The glandular mucosa stops at the edge of the decidual crypt mass, (Fig. 25, i).

Ewe 8039 Eleventh Day Postpartum

This ewe lambed on April 8, 1932 at 10:00 A.M. The foetal membranes were passed at 3:00 P.M. She was killed on April 19, 1932 at 10:00 A.M.

The right horn is 250 millimeters in length and 24 millimeters at its greatest diameter.

The left horn is 280 millimeters in length and 28 millimeters at its greatest diameter.

One hundred ten cotyledons are present in the uterus. There are cup-like depressions on their summits and the walls are covered with epithelium up to the circular openings, (Fig. 26, d).

About 100 c.c. of a thick, yellowish-white, tenacious exudate is in the middle of the left horn, (Fig. 26, d).

Histology of the Glanduler Mucosa.

In some respects this uterus shows delayed involutionary progress while in other respects it shows advanced changes. It is one of the three uteri of the series in which a heavy infiltration of leucocytes was found.

Overlying the epithelium in the glandular mucosa is a layer of leucocytes, (Fig. 27, a). The epithelial surface of the mucosa is thrown up into numerous rugae. Vacuolar degeneration is active in the epithelial cells of the glandular mucosa. The process must have been slow or dormant during the first part of the puerperium, otherwise the rugae on the surface would be much shorter and not so numerous, (Fig. 27, b). The uterine glands also show evidence of delayed involutionary progress in that the lumina of the glands are much larger than would be expected in an eleventh day postpartum uterus, (Fig. 27, c). Further evidence of delayed involution can be seen in the

edematous condition of the connective tissue between the glands and its loose attachment to the muscular wall, (Fig. 27, e).

Histology of the Cotyledon

The condition found in the cotyledons in this uterus is rather surprising in comparison with the cotyledons in the ninth and tenth day postpartum uteri.

In the ninth and tenth day uteri we found the glandular mucosa and placental matrix band, that constitutes the wall of the cotyledon, receding toward the base of the cotyledon. As the wall recedes the decidual crypt mass is being turned outward toward the lumen of the uterus. In this uterus we do not find the glandular wall or placental matrix band receding toward the base of the cotyledon, (Fig. 28). The edematous condition of the glandular mucosa and its loose attachment to the muscular wall probably accounts for the walls of the cotyledons not being reduced as in previous uteri. The heavy infiltration of leucocytes has resulted in the rapid erosion of the decidual crypt mass and we find only a small amount on the inner edge of the matrix cells, (Fig. 28, c). The erosion and removal of the decidual crypt mass has resulted in the formation of a cavity formerly occupied by the crypt mass.

It would appear that involutionary changes in the

cotyledons are further advanced in this uterus because of the rapid removal of the decidual crypt mass. We believe however, that the rapid removal of the decidual crypt mass is not the most important result to be considered in involution of the ewe's uterus. In our opinion the most important result is the everting of the decidual crypt mass so that it is exfoliated and eroded into the lumen of the uterus in order to avoid the invasion of the necrotic crypt mass with fibroblasts and the formation of scar tissue.

Ewe 8042 Twelfth Day Postpartum

This ewe lambed on April 6, 1932 at 11:00 A.M. The foetal membranes were passed at 2:00 P.M. She was killed on April 18, 1932 at 10:00 A.M.

The right horn is 215 millimeters in length and 27 millimeters at its greatest diameter.

The left horn is 205 millimeters in length and 34 millimeters at its greatest diameter.

The lumen of the uterus is completely filled with thick, sticky, chocolate-brown exudate except for a short distance at the lower end of each horn near the internal os of the cervix. The lumen of the cervix is also full of exudate which is more fluid than that in the horns. The cotyledons were not counted as it was impossible to

do so without disturbing the structural relationship of the necrotic tissue with the underlying mucosa and thus destroying the correct histological picture.

Histology of Glandular Mucosa

Vacuolar degeneration of the glandular epithelium is very pronounced, (Fig. 29, b). The uterine glands appear to be completely involuted. There appears to be a relatively greater abundance of connective tissue in the glandular mucosa in comparison with previous uteri in which the glands were not completely involuted.

Some of the dark brown exudate overlying the glandular mucosa is indicated at (a) in Fig. 29. Here and there in the exudate can be seen cellular debris, doubtless exfoliated portions of the necrotic crypt mass.

Histology of the Cotyledons

Involutionary changes in the cotyledons have not progressed very far beyond those described in the tenth day uterus. The principle difference is in the placental matrix cells which are drawing together in a smaller and thicker mass beneath the decidual crypt mass, (Fig. 30,b).

Ewe 8036 Thirteenth Day Postpartum

This ewe lambed on April 6, 1932 at 7:00 A.M. The foetal membranes were passed at 11:45 A.M. She was killed on April 19, 1932 at 9:30 A.M.

The length of the right horn is 225 millimeters. Diameter not recorded.

The left horn is 305 millimeters in length. Diameter not recorded.

In the lumen of the uterus is a small quantity of thick, sticky, chocolate-brown exudate. The lumen of the cervix is full of the exudate in a much more fluid state than that in the horns.

On the top of the cotyledons are flat, slightly oval discs of dark chocolate colored material which are very sticky to the touch. These flat, soft, sticky caps are very easily removed from the cotyledons, (Fig. 31,d). There are 89 cotyledons in the uterus.

Histology of Glandular Mucosa

The glandular mucosa is in about the same state as described in the twelfth day uterus.

Histology of the Cotyledons

The cotyledons are in about the same stage of invo-

lution as those in the twelfth day uterus except that there has been more of the decidual crypt mass eroded or exfoliated into the lumen of the uterus.

Ewe 8028 Fourteenth Day Postpartum

This ewe lambed on March 30, 1932 at 11:45 A.M. The foetal membranes were passed at 12:45 P.M. She was killed on April 13, 1932 at 10:30 A.M.

The right horn is 150 millimeters in length and 21 millimeters at its greatest diameter.

The left horn is 175 millimeters in length and 25 millimeters at its greatest diameter.

There are 123 cotyledons present in this uterus. For about three-fourths the way up each horn from the internal os of the cervix the exudate is more fluid than in the horn tips, where it is the characteristic thick,chocolate-brown exudate similar to that already described. In the lower part of each horn where the exudate is fluid there is not as much of the necrotic crypt mass on the summits of the cotyledons as in the upper parts of the horns where the exudate is thick and comparatively dry.

Histology of the Glandular Mucosa

The rugae projecting above the rest of the glandular

mucosa are covered with a peculiar type of epithelium which differs from the epithelium covering the lower, flatter portions of the mucosa, (Fig. 32, a). The epithelial cells on the rugae are much longer and the nuclei are closer to the free ends of the cells, while the epithelium covering the flatter portions of the mucosa is composed of much shorter cells and the nuclei are near the base of the cells. Vacuolar degeneration is seen only in the tall epithelial cells on the rugae. The lumina of the blood vessels are gradually being reduced by proliferation of the intima. Connective tissue fibres are found thickly scattered between the glands, (Fig. 32,c).

Histology of the Cotyledons

In the middle and cervical ends of the horns the cotyledons are nearly denuded of the necrotic decidual crypt masses, (Fig. 33, a). On cotyledons where the decidual crypt mass has been eroded down to the placental matrix cells, epithelial cells from the glandular mucosa are beginning to grow over and cover the matrix cells, (Fig. 32, b). The placental matrix cells are grouping into the caruncular mass, (Fig. 33, b), similar to that found in the nonpregnant uterus.

Ewe 8030 Sixteenth Day Postpartum

This ewe lambed on April 5, 1932 at 1:45 P.M. The foetal membranes were not recovered. She was killed on April 21, 1932 at 10:15 A.M.

The right horn is 265 millimeters in length and 20 millimeters at its greatest diameter.

The left horn is 290 millimeters in length and 21 millimeters at its greatest diameter.

There is no evidence, on opening this uterus, of retained foetal membranes thus showing that they were passed though not recovered, (Fig. 34).

Involution of this uterus appears to be much slower than in the preceding uterus. The elimination of the decidual crypt mass from the cotyledons by liquefaction is much slower, (Fig. 34). Ninety-eight cotyledons are present in the uterus. The exudate in the lumen of the uterus is of a thick, sticky chocolate-brown character and is not as fluid as that in the preceding uterus. Some of the exudate in a more fluid state than that in the horns can be seen in the lumen of the cervix, (Fig. 34, e). The decidual crypt mass of the cotyledons is easily removed by grasping it with a thumb forceps. Several were removed in this manner, (Fig. 34, d).

Histology of the Glandular Mucosa

The epithelial surface is much flatter than in any uterus yet examined, (Fig. 35, c). However, not all of the epithelial surface of the glandular mucosa is as free from rugae as shown in Fig. 35.

Histology of the Cotyledons

The cotyledons present the usual features with the necrotic crypt mass everted toward the lumen of the uterus, and the placental matrix cells drawing together at the base of the crypt mass, (Fig. 35, a and b).

Ewe 8033 Seventeenth Day Postpartum

This ewe lambed on April 4, 1932 at 2:45 P.M. The foetal membranes were passed at 5:00 P.M. She was killed on April 21, 1932.

The right horn is 160 millimeters in length and 18 millimeters at its greatest diameter.

The left horn is 155 millimeters in length and 18 millimeters at its greatest diameter.

Quite a contrast is found between the endometrial surface of this uterus and that found in previous uteri, (Fig. 36). The cotyledons have little or none of the

deciduel crypt mass on their summits, (Fig. 36, d), and there is but a scanty amount of exudate in the lumen of the uterus. One hundred and twenty-five cotyledons are present in the uterus. The epithelium of the glandular mucosa is white in color and has a smooth glistening appearance in contrast to the fluffy, wrinkled epithelium of the mucosa during the first part of the puerperium.

Histology of the Glandular Mucosa

The epithelium is relatively smooth with but few rugae formations on it, (Fig. 37, d). The mucosa is thicker and the areas between the glands are filled with connective tissue. The walls of the blood vessels are thick and their lumina are being slowly reduced in size.

Histology of the Cotyledons

The decidual crypt mass is eliminated almost down to the placental matrix cells. In Fig. 37 only a small amount is found at (a). The epithelium is spreading over the permenent matrix cells from the glandular mucosa. In Fig. 37 (e) can be seen how far the epithelium has spread over the matrix cells. The mass of matrix cells has contracted into the caruncular shape similar to that found in the non-pregnant uterus.

Ewe 8045 Twenty-second Day Postpartum

This ewe lambed on March 30, 1932 at 3:45 P.M. The foetal membranes were passed at 8:00 P.M. She was killed on April 21, 1932 at 10:00 A.M.

The right horn is 190 millimeters in length and 24 millimeters at its greatest diameter.

The left horn is 170 millimeters in length and 22 millimeters at its greatest diameter.

Involution is not yet complete as some of the cotyledons, especially those in the right horn, appear to have some of the decidual crypt mass on their summits, (Fig. 38). There is only a small quantity of exudate in the uterus. One hundred cotyledons are present.

Histology of the Glandular Mucosa

About the only change in the mucosa from that already noted in the seventeenth day uterus is the smaller lumina of the blood vessels, (Fig. 39, e).

Histology of the Cotyledons

Nearly all of the decidual crypt mass has been eliminated down to the caruncle or placental matrix cells, (Fig. 39, a). The caruncle is covered with epithelium except where there is still a small portion of the decidual crypt mass to be eliminated.

Ewe 8031 Twenty-sixth Day Postpartum

This ewe lambed on April 4, 1932 at 9:00 A.M. The foetal membranes were passed at 11:45 A.M. She was killed on April 30, 1932 at 1:00 A.M.

The right horn is 159 millimeters in length and 18 millimeters at its greatest diameter.

The left horn is 185 millimeters in length and 12 millimeters at its greatest diameter.

The endometrial surface of this uterus has about the same appearance as that of the twenty-second day uterus. Some of the caruncular elevations have a ring of pigment around their edges.

One hundred twelve cotyledons are present in the uterus.

Histology of the Glandular Mucosa

The glandular mucosa has the appearance of that in a non-pregnant uterus except that the blood vessels are not completely involuted.

Histology of the cotyledons

Involution of the cotyledons is nearly complete (Fig. 40).

In Fig. 40 at (a) is a small amount of decidual tissue yet to be eliminated. Nearly all of the placental matrix cells of the caruncles are covered with epithelium.

Ewe 8029 Thirtieth Day Postpartum

This ewe lambed on April 2, 1932 at 8:00 A.M. The foetal membranes were not passed. She was killed on May 2, 1932 at 10:00 A.M.

The right horn is 215 millimeters in length and 17 millimeters at its greatest diameter.

The left horn is 180 millimeters in length and 17 millimeters at its greatest diameter.

In the lumen of the right horn is a large amount of solid, sticky chocolate-brown material which is undoubtedly part of the foetal membrane that was retained, (Fig. 41, e). The left horn contains a small amount of chocolate-brown, fluid exudate. The general appearance of the endometrium does not indicate that involution has been retarded because of the retained foetal membranes. The caruncles have a bright, shiny appearance as if their surface is completely covered with epithelium.

One hundred thirty-four cotyledons are present in the uterus.

Histology of the Glandular Mucosa

Except for the blood vessels, the glandular mucosa has completely involuted.

Histology of the Cotyledons

The cotyledons are completely involuted. All of the

decidual crypt mass has been eliminated from the placental matrix cells and the latter are covered by epithelium, (Fig. 42).

In Fig. 43 can be seen a section through the sticky chocolate-brown mass found in the right horn. It is composed of a mass of necrotic tissue undoubtedly a part of the foetal membrane. There is no evidence of a heavy infiltration of leucocytes in this uterus such as would be expected if the foetal membrane had been retained due to infection.

Summary of Involution in the Mucosa of the Ewe's Uterus

The involutionary changes in the mucosa of the uteri of eighteen ewes have been traced from a few hours after parturition to thirty days postpartum. A brief description was given of the non-pregnant and pregnant uterus.

It was shown in the description of the pregnant uterus that great changes take place in the structural elements of the mucosa during gestation.

There is a great increase in area of the mucosa during gestation. This increase in area calls for a great increase in numbers of epithelial cells that cover the mucosa because the epithelial cells in the non-pregnant and

pregnant uterus do not differ in size.

The uterine glands also increase in size. The increase in size of the glands is accomplished by an increase in number of epithelial cells because there is no change in size of these cells in the non-pregnant and pregnant uterine glands. The increase in size of the lumina of the blood vessels is undoubtedly due to a proliferation of cells in their walls. With the increase in size of the uterine glands and blood vessels there appears to be a relative decrease in the connective tissue between these structures, and the mucosa seems to be very loosely attached to the muscularis. Compare (Fig. 2, e) with (Fig. 4, f).

Greater and more striking changes take place in the caruncles after conception. After the epithelial cells are denuded over their surface the placental matrix cells of the caruncles are stimulated to proliferate great masses of new cells by the villi of the chorion. These new cell growths from the matrix cells form crypts that grow up around the elongating and branching villi of the chorion. In addition to the formations of crypts from the matrix cells there occurs a rearrangement of the placental matrix cells from the caruncular mass shown in (Fig. 2, c) to the band of cells surrounding the periphery of the crypts (Fig. 3, c).

After parturition the elimination of the structural elements in the mucosa that proliferated during gestation, followed by repair, constitutes involution of the mucosa.

Involution of the Glandular Mucosa

Involution of the uterine glands was found to be a relatively rapid process in comparison with the changes in other parts of the mucosa. The excess epithelial cells of the gland are destroyed by vacuolar degeneration. The degenerated cells are not absorbed in situ but are exfoliated into the lumina of the glands. Proof of this was adduced from the fact that after the glands had involuted to the size of glands found in a non-pregnant uterus, vacuolar degeneration in the cells of the glands stops and cellular debris is not found in their lumina.

The mucosa of the uterus in Ewe 8027, fifth day postpartum, was found studded with numerous retention cysts (Fig. 17). The theory was advanced that the cysts were caused by the exfoliated cellular debris, in the lumina of the glands, occluding their orifices and stopping the glandular secretion from flowing into the lumen of the uterus. The secretions then accumulated in the glands forming the retention cysts.

The same type of vacuolar degeneration found in the

glands was found destroying the excess epithelial cells on the glandular mucosa, (Fig. 7, b) and (Fig. 29, b). The process in the epithelial cells of the mucosa was found in progress in all the uteri of the series. It cannot be stated whether the degenerated cells were exfoliated into the lumen of the uterus or absorbed in situ, because of the large amounts of cellular debris in the exudate lying on the epithelium. No evidence of the cells being absorbed in situ was observed.

Involution of the Cotyledons.

After parturition and the passing of the foetal membranes the empty crypts of the cotyledon are left (Fig. 5, c) surrounded by the permanent placental matrix cells (Fig. 5, a). A portion of the glandular mucosa covers the walls of the cotyledon that project into the lumen of the uterus.

The first involutionary change noted in the cotyledon was a line of hyaline degeneration involving the periphery of the crypts on the inner edge of the placental matrix band (Fig. 5, d). Some of the placental matrix cells may be involved, although the line of hyaline degeneration does not extend any deeper than the fundus of the crypts that contain necrotic tips of retained chorionic villi, (Fig. 9, brace b), (Fig. 10, b) and

(Fig. 13, brace b). The line of hyaline degenerated cells (d) forms a complete barrier between the outer circumference of the crypt mass (e) and placental matrix band (Fig. 5, a).

We are not able to state what causes the formation of this line of hyaline degeneration but believe that some very important changes occur as a sequence of its formation.

It was observed that the blood vessels that traverse the line of hyaline degeneration from the matrix band to the crypts were thrombosed in both these areas.

Proof that the blood vessels are thrombosed is based on the macroscopical observation that the crypt mass in the cotyledons is anemic in appearance during the first three or four days of the puerperium, after which they become brown in color, due to degenerative changes of the cells. Histological examination of the cotyledons in the first, second and fourth day postpartum uteri reveals more convincing evidence. It is hard to conceive that the villus could be expelled from the crypts during the passing of the foetal membranes without rupturing some of the capillaries and smaller blood vessels in the crypt walls causing hemorrhages. In no case, however, was there any evidence of hemorrhages from the maternal blood vessels in the crypts. This evidence, coupled with the coagu-

lated or agglutinated appearance of the blood in the vessels is convincing proof that the blood vessels are thrombosed. The final proof, however, was found in the cotyledons of Ewe 8043, fourth day postpartum. This uterus was one in which a heavy infiltration of leucocytes was found. The leucocytes were found invading the crypt mass from the blood vessels in the placental matrix band (Fig. 14, brace d). All parts of the crypt mass would have been inveded by leucocytes from the blood vessels that traverse its whole extent if they had not been thrombosed.

We are not prepared to state whether the hyaline degeneration causes the thrombosing of the blood vessels, or whether it is due to some other cause.

As a sequent of the blood vessels being thrombosed the cells of the crypt mass are deprived of nutrition and necrose. The cells at the apex of the crypts farthest away from the placental matrix band necrose first.

Necrosis of the cells in the crypts progresses very rapidly from their apex towards the fundus of the crypts. In the third day postpartum uterus nearly all the cells in the crypt mass are necrosed except some of the cells in the fundus of the crypts. It was not until the seventh day postpartum uterus was examined, however, that all the cells in the crypt mass were

found to be necrosed. The close proximity of the cells in the fundus of the crypts to the blood vessels in the placental matrix band, from which they may have derived nourishment, may explain their delayed necrosis,

The beginning of a new involutionary process was observed in the cotyledons of the seventh day postpartum uterus. This process consists of the drawing down or receding of the glandular mucosa and placental matrix band that constitutes the wall of the cotyledon surrounding the necrotic crypt mass. The receding of these structures is the reverse of that which took place during the development of the cotyledons of pregnancy (see description of "Pregnant Uteri").

The changes that take place in the cotyledons as a result of the process are very clearly illustrated in figs. 20, 22, and 23 which are photomicrographs of cotyledons from the sixth, seventh, and ninth day postpartum uteri. In (Fig. 23) the glandular mucosal wall has been drawn down or has receded, and the placental matrix band which appears as a thin band of cells around the periphery of the necrotic crypt mass in (Fig. 20, c) has receded or has been drawn down into a thickened mass below the necrotic crypt mass (Fig. 23, b). As the puerperium advances the necrotic crypt mass (Fig. 23, a) is eroded, due to autolysis, or in part is exfoliated into

the lumen of the uterus where it is liquefied. Some of the exfoliated necrotic crypt mass may even pass through the cervix into the vagina (Fig. 24, f) and (Fig. 34, e). That part of the necrotic crypt mass which passes through the cervix into the vagina is evidently liquefied before reaching the vulva as there was no external evidence of a uterine discharge after the first two or three days of the puerperium.

We have no explanation to offer that would account for the drawing down or receding of the cotyledonary walls that surround the necrotic crypt mass.

From the ninth day onward the necrotic crypt mass becomes smaller and smaller due to liquefaction and exfoliation. Compare (Fig. 23, a) with (Fig. 33, a). During this time the uterus is constantly becoming smaller, which may account for the placental matrix cells being formed into a caruncular shaped mass below the necrotic crypt tissue. Compare (Figs. 25, b and 37, b.

The uterine epithelium from the inter-cotyledonary glandular mucosa begins to spread in over the placental matrix cells as the necrotic crypt mass is denuded from its surface (Fig. 37, e). In (Fig. 42) a photomicrograph of a cotyledon of the thirtieth day postpartum uterus all of the necrotic crypt mass has been eroded from the placental matrix mass and the surface of the

matrix cells is completely covered with epithelium.

Involution of the cotyledon of pregnancy is now complete and it is restored to the caruncular shaped mass of placental matrix cells found in the non-pregnant uterus. Compare (Figs. 1 and 41) and (Figs. 2 and 42).

The disposal of the large amounts of necrotic tissue from the cotyledons during the puerperium is a non-inflammatory process. Proof of this statement can be adduced from the fact that only three of the series of eighteen uteri showed a heavy infiltration of leucocytes. The heaviest infiltration of leucocytes was found in the eleventh day postpartum uterus. There was also a heavy infiltration of leucocytes in the fourth and twelfth and a slight infiltration in the thirteenth day postpartum uterus. In the other uteri of the series leucocytes were lacking or were present in scanty numbers.

The presence of large number of leucocytes undoubtedly denotes infection or inflammatory processes other than the normal processes of involution.

The foetal membranes were recovered from all but five ewes of the series. See (Table III). In the uterus of only one of the five ewes from which the foetal membranes were not recovered was any evidence found

that the membranes had been retained in the uterus. The uterus from which the foetal membranes were not passed was from ewe 8029 thirty days postpartum. The right horn of the uterus contained a mass of necrotic tissue, sections of which showed it to be a portion of the retained foetal membranes (Figs. 41 and 43).

There was no evidence of leucocytic infiltration in the mucosa of this uterus showing that the membranes must have been retained due to some other cause than infection or inflammation.

In examining the foetal membranes passed after parturition, a quantity of thick, white gelatinous substance, about the size of a small apple, was found adhering to the uterine surface of the membranes at the horn tips opposite to the opening of the oviducts. The substance had about the same appearance as the uterine seal in the cervix, and would indicate that the orifices of the oviducts are sealed during pregnancy in much the same way that the cervix is sealed.

Three tables are included in this paper.- In Table I are tabulated the measurements of the uterine horns. Variations in length and diameter are evident, but in general there is a gradual decrease in size as the puerperium advances. The length of the right horn of the uterus of ewe 8029 thirtieth day postpartum is

greater than any of the horns of the preceding uteri going back to the seventeenth day postpartum uterus. The length of the right horn of the uterus of ewe 8029 is undoubtedly due to the retained foetal membranes found in the horn. The retained foetal membranes did not appear to retard involution of the uterus in any other respect as the mucosa was completely regenerated.

In Table II are tabulated the time at which parturition took place, and the interval in hours between parturition and the passing of the foetal membranes. The average time for the twelve foetal membranes recovered was 3 hours and 35 minutes.

In Table III are tabulated for comparison the number of foetal placental areas on the chorion, and the number of cotyledons or raised areas on the endometrial surface of the uterus, from which the foetal membranes passed. It is quite evident from the comparisons that the foetal membranes do not always make contact with all the caruncles in the uterus. In fact the number of foetal placentae on the foetal membranes was less in all cases except in ewe 8027 where the foetal membranes did not make contact with all the caruncles present in the uterus. In the other uteri of the series the comparison of the foetal placentae on the membranes was less than the number of cotyledons and non-functioning caruncles in the mucosa of the uterus from which the foetal

membranes passed. This is in accord with Hammond's (12) findings in the cow and is further evidence that the power of initiating placental growths on the caruncles rests with the chorion.

TABLE I

Number of Ewe	Date Ewes Lambed	Date Ewes were Killed	Length of Right Horn in M.M.	Greatest Diameter Right Horn	Length of Left Horn in M.M.	Greatest Diameter Left Horn	Number of Days Post partum Ewes were Killed
24	1-26-32	1-26-32					Approximately 12 hours
8044	5-7-32	5-9-32	390	68	300	47	2nd Day
8035	5-6-32	5-9-32	360	65	290	50	3rd "
8043	5-3-32	5-7-32	420	54	500	65	4th "
8027	4-25-32	4-30-32	350	60	490	76	5th "
8040	4-23-32	4-29-32	470	60	330	43	6th "
8034	4-22-32	4-29-32	370	44	280	33	7th "
8026	4-10-32	4-19-32	235		315	26	9th "
8032	4-9-32	4-19-32	250	27	200	22	10th "
8039	4-8-32	4-19-32	250	24	280	28	11th "
8042	4-6-32	4-18-32	215	27	205	34	12th "
8036	4-6-32	4-19-32	225		305		13th "
8028	3-30-32	4-13-32	150	21	175	25	14th "
8030	4-5-32	4-21-32	265	20	290	21	16th "
8033	4-4-32	4-21-32	160	18	155	18	17th "
8045	3-30-32	4-21-32	190	24	170	22	22nd "
8031	4-4-32	4-30-32	159	18	185	12	26th "
8029	4-2-32	5-2-32	215	17	180	17	30th "

TABLE II.

Number of Ewe	Time Ewes Lambed	Time foetal membranes were passed	Interval in Hours Between Dropping of Lamb and Passing of the Foetal Membranes
24	Between 11:00 P.M. & 7: A.M	Time not known	
8044	11:30 A.M.	Foetal membranes not recovered	
8035	1:00 P.M.	4:30 P.M	3 hours, 30 minutes
8043	9:30 A.M.	2:00 P.M.	4 hours, 30 "
8027	3:45 P.M.	6:45 P.M.	3 "
8040	3:45 P.M.	Foetal membranes not recovered	
8034	8:45 A.M.	Foetal membranes not recovered	
8026	10:15 A.M.	2:00 P.M.	3 " 45 "
8032	11:45 A.M.	4:00 P.M.	4 " 15 "
8039	10:00 A.M.	3:00 P.M.	5 "
8042	11:00 A.M.	2:00 P.M.	3 "
8036	7:00 A.M.	11:45 A.M.	4 " 45 "
8028	11:45 A.M.	12:45 P.M.	1 "
8030	1:45 P.M.	Foetal membranes not recovered	
8033	2:45 P.M.	5:00 P.M.	2 " 15 "
8045	3:45 P.M.	8:00 P.M.	4 " 15 "
8031	9:00 A.M.	11:45 A.M.	2 " 45 "
8029	8:00 A.M.	Foetal membranes not recovered	

TABLE III

Comparison of the number of cotyledons and caruncles found in the involuting uterus with the number of foetal placentae found on the foetal membranes. Note- It is quite evident from a comparison of the number of foetal placentae on the foetal membranes with the number of cotyledons and caruncles in the uterus that the caruncles in the non-pregnant uterus are potential cotyledons only and that these may or may not function during subsequent pregnancies.

Number of Ewe	Number of Cotyledons and Non-functioning caruncles in uterus	Number of foetal placentae on chorion	Remarks
24	No Count Made	No Count Made	
8044	82		Foetal membranes not recovered
8035	86	81	
8043	84	75	
8027	83	83	
8040	91		Foetal membranes not recovered
8034	134		Foetal membranes not recovered
8026	92	83	
8032	137	78	
8039	110	64	
8042		78	Uterus was filled with a thick exudate which was not disturbed to count cotyledons.
8036	89		Foetal membranes so badly torn no count was made.
8028	123	77	
8030	98		Foetal membranes not recovered
8033	125	94	
8045	100	48	One horn of the foetal membranes was only half the length of the other.
8031	112	95	
8029	134		Foetal membranes not recovered.

BIBLIOGRAPHY

1. Friedländer, Utersuchungen uber den uterus. Liepzig 1870.

2. Kundrat und Engelman, Utersuchungen uber die uterus - schleimhaut in den wiener mediz. L ehrbuchem 1873.

3. Leopold, Studium uber die uterus - mucosa, USW. arch. f. Gynoec und geburtsh. Bd. XII.

4. Williams, J. Whitridge, Regeneration of the Uterine Mucosa after Delivery, with Especial Reference to the Placental Site. Amer. Jour. of O bst. and Gyne. Nov. 1931, Vol. XXII No. 5, pp 661-696.

5. Fleming, Geo., Veterinary Obstetrics Ed. 2 revised. W. R. Jenkins, Publisher 1900.

6. DeBruin, M. G., Bovine Obstetrics. Translated by Wyman. W.E.A. 1901.

7. Hilty, Heinrich, Utersuchungen uber die Evolution und, Involution der uterusmucosa Vom Rind, Schweig, Archiv. f. Tiekeilkunde, 1908.

8. Hallman, E. T., Further Studies in the Disease of the Reproductive Organs of Cattle. Cornell Veterinarian, July, 1924.

9. Williams, W. L., The Significance of Utero - chorionic lesions in the cow. Cornell Veterinarian, 19, 254, 1929.

10. Marshall, Phil, Trans. Roy, Soc. B, 196, 1903.

11. Casada, L. E. and McKenzie, F. F., The Oestrous Cycle of the Ewe; Histology of the Genital Tract. Research Bulletin 170, College of Agriculture, University of Missouri.

12. Hammond, John. The Physiology of Reproduction in the Cow. 1927.

13. Assheton, R. The Morphology of the Ungulate Placenta, particularly the Development of that Organ in the Sheep, and notes upon the Placenta of the Elephant and Hyrax. Phil. Trans. Roy, Soc. B 198, 1906.

Fig. 1
Non-Pregnant Uterus

(A) Right horn, (b) left horn, (c) cervix, (d) vagina, (e) caruncles, (f) glandular mucosa.

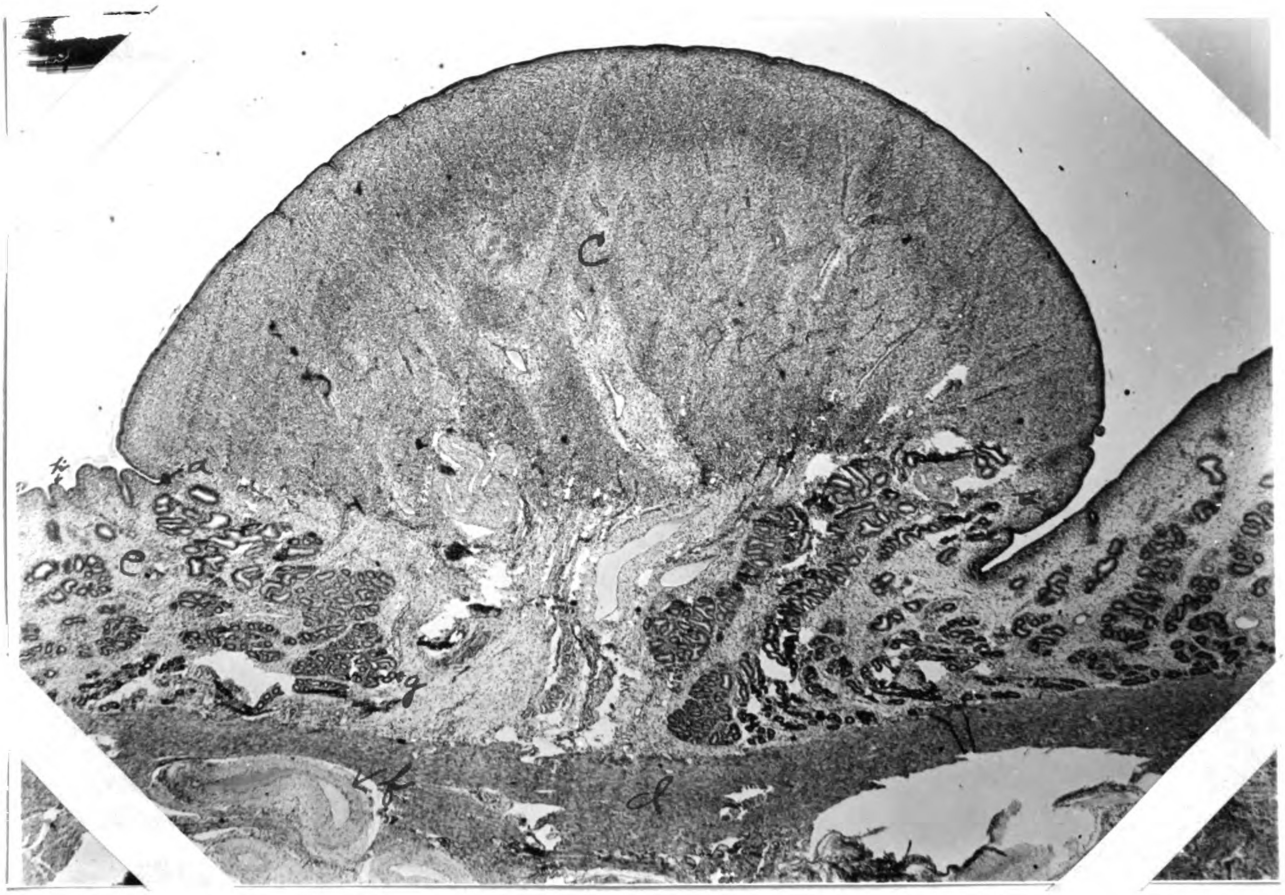

Fig. 2

Fig. 2 X 28 Caruncle and Glandular Mucosa Non-Pregnant Uterus.

(A and b) points at which glandular mucosa joins the stroma of the caruncle, (c) matrix of the caruncle, (d) muscular wall of uterus, (e) glandular mucosa, (f) blood vessel in muscular layer of uterus, (g) uterine glands, (h) epithelium over glandular mucosa.

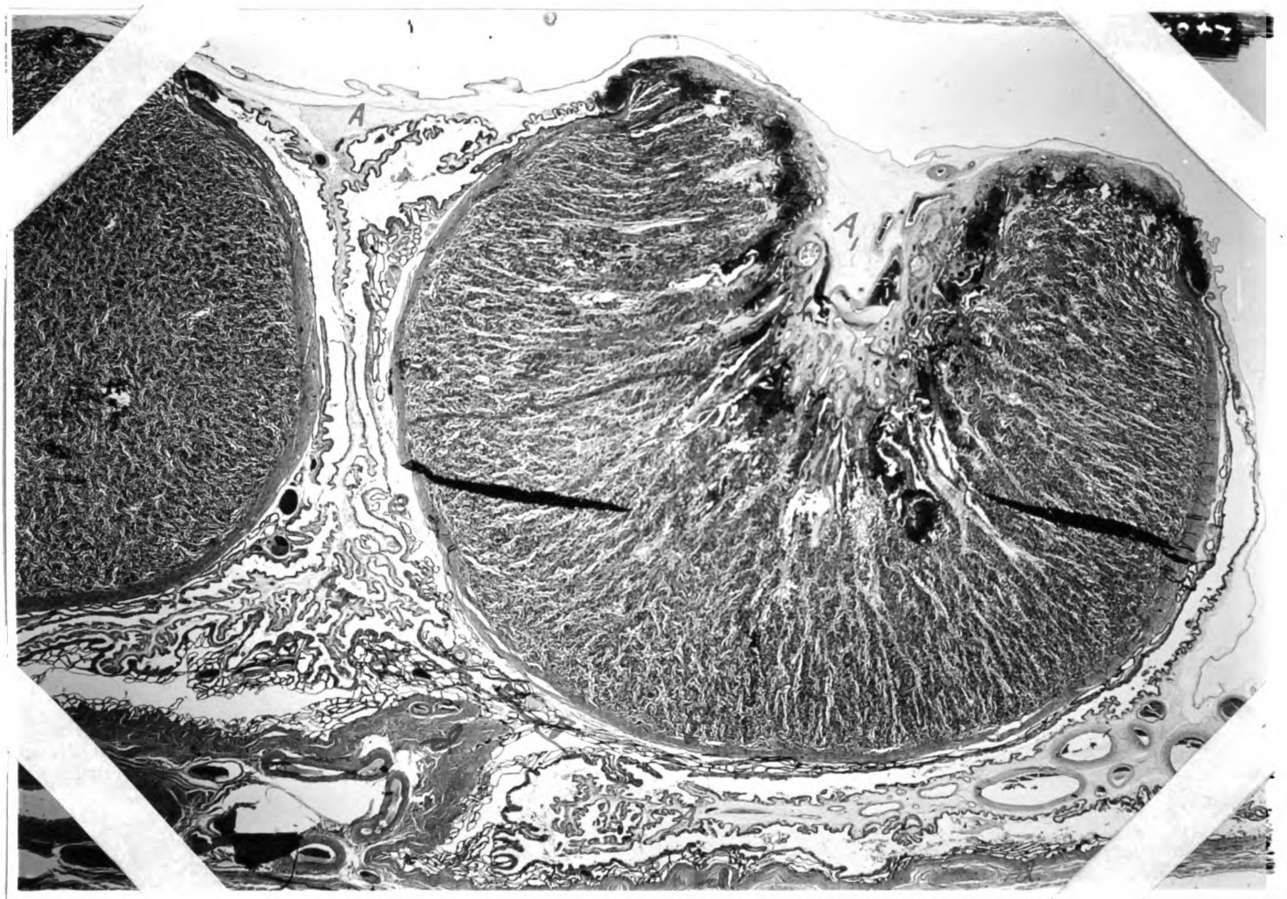

Fig. 3

Fig. 3, X 12 Cotyledon from Pregnant Uterus

(A, A_2 A_3) chorion over glandular mucosa of uterus, (A_1) foetal placental portion of chorion where villi enter crypts, (brace b) decidual crypts of cotyledon, (c) permanent placental matrix cells of cotyledon, (d) muscular wall of uterus, (e) uterine glands, (f) point at which glandular mucosa is attached to matrix, (g) short mucosal stem of cotyledon.

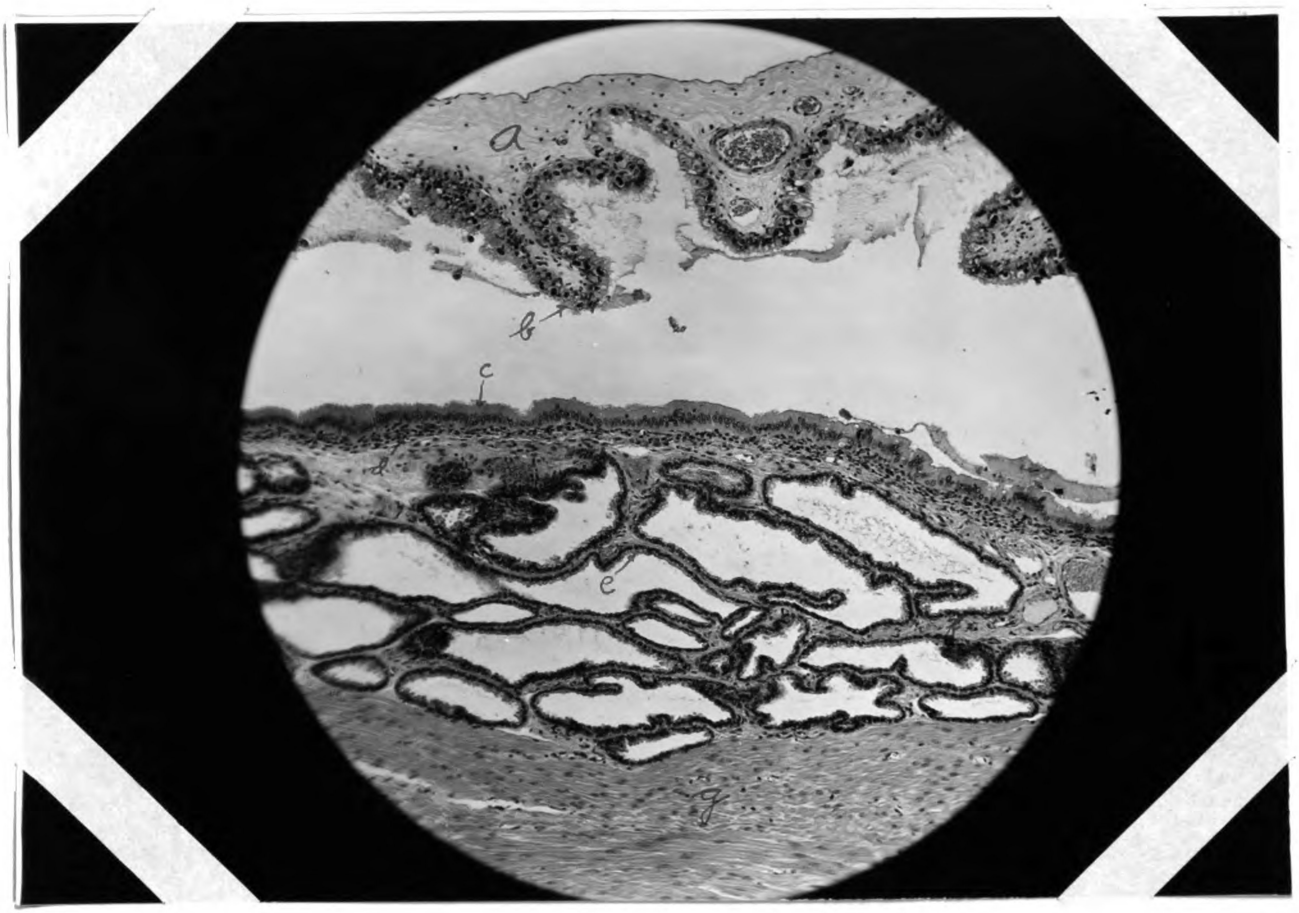

Fig. 4, X 78 Glandular Mucosa Pregnant Uterus.

(A) chorion, (b) epithelium of chorion, (c) epithelium on glandular mucosa, (d) thin layer of dense connective tissue, (e) epithelium of glands, (f) loose connective tissue of mucosa, (g) muscular wall.

Fig. 5, X 8 Cotyledon of approximately 12 hours post-partum.

(A & b) placental matrix band, (c) decidual crypt mass, (d) line of hyaline degeneration, (e) muscular wall of uterus, (f) serous coat, (g) uterine glands, (h) epithelium of glandular area.

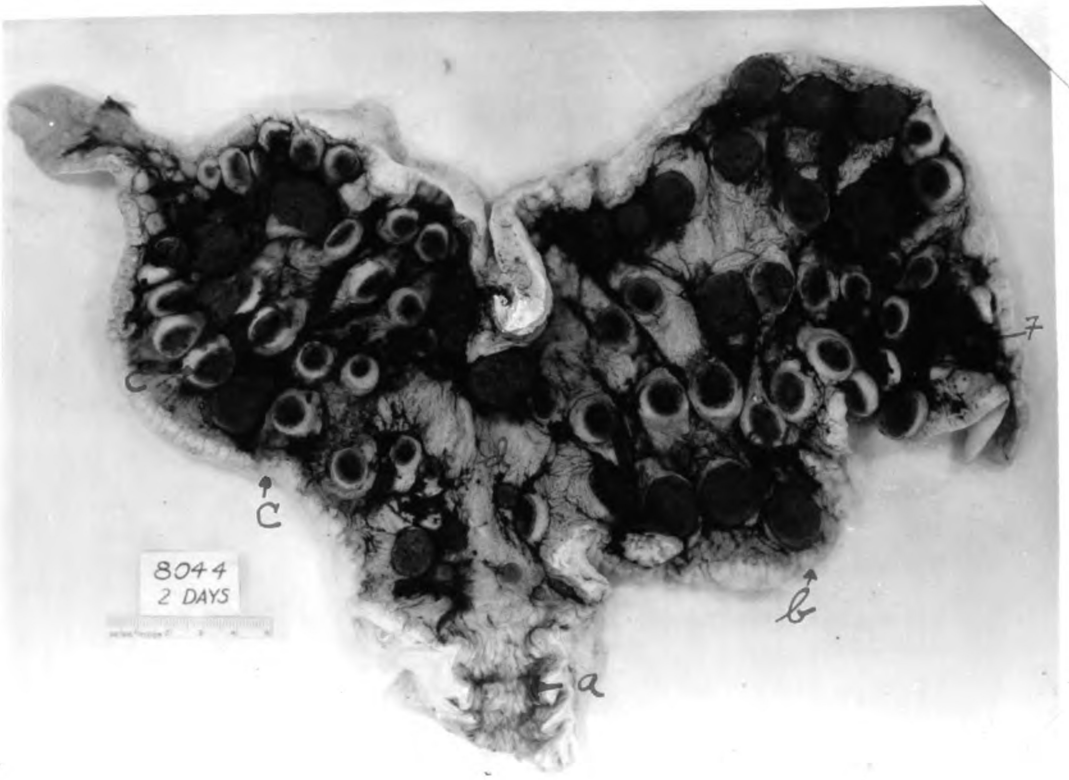

Fig. 6. Endometrium of 2nd. Day Postpartum Uterus.

(A) cervix, (b) right horn, (c) left horn, (d) glandular mucosa, (e) cotyledon, (f) chocolate brown exudate on mucosa.

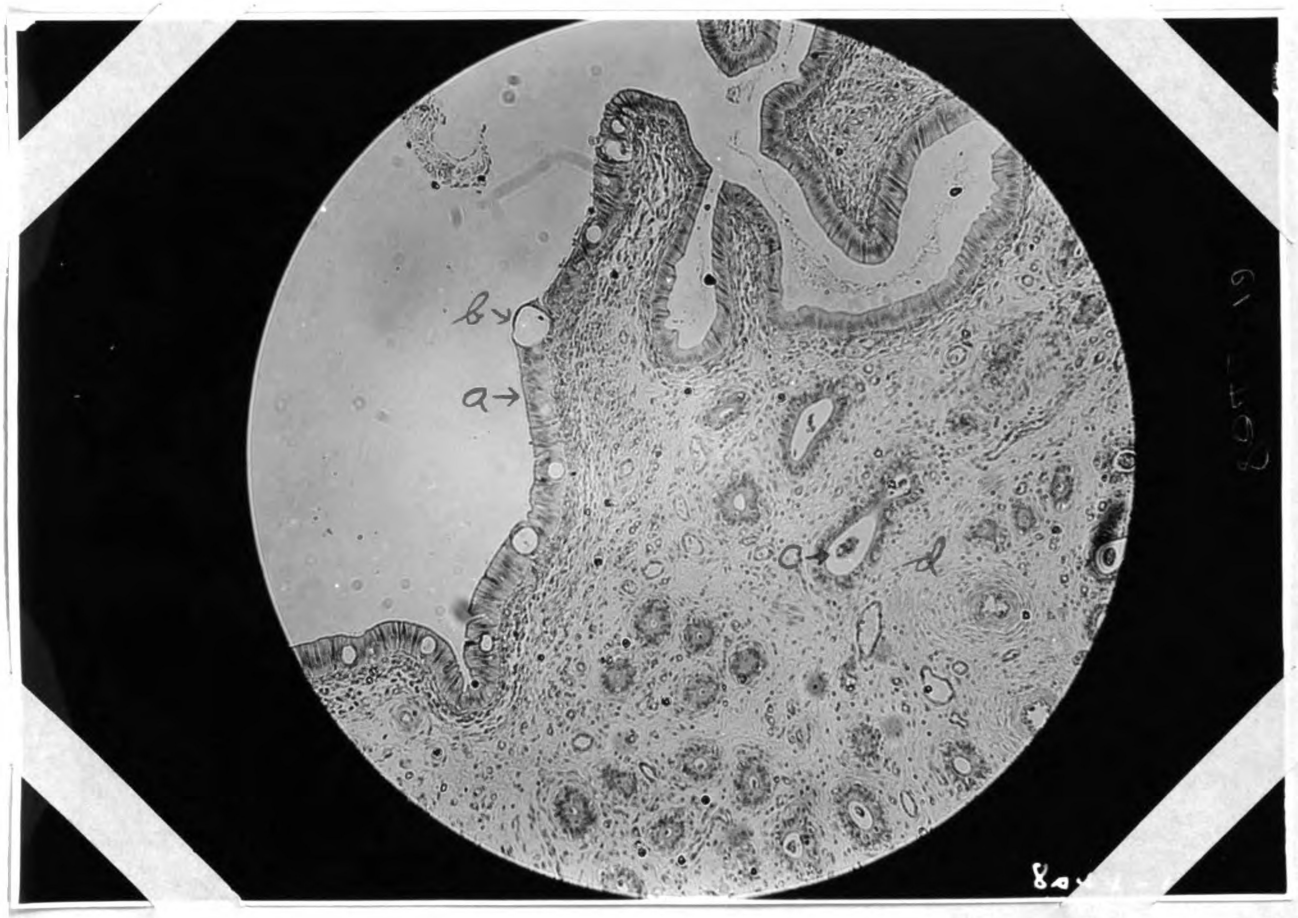

Fig. 7, X 36. Glandular Mucosa 2nd day Post-partum

(A) epithelium, (b) vacuole degeneration of epithelial cell, (c) uterine gland with cellular debris in lumen, (d) connective tissue.

Fig. 8, X 10. Cotyledon 2nd. day Post-partum.

(A) decidual crypt mass, (b) placental matrix band, (c) line of hyaline degeneration, (d) epithelium of glandular mucosa, (e) muscular wall, (f) thrombosed blood vessel in crypt mass, (g) uterine glands, (h) blood vessel.

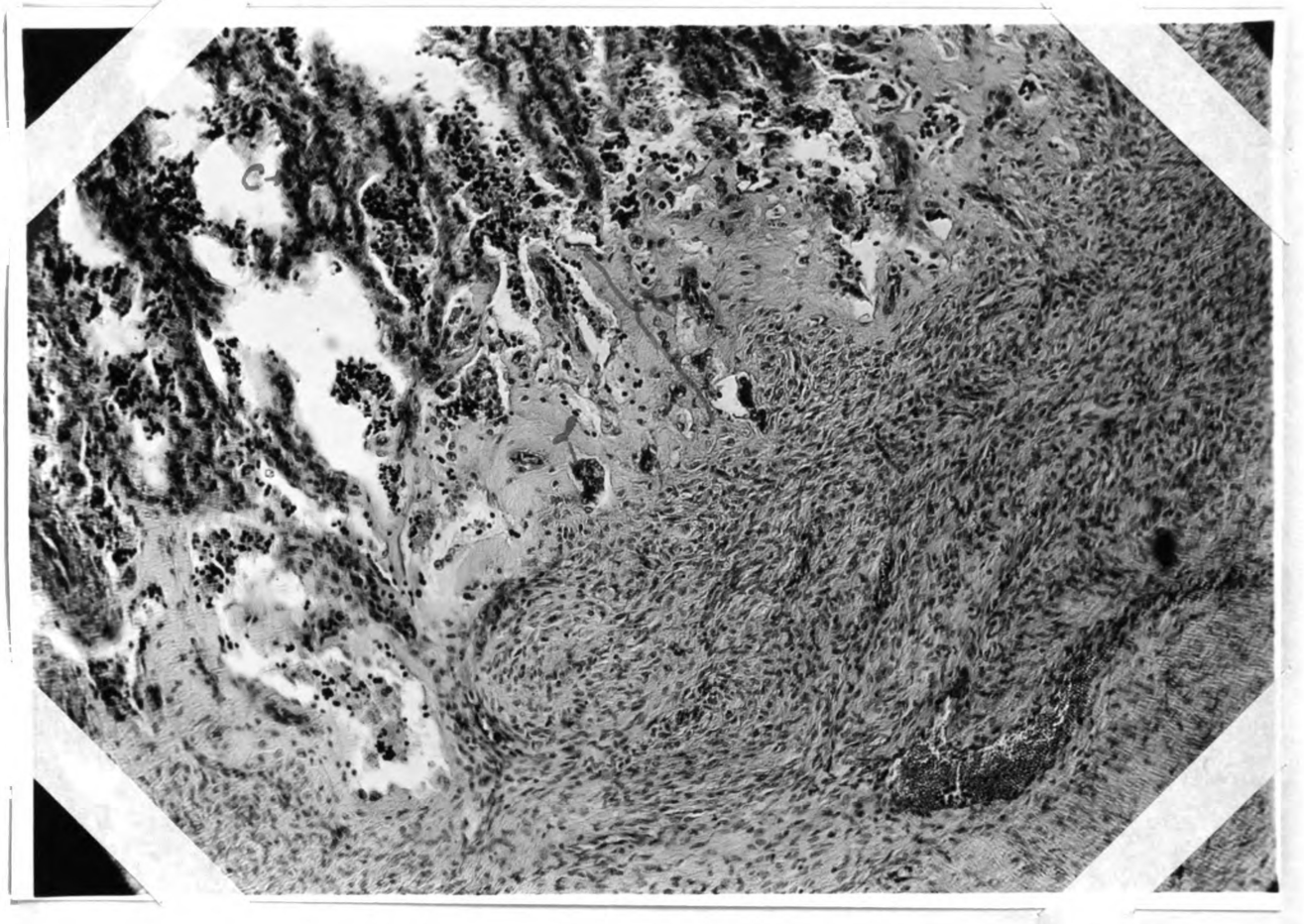

Fig. 9, X 186. Portion of Cotyledon 2nd. day post-partum.

(A) placental matrix cells, (b) line of hyaline degeneration, (c) walls of crypts with degenerating cells, (d) tips of a retained chorionic villus, (e) blood vessel.

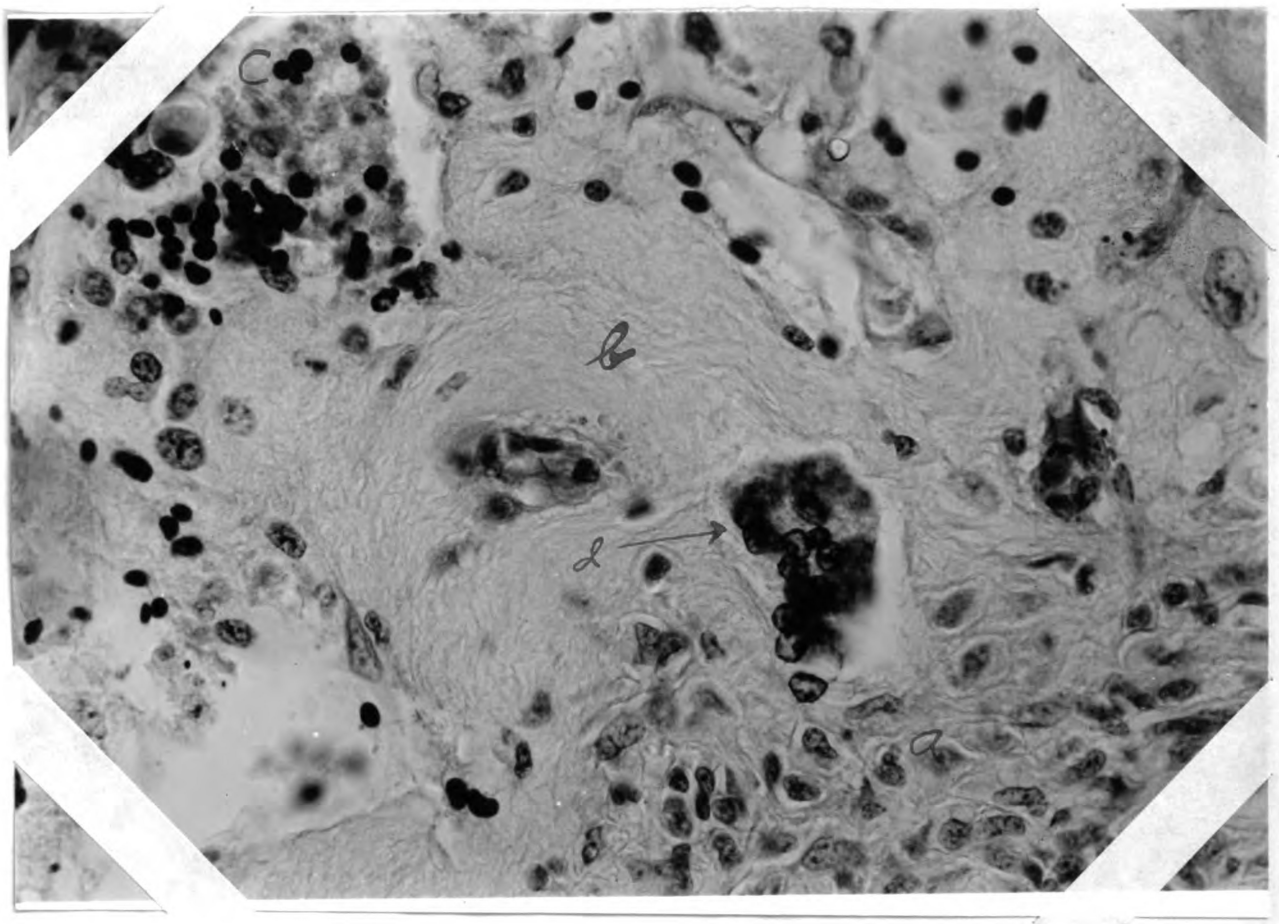

Fig. 10, X 570. Higher Magnification of Fig. 8.

(A) placental matrix cells, (b) line of hyaline degeneration, (c) necrotic crypt cells, (d) tip of chorionic villus.

4-2
Day
X576

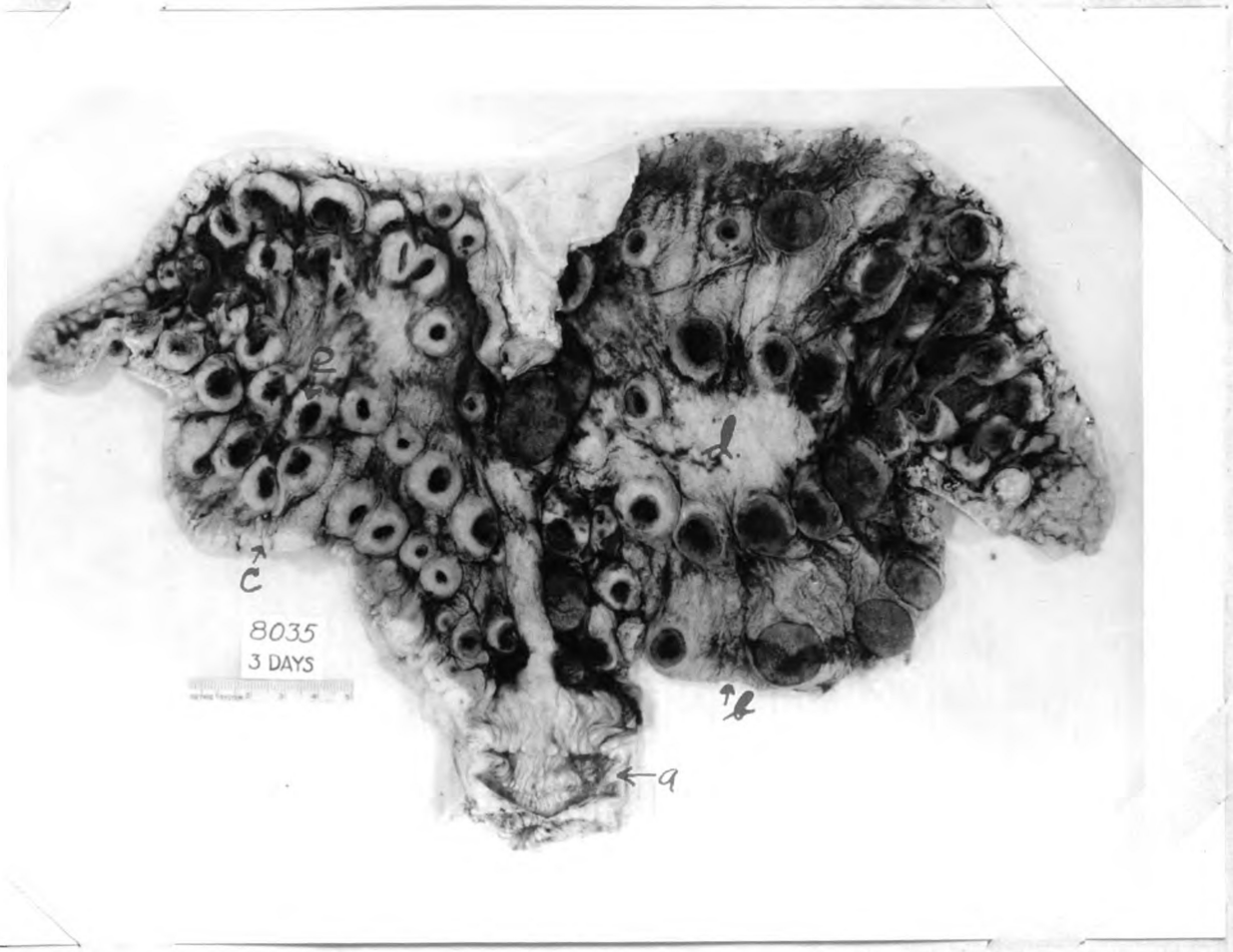

Fig. 11. **Endometrium of 3d. Day Postpartum Uterus.**

(A) cervix, (b) right horn, (c) left horn, (d) glandular mucosa, (e) cotyledon.

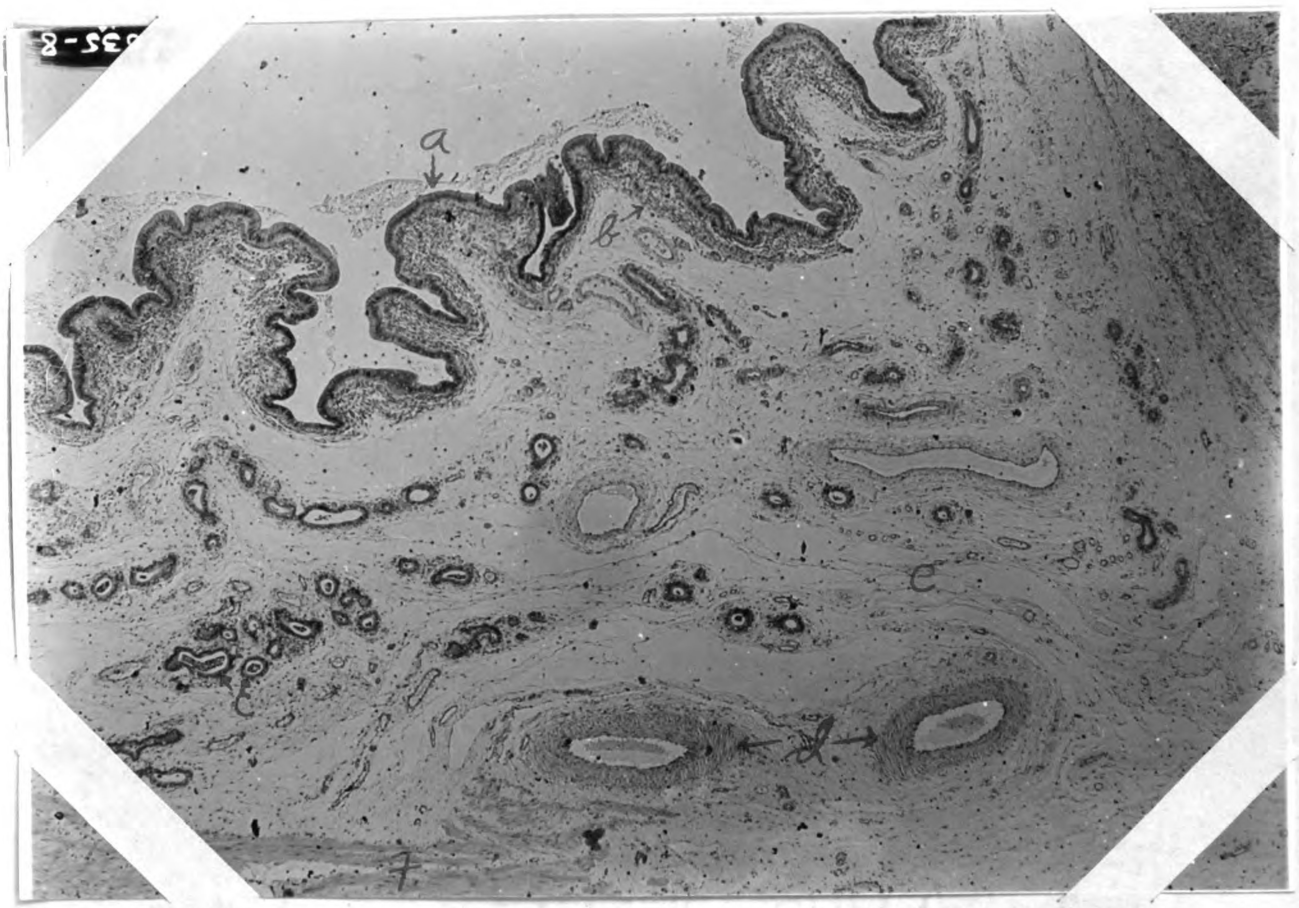

Fig. 12, X 36. Rugae Formation on Mucosa 3rd. Day Uterus.

(A) epithelium, (b) shallow layer of dense connective tissue, (c) uterine glands with lumen full of cellular debris, (d) blood vessels in process of involution (note thickening of intima), (e) connective tissue of loose glandular mucosa (note the few nuclei), (f) muscular wall.

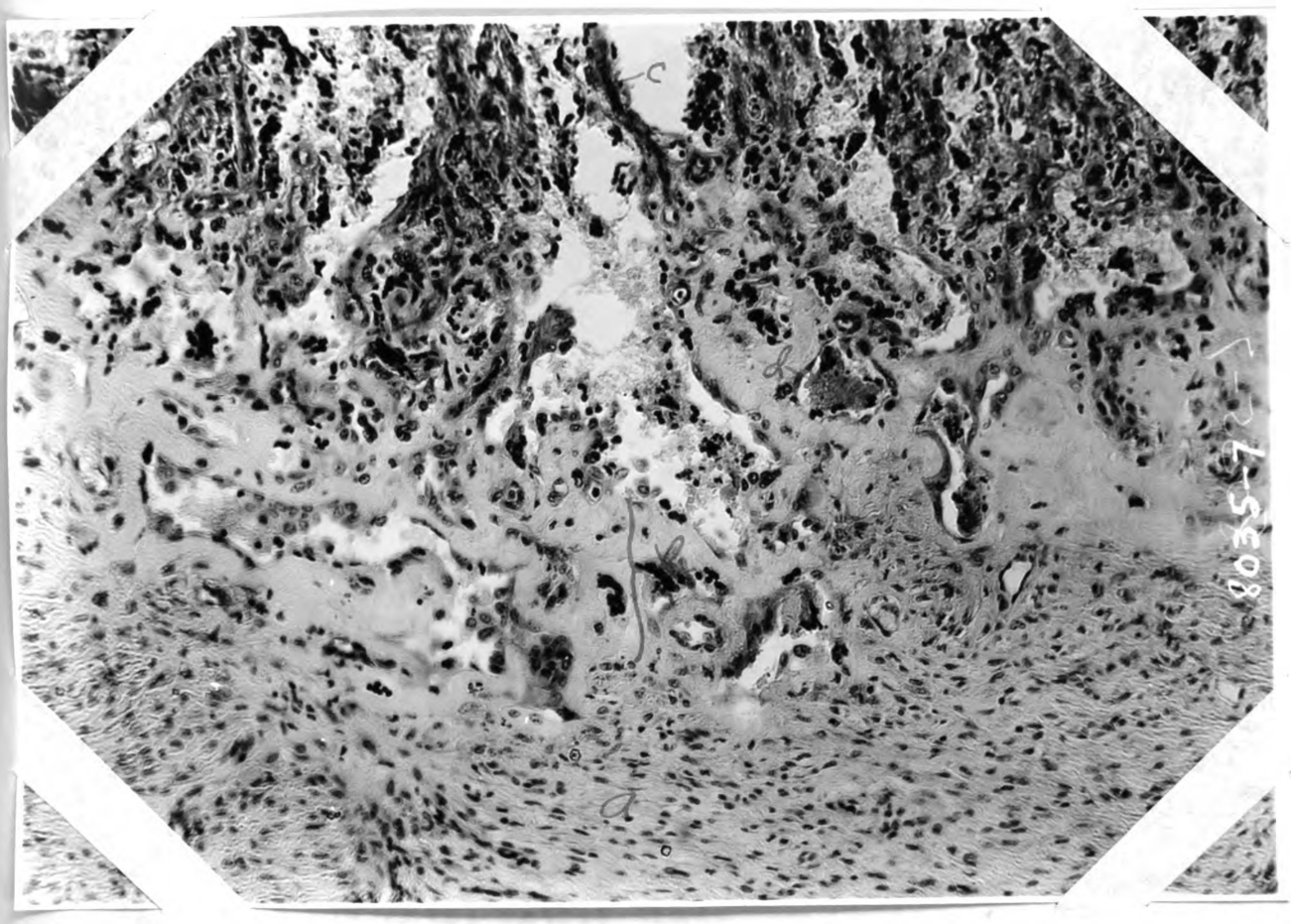

Fig. 13, X 250. Portion of Cotyledon 3rd. day Post-partum.

(A) placental matrix cells, (b) line of hyaline degeneration, (c) necrotic cells of crypt walls, (d) necrotic tip of chorionic villus.

Fig. 14, X 15. Cotyledon 4th. Day Postpartum Uterus.

(A) decidual crypt mass, (brace at b & c) placental matrix band, (brace at d) dark area around periphery of crypt mass being invaded by leucocytes, (e) epithelium over glandular mucosa covering wall of cotyledon, (f) uterine glands, (g) tip of chorionic villus retained in crypt, (h) thrombosed blood vessels in crypt mass.

Fig. 15, X 225. Portion of Cotyledon 4th. Day Postpartum.

(A) placental matrix cells, (b) crypt cells in process of necrosis, (c) portions of chorionic villi, (d) leucocytes invading crypt mass from placental matrix band.

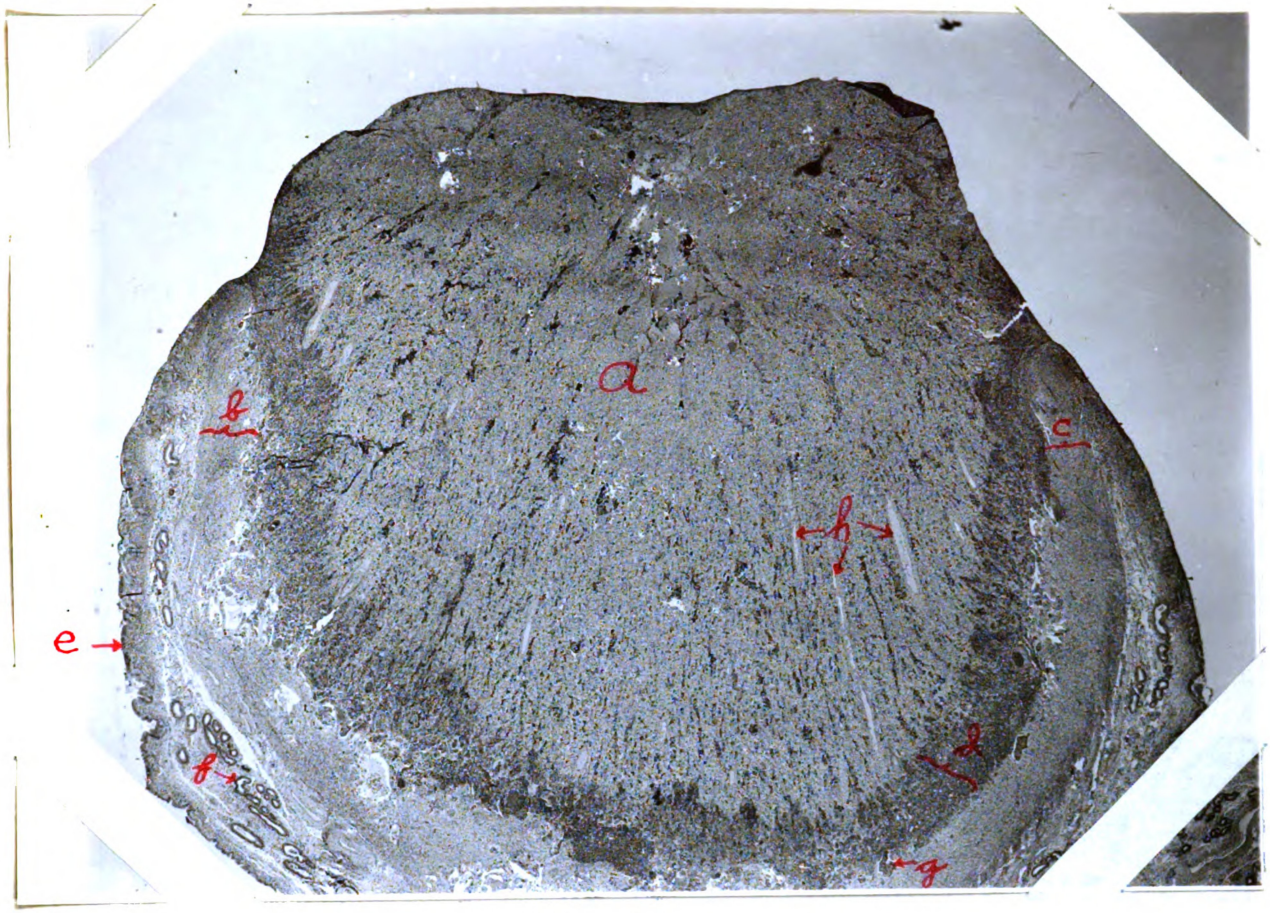

Fig. 14.

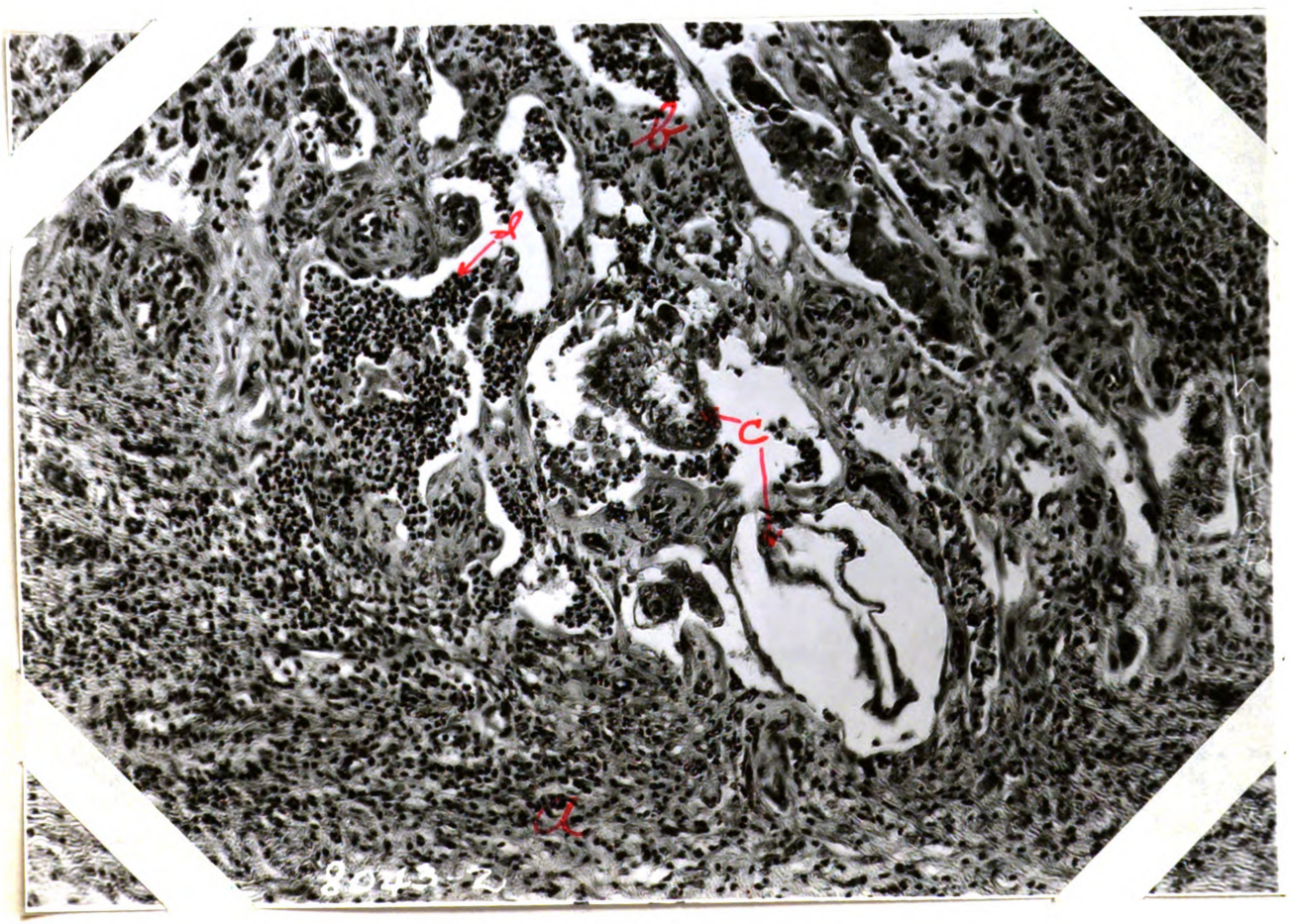

Fig. 15.

1
Day
5

3-2
Day

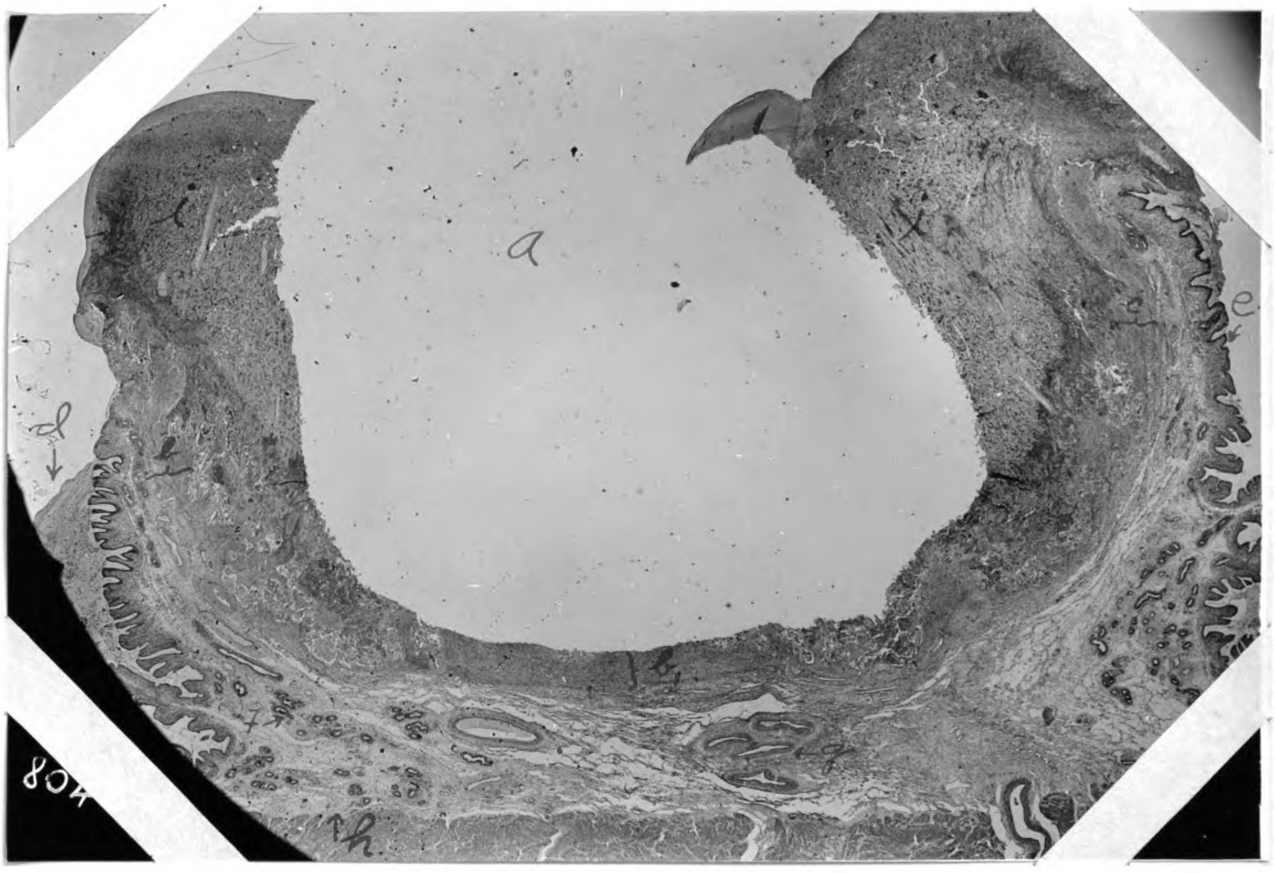

Fig. 16, X 11. Cotyledon With Most of Decidual Crypt Mass Removed Before Fixing in Bouin's Solution.

(A) cavity from which crypt mass was removed, (b,b_1 & c) placental matrix band, (d) exudate of cellular debris, (e) epithelium of glandular mucosa, (f) uterine glands, (g) blood vessels, (h) muscular wall, (i) portions of crypt mass not grasped by thumb forceps and therefore not removed.

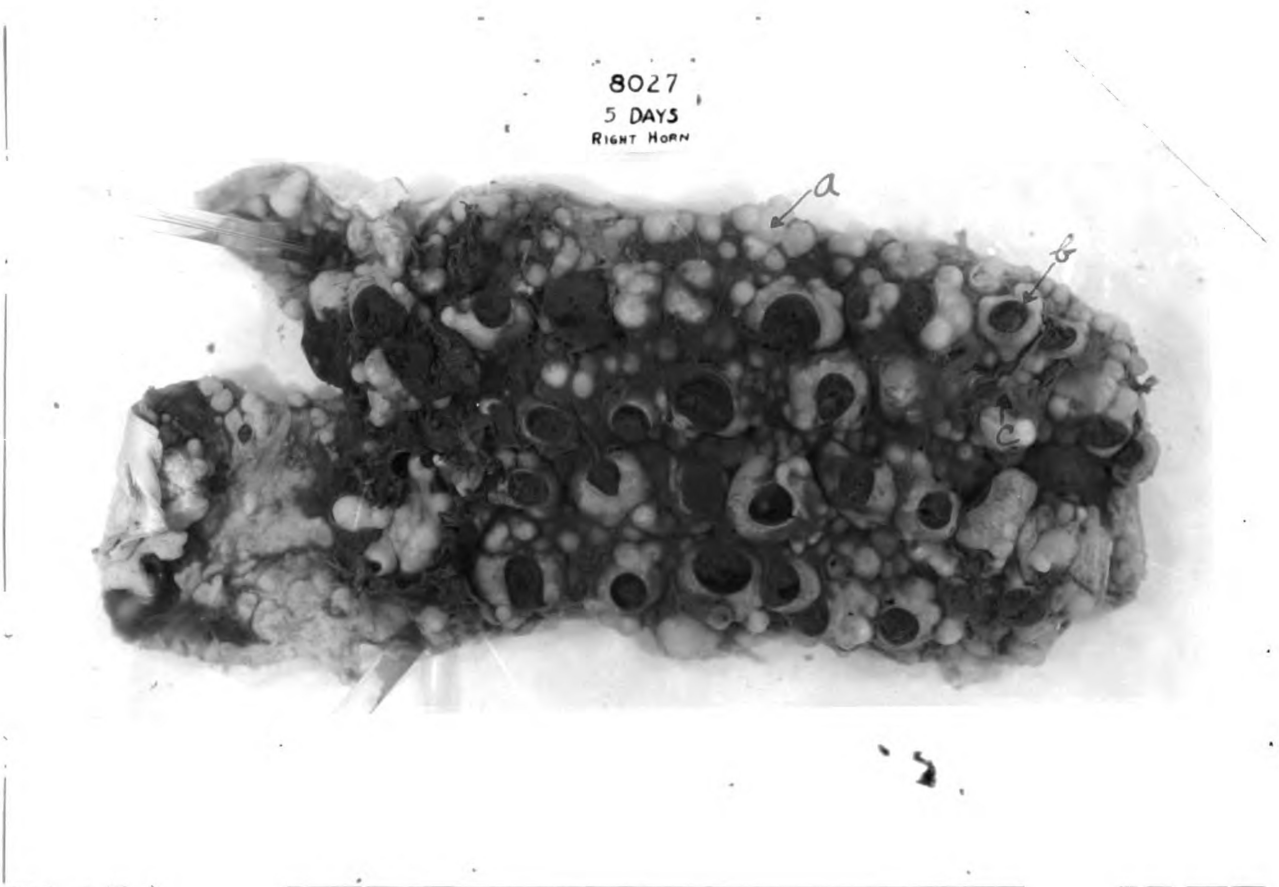

Fig. 17. Endometrium of 5th. day post-partum Uterus.
(A) retention cysts, (b) cotyledon, (c) exudate.

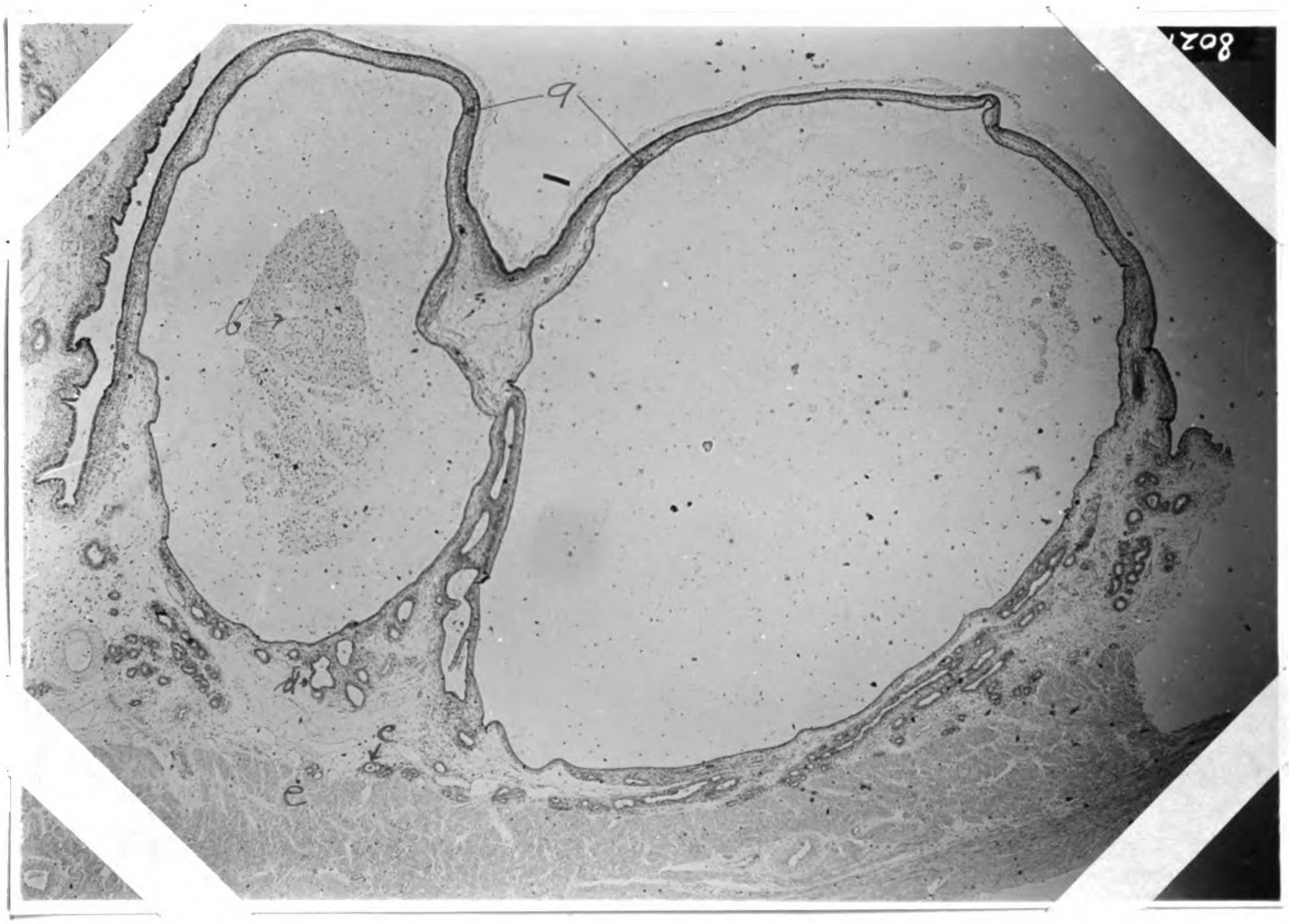

Fig. 18, X 22. Retention Cysts in Glandular Mucosa.

(A) retention cysts, (b) cellular debris in lumen of cysts, (c) uterine gland with cellular debris in lumen, (d) uterine gland with large lumen, (e) muscular wall of uterus.

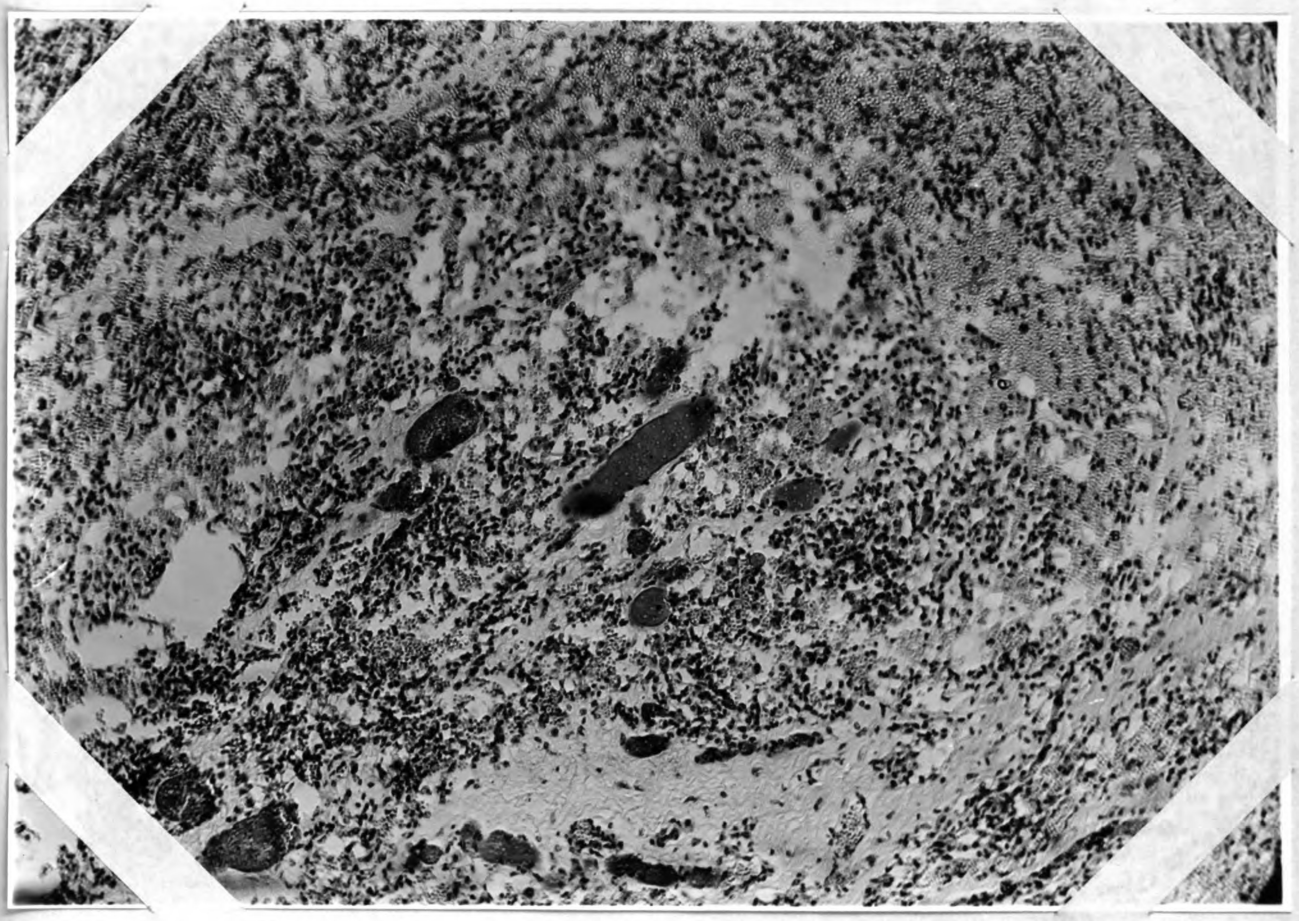

Fig. 19, X 75. Foetal Placenta of 5th. Day Postpartum Chorion.

(A) necrotic cells of foetal villi, (b) red blood cells, (c) blood vessel.

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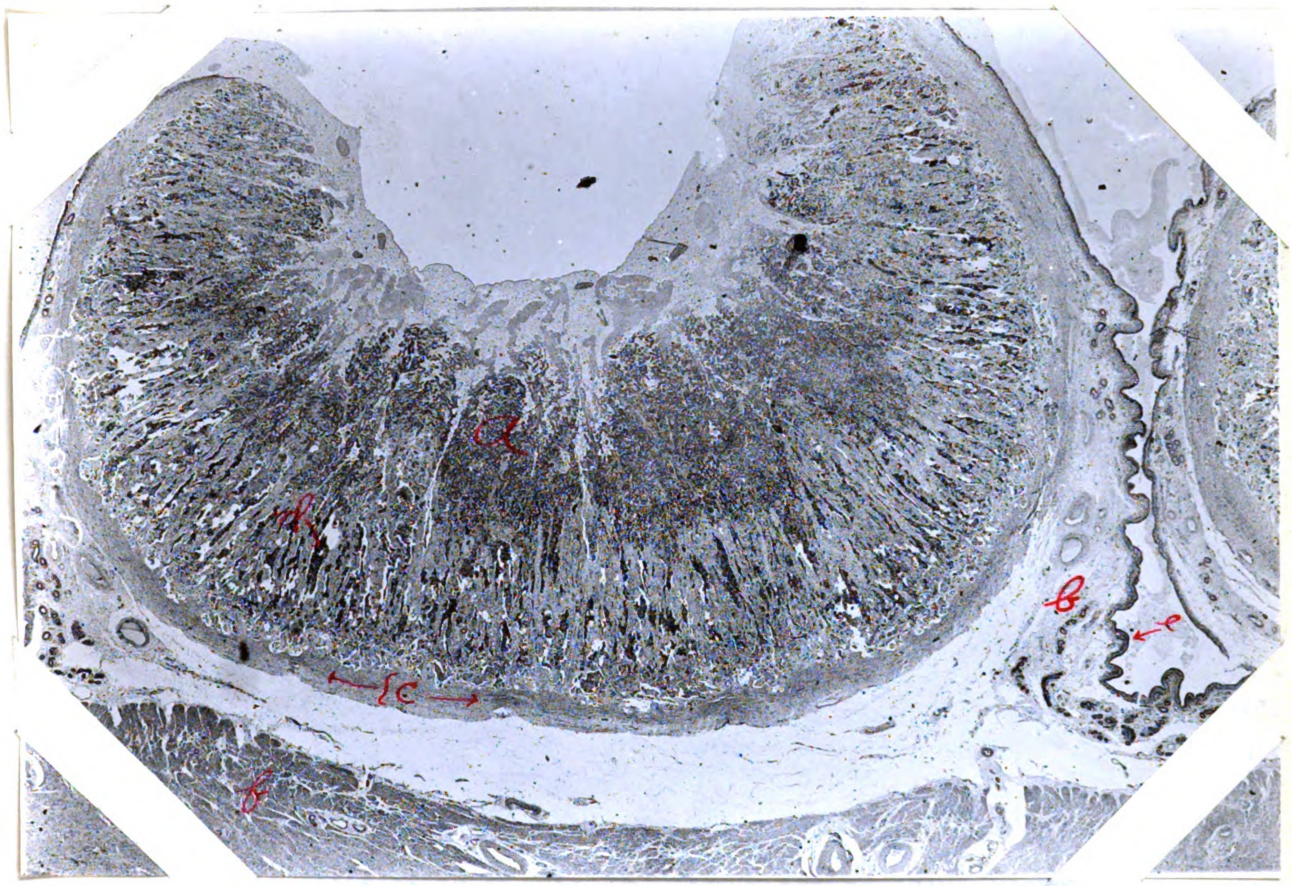

Fig. 20, X 12-1/2. Cotyledon 6th Day Postpartum.

(A) decidual crypt mass, (b) glandular mucosa with but few connective tissue cells, (c) placental matrix cells, (d) portions of chorionic villi retained in crypts, (e) epithelium of glandular mucosa, (f) muscular wall of uterus.

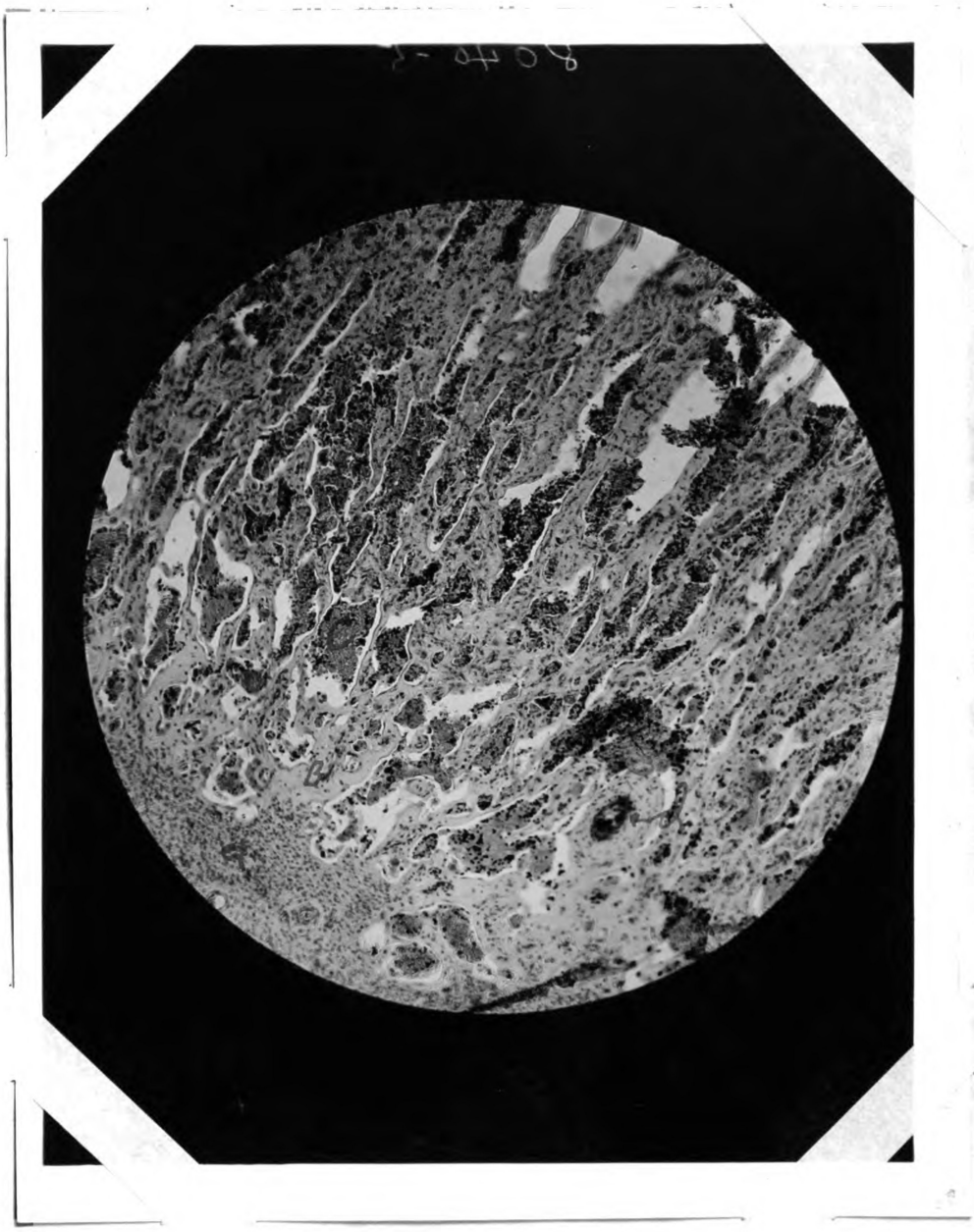

Fig. 21, X 150. Portion of Cotyledon 6th. day Post-partum.

(A) placental matrix cells, (b) line of hyaline degeneration, (c) portion of chorionic villus in crypt, (d) thrombosed blood vessel in crypt wall.

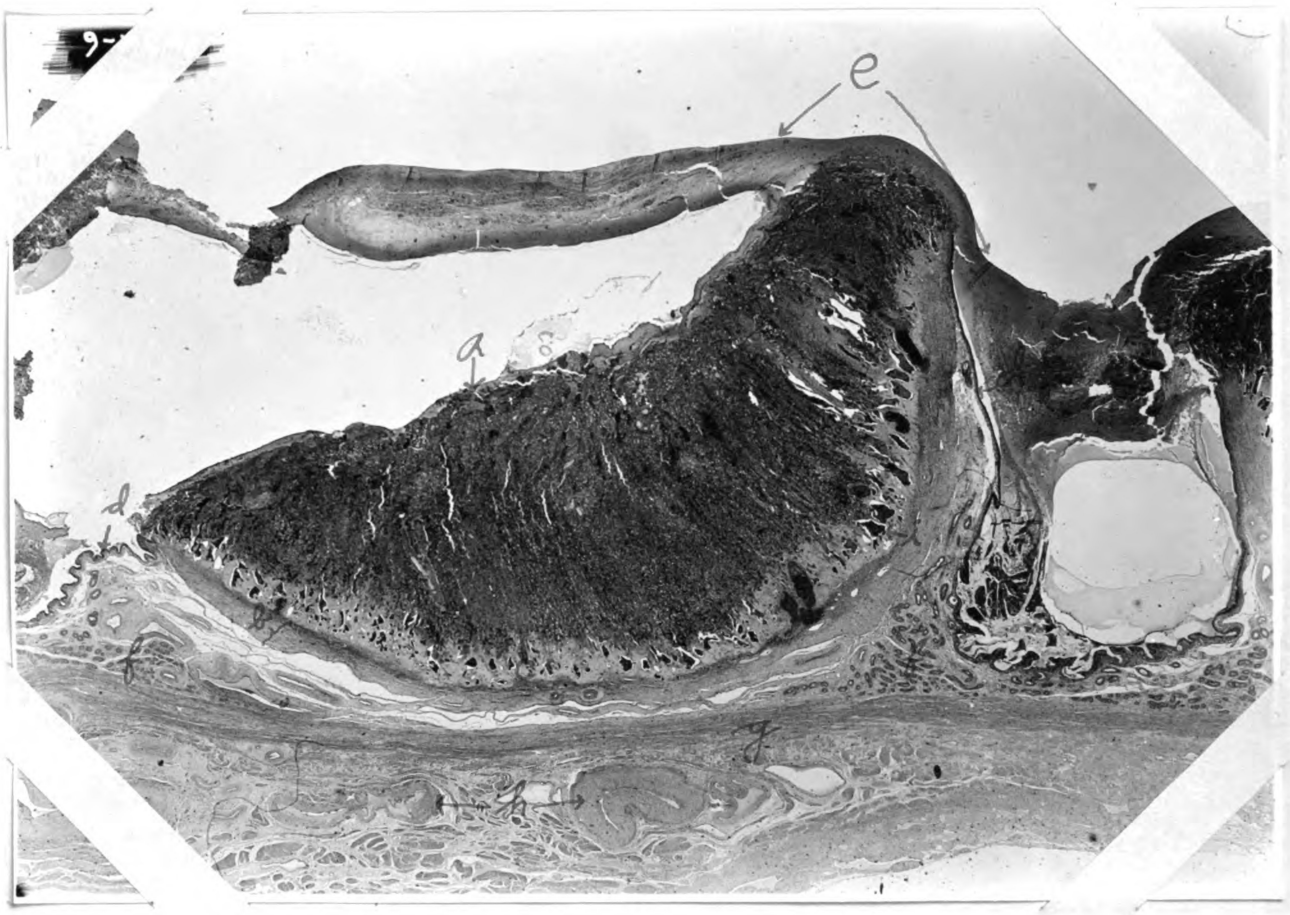

Fig. 22, X 12-1/2. Cotyledon of 7th Day Postpartum Uterus.

(A) decidual crypt mass, (b) placental matrix band, (c) periphery of crypt mass, (d) epithelium of glandular mucosa, (e) exfoliated crypt cells in exudate, (f) uterine glands, (g) muscular wall of uterus, (h) lumen of blood vessels being reduced by proliferation of intima, (i) portion of chorionic villus in crypt.

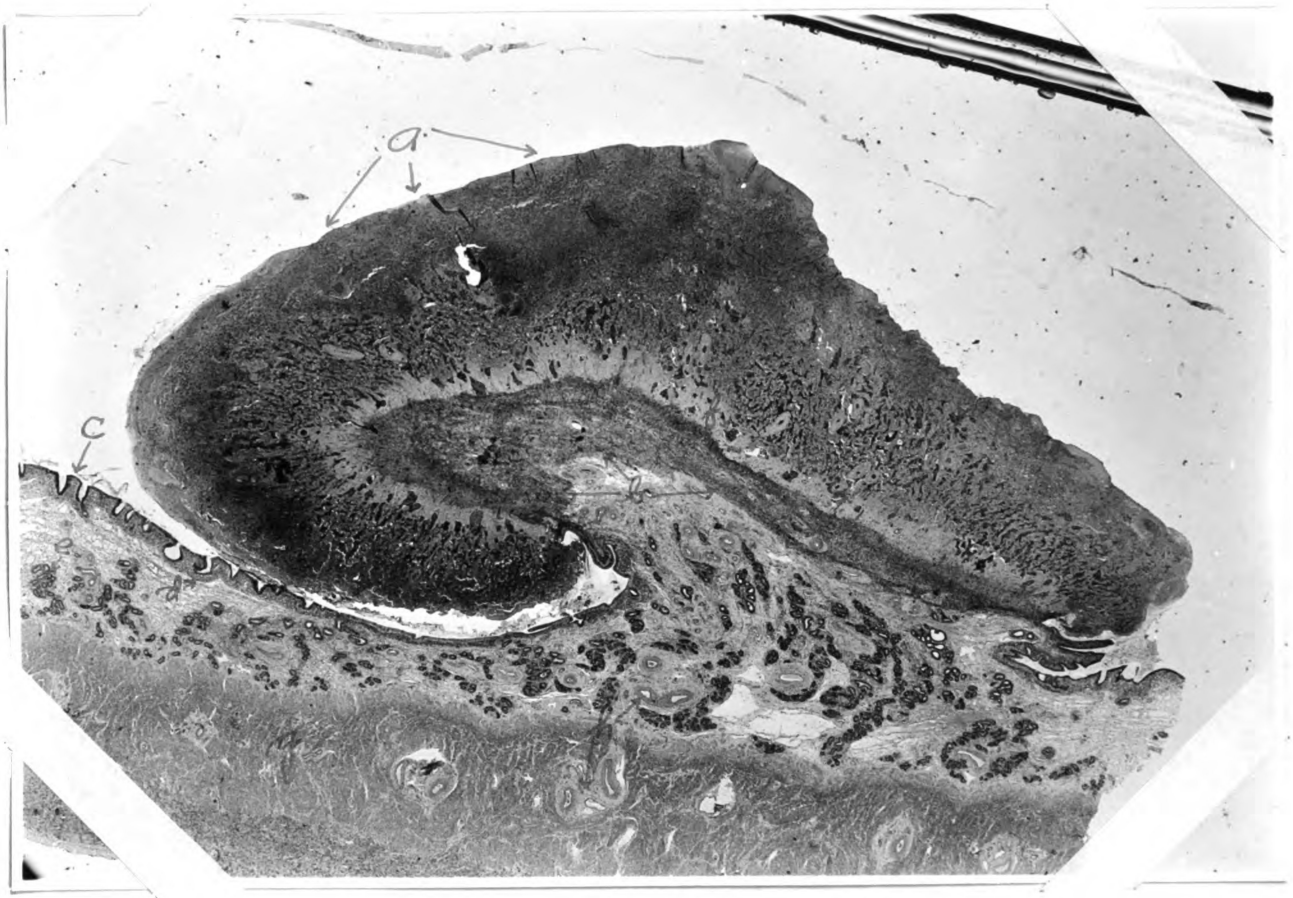

Fig. 23, X 12-1/2. Cotyledon 9th. day Post-partum Uterus.

(A) decidual crypt mass, (b) placental matrix cells, (c) epithelium of glandular mucosa, (d) dense connective tissue under epithelium, (e) uterine glands, (f) portion of chorionic villus, (g) muscular wall, (h) blood vessels.

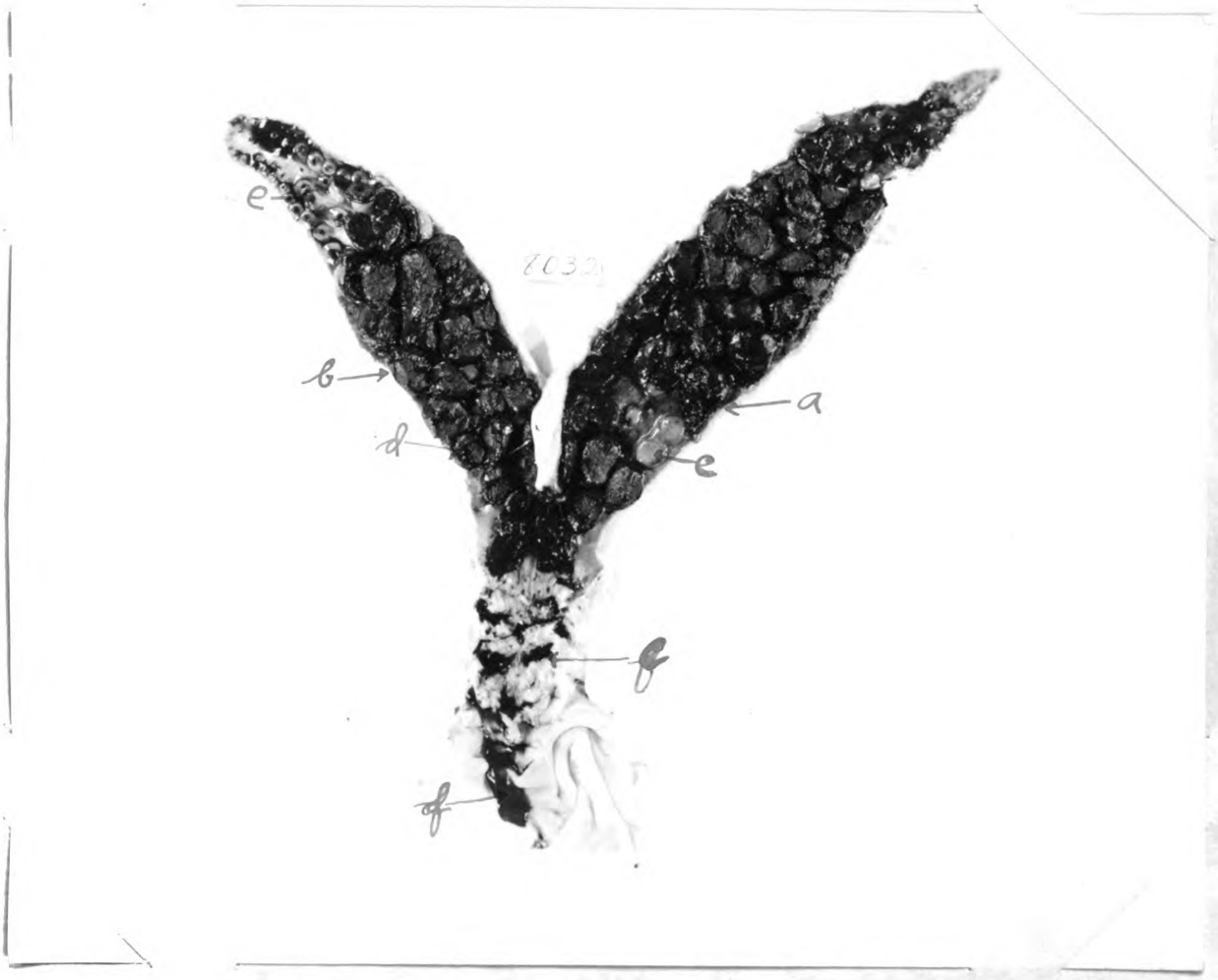

Fig. 24. Endometrium 10th. day Post-partum Uterus.

(A) right horn, (b) left horn, (c) cotyledons from which the decidual crypt mass has been removed, (d) cotyledon with the decidual crypt mass, (e) small cotyledons at horn tip much further advanced in involution, (f) lochia in lumen of cervix.

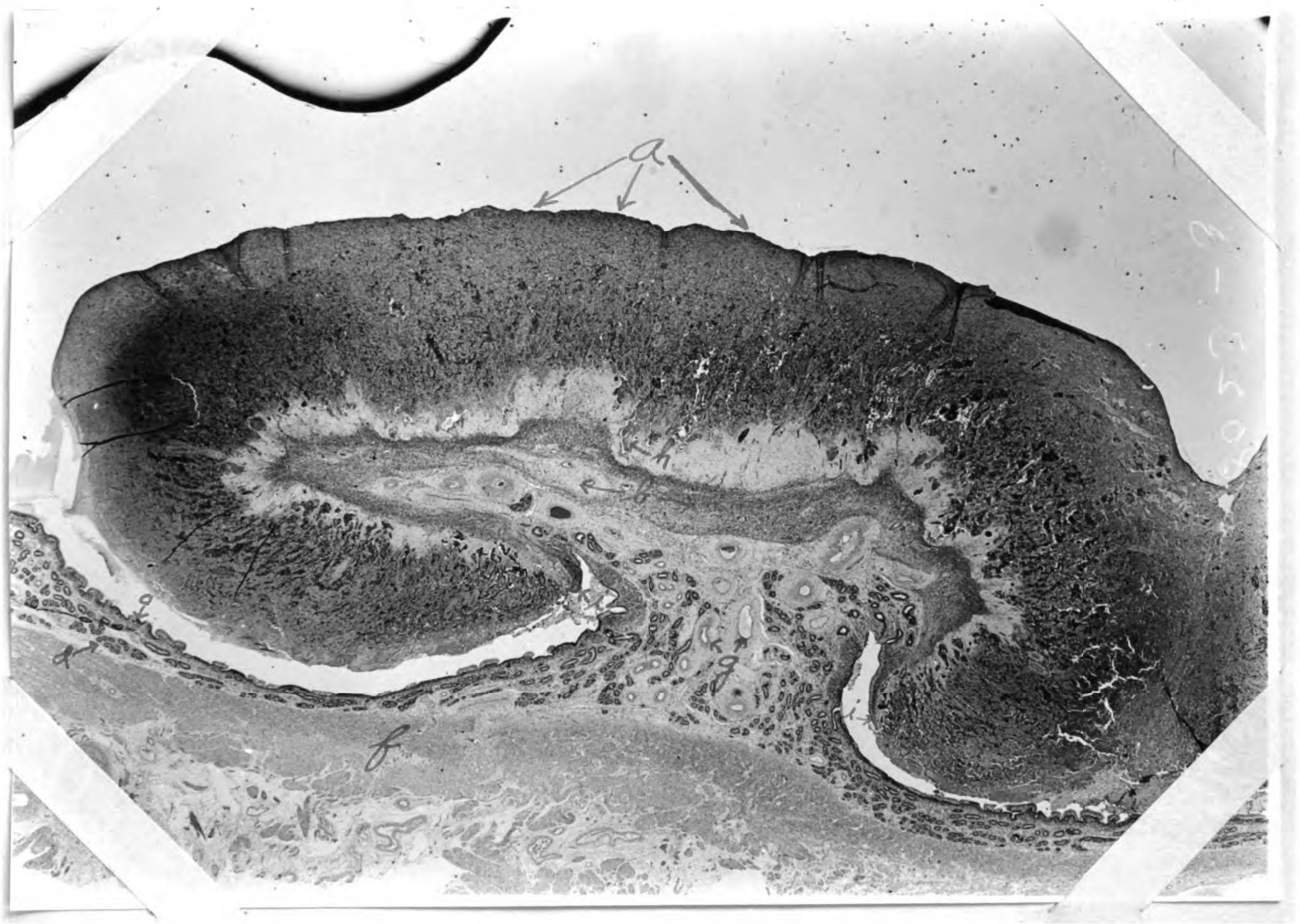

Fig. 25, X 12-1/2. Cotyledon 10th. Day Postpartum Uterus.

(A) decidual crypt mass, (b) placental matrix cells, (c) epithelium of glandular mucosa, (d) uterine glands, (f) muscular wall, (g) blood vessels, (h) portions of chorionic villus, (i) point at which the glandular epithelium circumscribed opening into cotyledon.

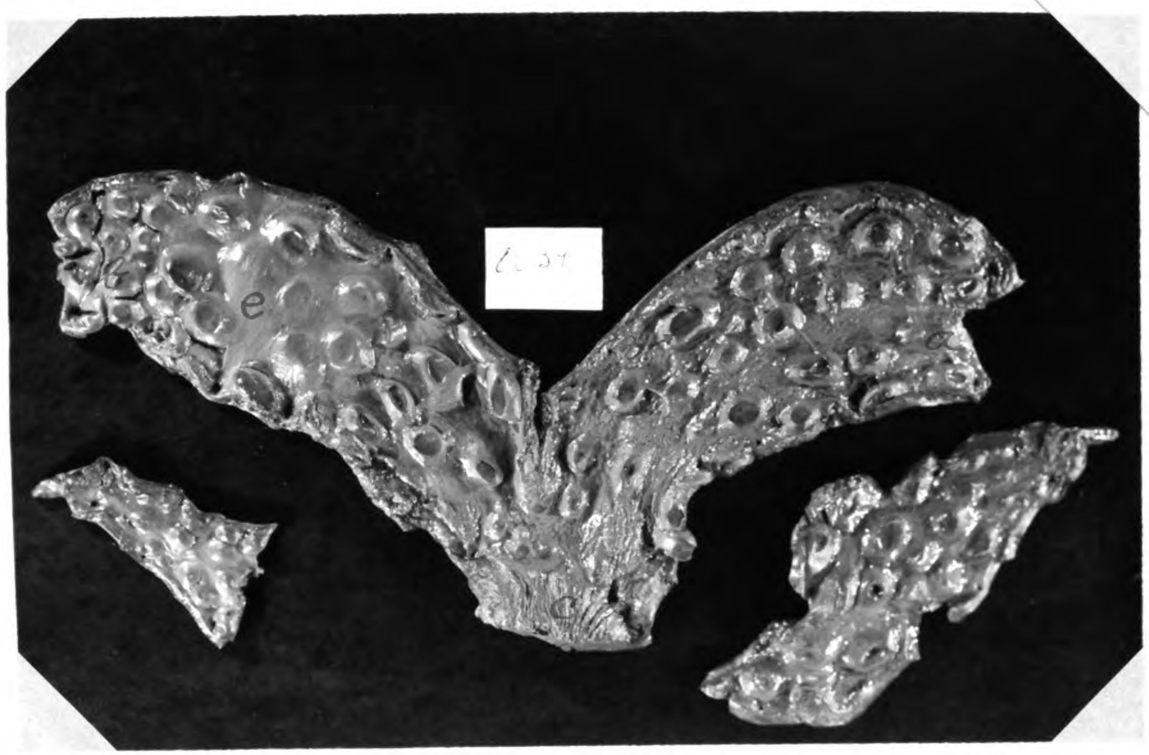

Fig. 26. Endometrium 11th. Day Postpartum Uterus.

(A) right horn, (b) left horn, (c) cervix, (d) cotyledon, (e) thick white exudate.

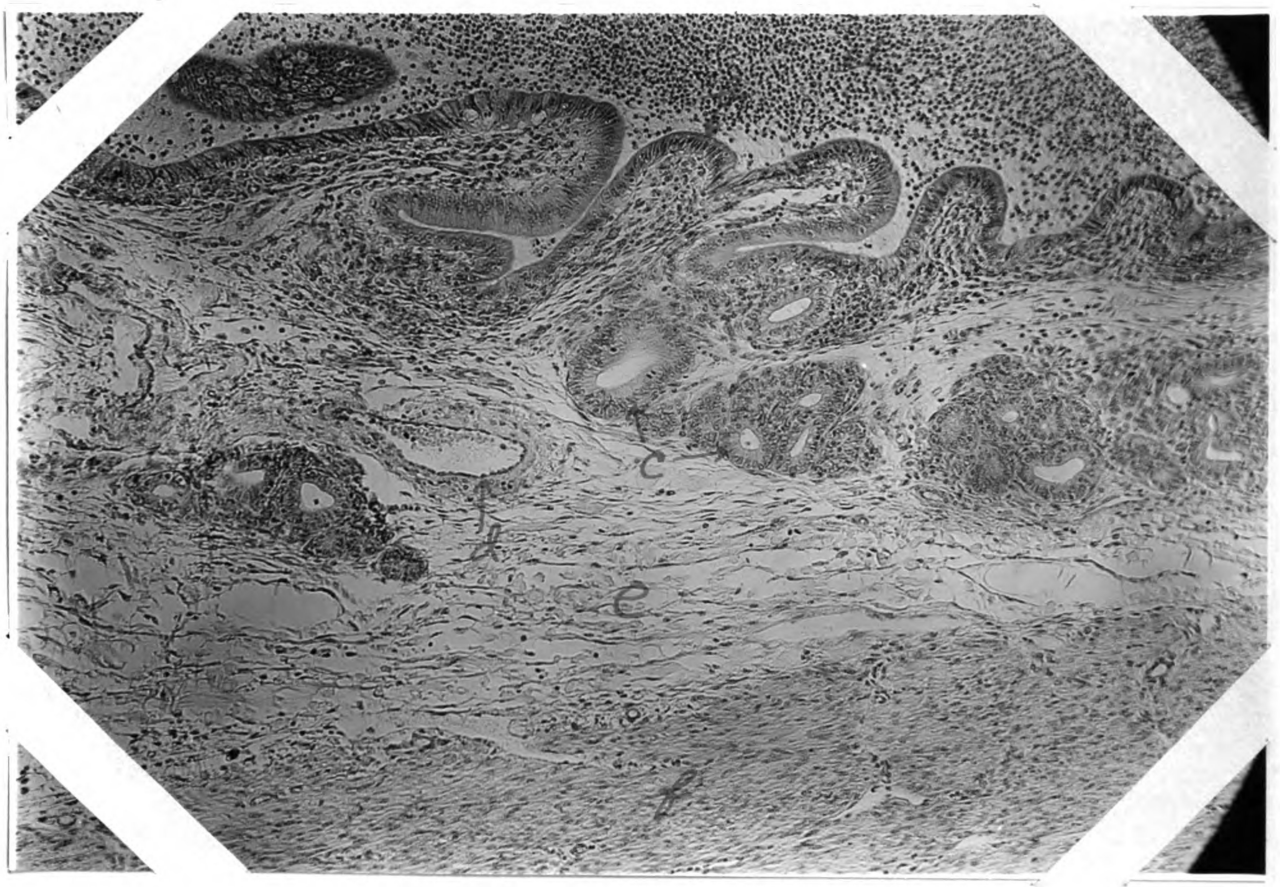

Fig. 27, X 26. Glandular Mucosa 11th. Day Postpartum.

(A) Leucocytes on epithelium, (b) epithelium, (c) uterine glands, (d) blood vessel, (e) connective tissue of mucosa, (f) muscular wall of uterus.

Fig. 28, X 20. Cotyledon 11th. Day Postpartum.

(A) placental matrix cells, (b) leucocytes, (c) light area from which the decidual crypt mass has been denuded, (d) epithelium over glandular mucosa, (e) uterine glands, (f) blood vessel, (g) connective tissue of glandular mucosa.

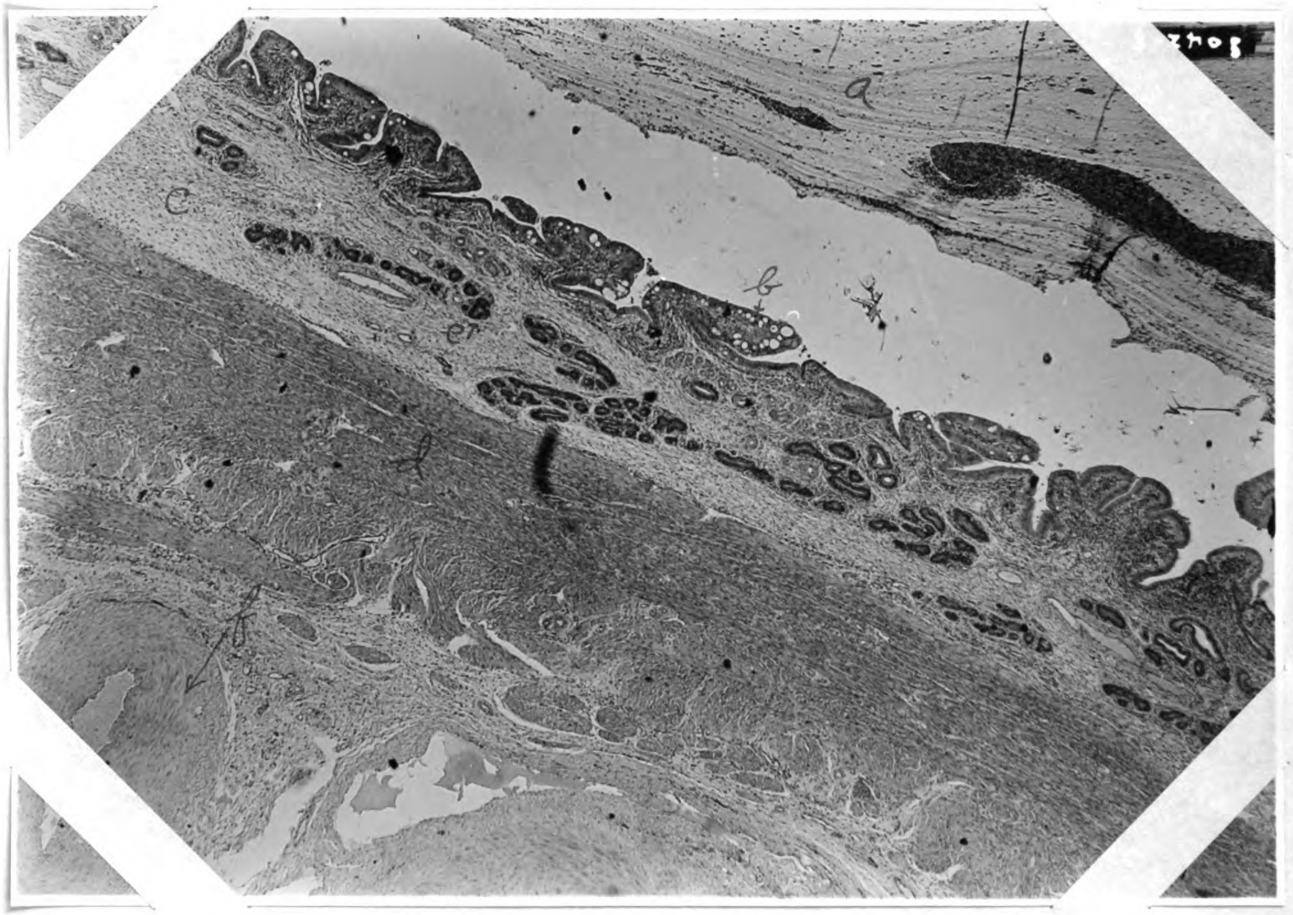

Fig. 29, X 36. Glandular Mucosa 12th day Post-partum.

(A) exudate overlying epithelium, (b) epithelial cells in process of vacuolar degeneration, (c) connective tissue of glandular mucosa, (d) muscular wall, (e) uterine glands, (f) blood vessel.

Fig. 30, X 10. Cotyledon 12th. Day Postpartum.

(A) decidual crypt mass, (b) placental matrix cells, (c) epithelium over glandular mucosa, (d) muscular wall of uterus, (e) blood vessels in loose connective tissue of mucosa under placental matrix cells, (f) uterine glands.

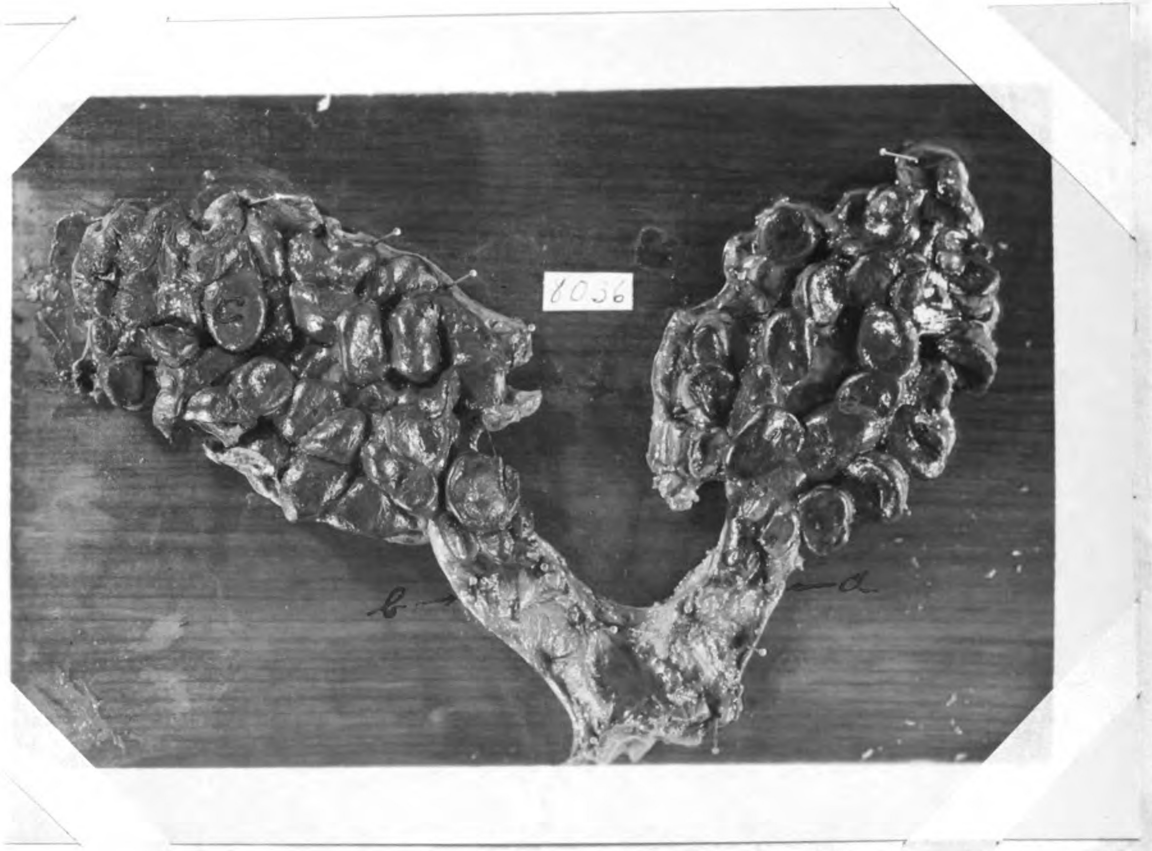

Fig. 31. Endometrium 13th. Day Postpartum Uterus.

(A) right horn, (b) left horn, (c) cotyledon, (d) cotyledon from which the decidual crypt mass was removed.

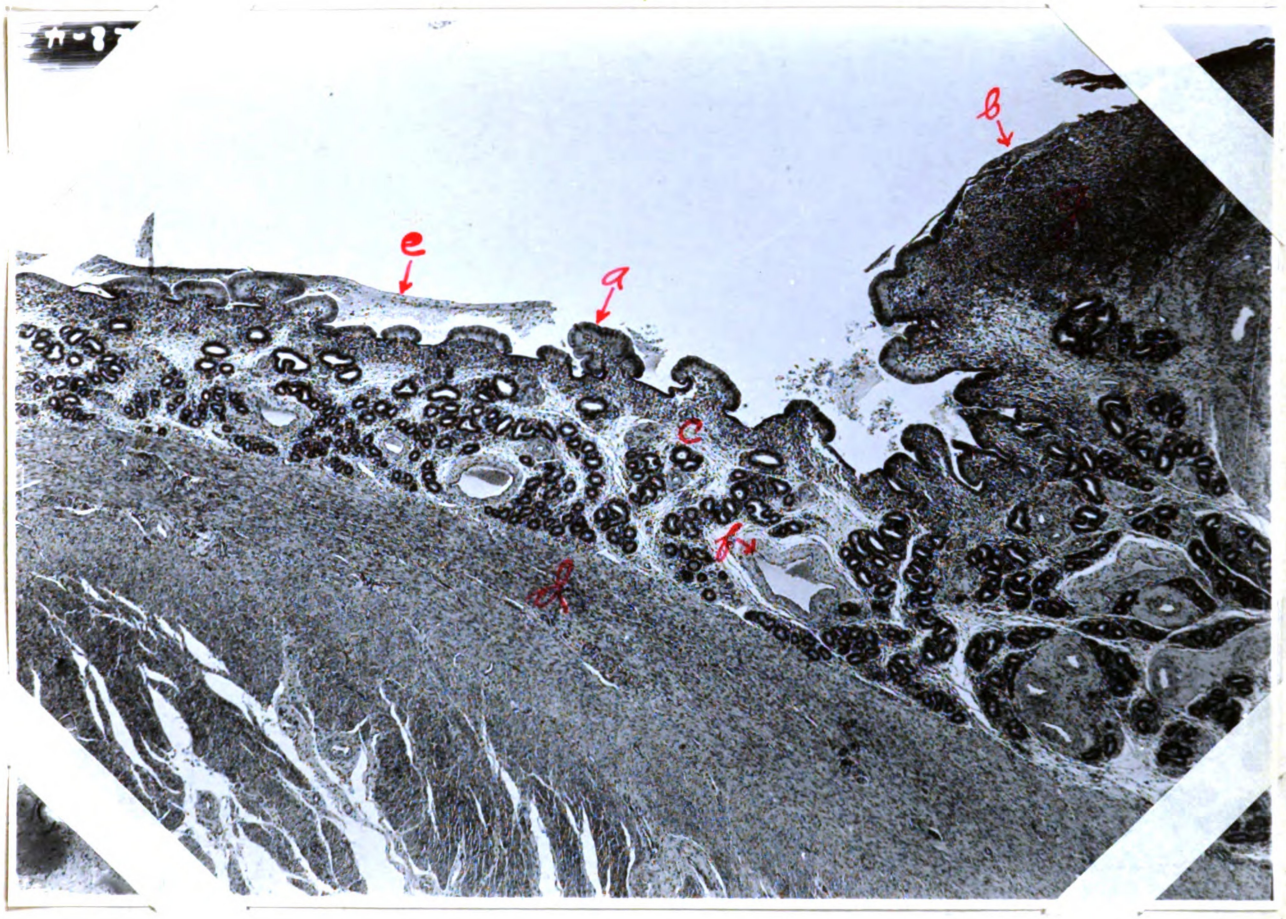

Fig. 32, X 36. Glandular Mucosa 14th. Day Postpartum.

(A) epithelium, (b) epithelium beginning to spread over placental matrix cells, (c) connective tissue of mucosa, (d) muscular wall of uterus, (e) exudate overlying mucosa, (f) blood vessel, (g) placental matrix cells.

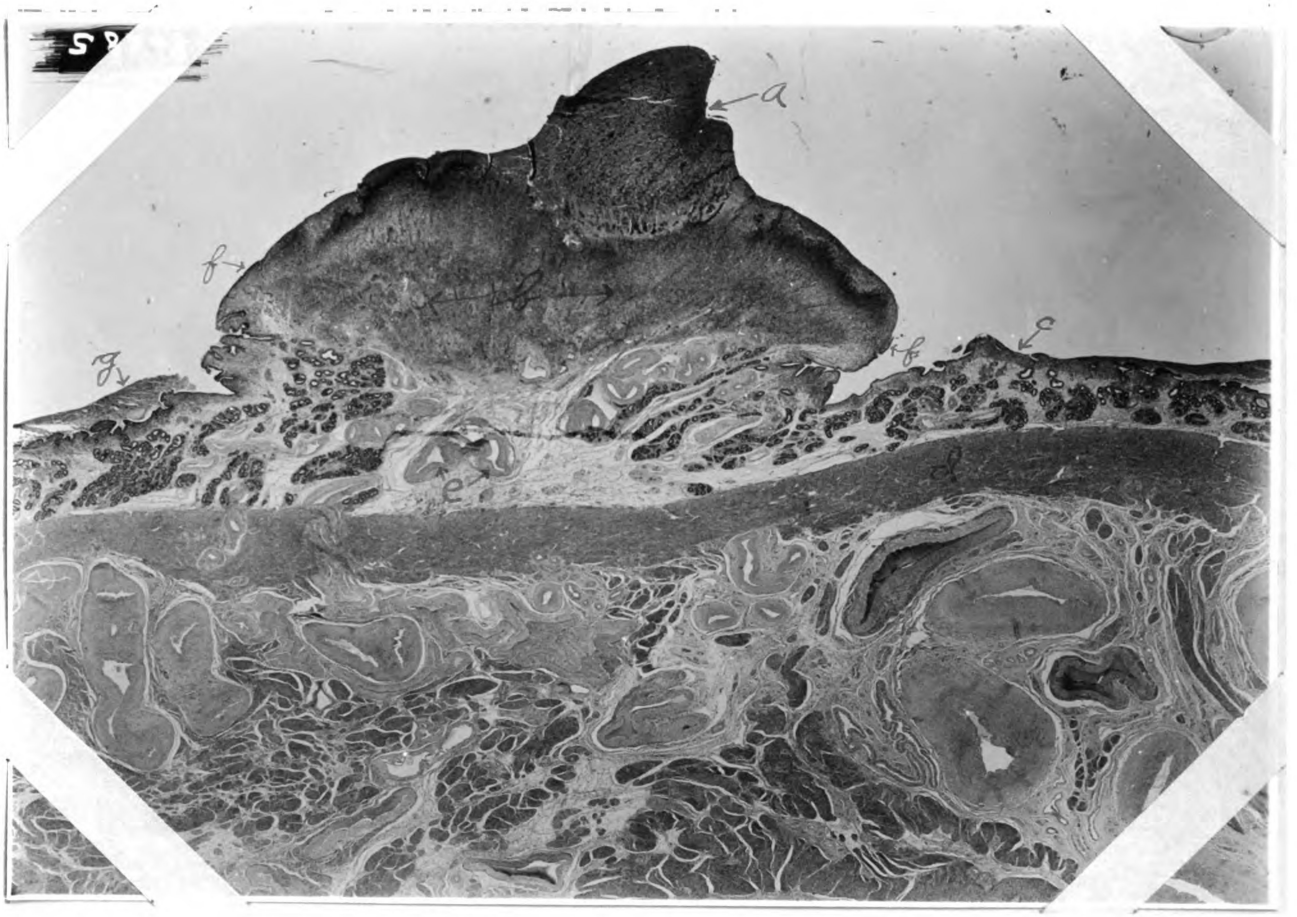

Fig. 33, X 16. Cotyledon 14th. Day Postpartum.

(A) decidual crypt mass, (b) placental matrix cells, (c) epithelium of glandular mucosa, (d) muscular wall of uterus, (e) blood vessels, (f) epithelium spreading over matrix cells, (g) exudate lying on mucosa.

Fig. 34. Endometrium 16th. day Post-partum Uterus.

(A) right horn, (b) left horn, (c) cotyledon, (d) cotyledon from which decidual crypt mass was removed, (e) lochia in lumen of cervix.

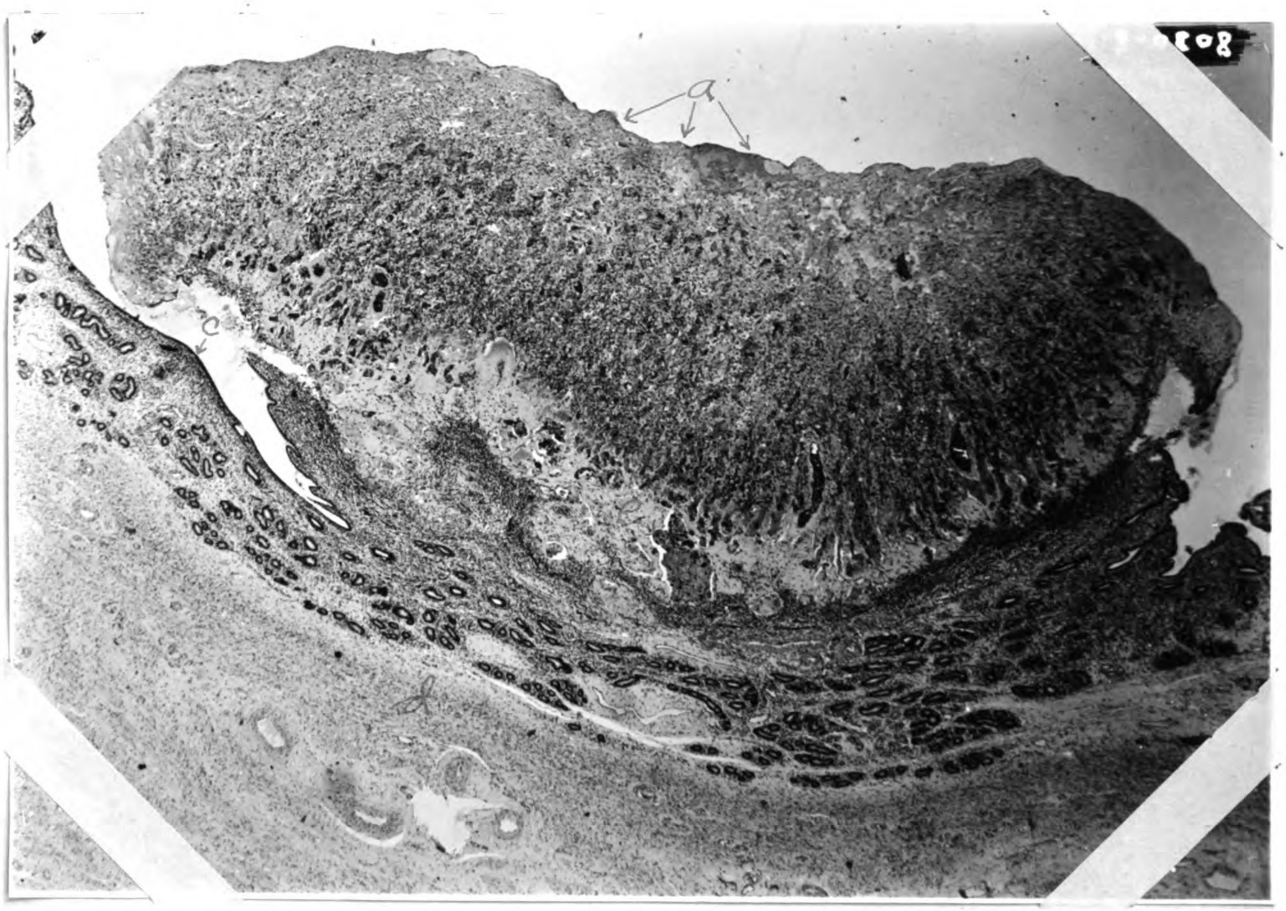

Fig. 35, X 32. Cotyledon 16th. Day Postpartum.

(A) decidual crypt mass, (b) placental matrix cells, (c) epithelium on glandular mucosa, (d) muscular wall of uterus, (e) portion of retained chorionic villus.

Fig. 36. Endometrium 17th. Day Postpartum Uterus.

(A) right horn, (b) left horn, (c) cervix, (d) cotyledon.

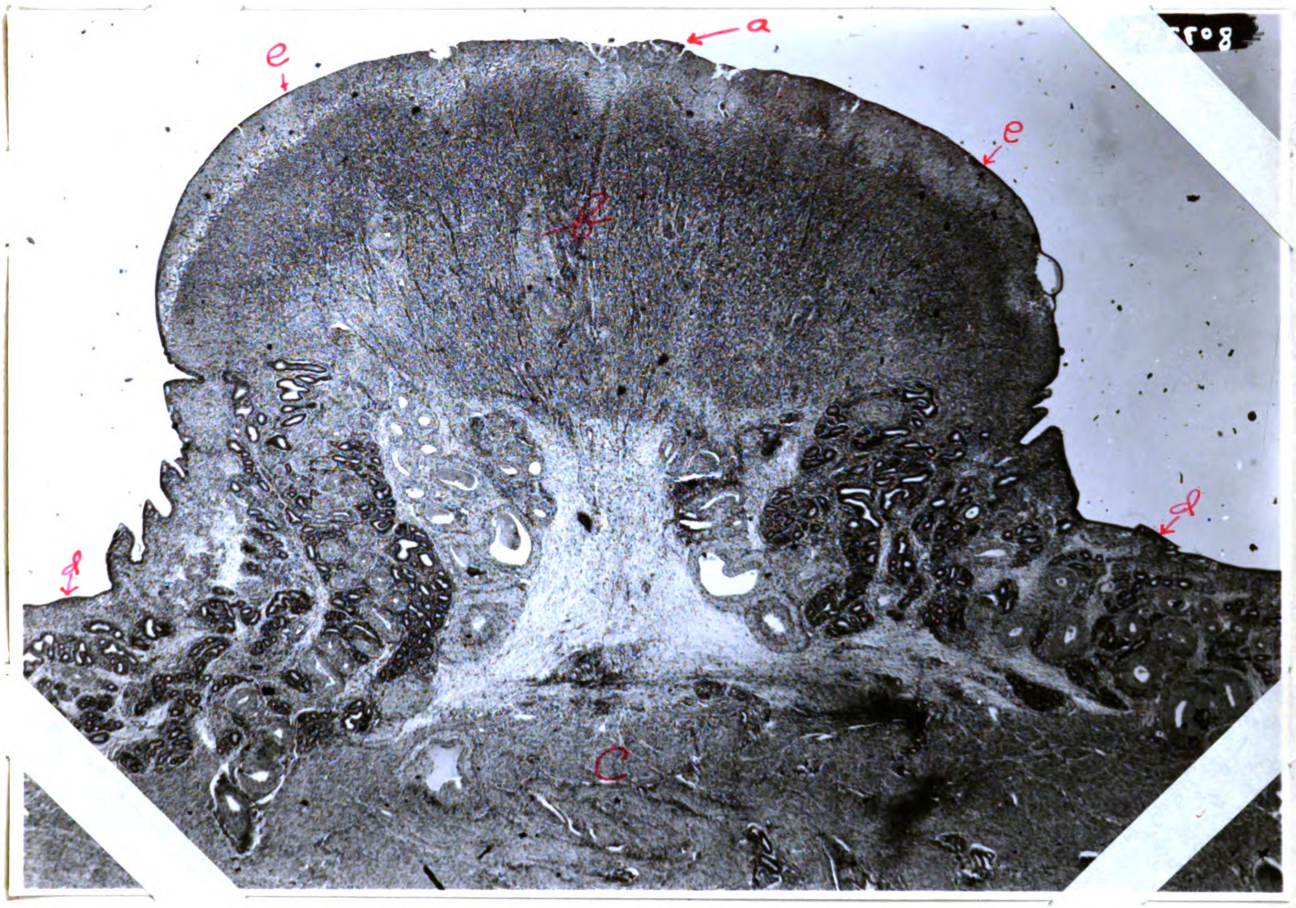

Fig. 37, X 26. Cotyledon 17th. Day Postpartum.

(A) small amount of decidual tissue, (b) placental matrix cells, (c) muscular walls, (d) epithelium on glandular mucosa, (e) epithelium spreading in and covering placental matrix cells.

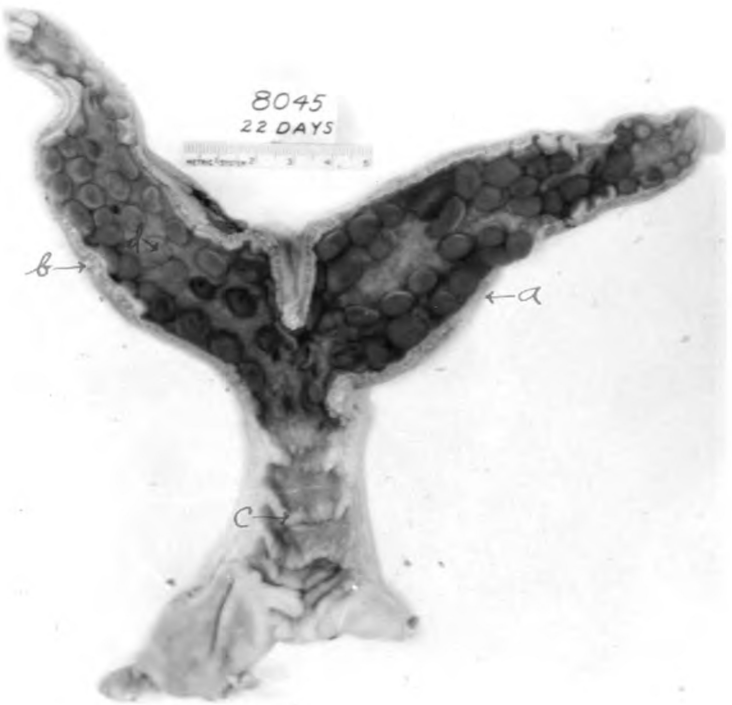

Fig. 38. Endometrium 22nd. Day Postpartum Uterus.
(A) right horn, (b) left horn, (c) cervix, (d) cotyledon.

Fig. 39, X 26. Cotyledon 22nd. Day Postpartum.

(A) small amount of decidual tissue, (b) placental matrix cells, (c) epithelium over glandular mucosa, (d) muscular wall of uterus, (e) blood vessels.

Fig. 40, X 28. Cotyledon 26th. Day Postpartum.

(A) small amount of decidual tissue, (b) placental matrix cells, (c) muscular wall of uterus, (d) blood vessels, (e) epithelium over glandular mucosa, (f) epithelium spreading over matrix cells.

Fig. 41. Endometrium 30th. Day Postpartum Uterus.

(A) right horn, (b) left horn, (c) cervix, (d) cotyledon, (e) retained foetal membranes.

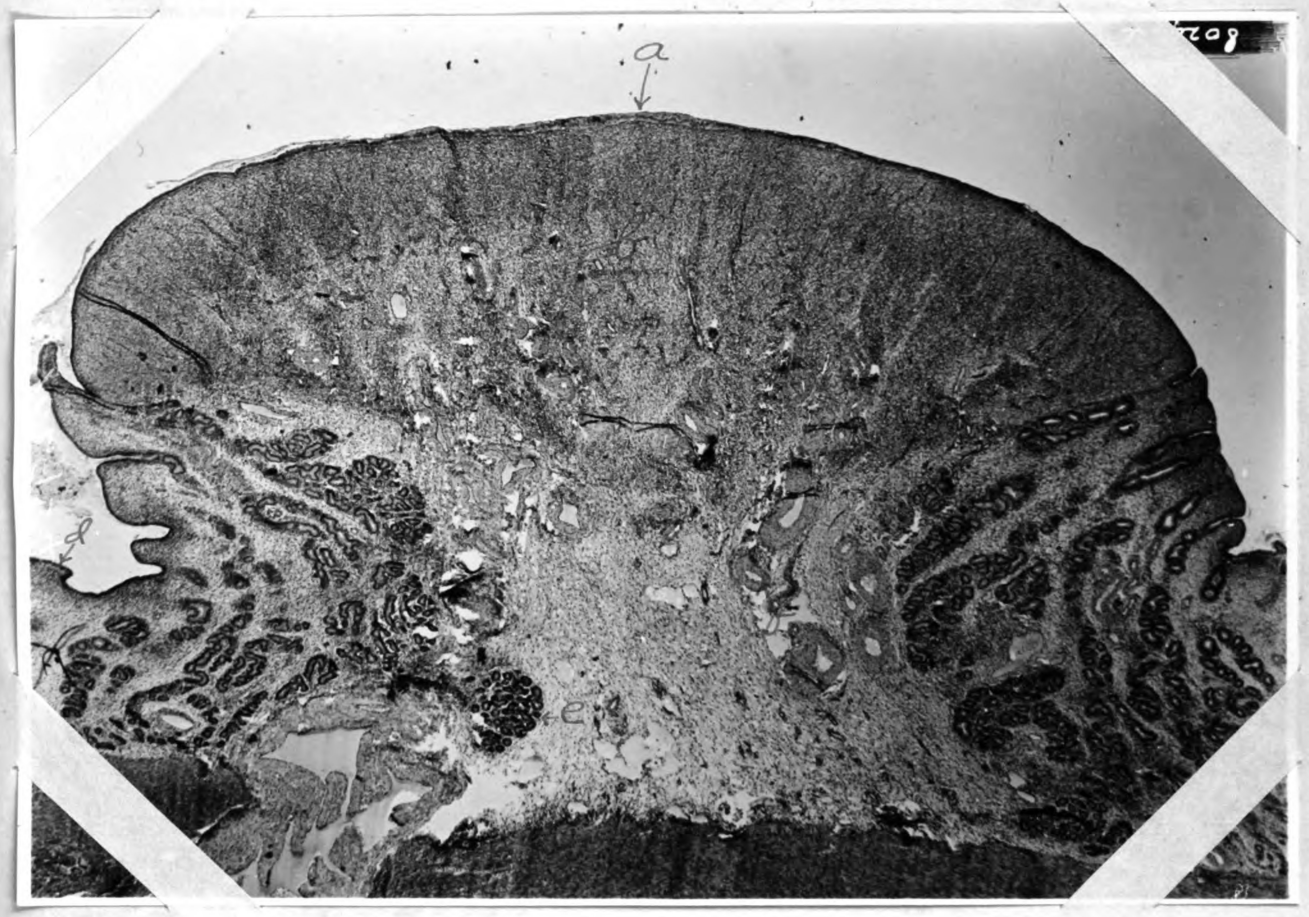

Fig. 42, X 28. Cotyledon 30th. Day Postpartum.

(A) placental matrix cells completely covered with epithelium, (b) placental matrix cells (caruncle), (c) muscular wall, (d) epithelium on glandular mucosa, (e) uterine glands, (f) blood vessel.

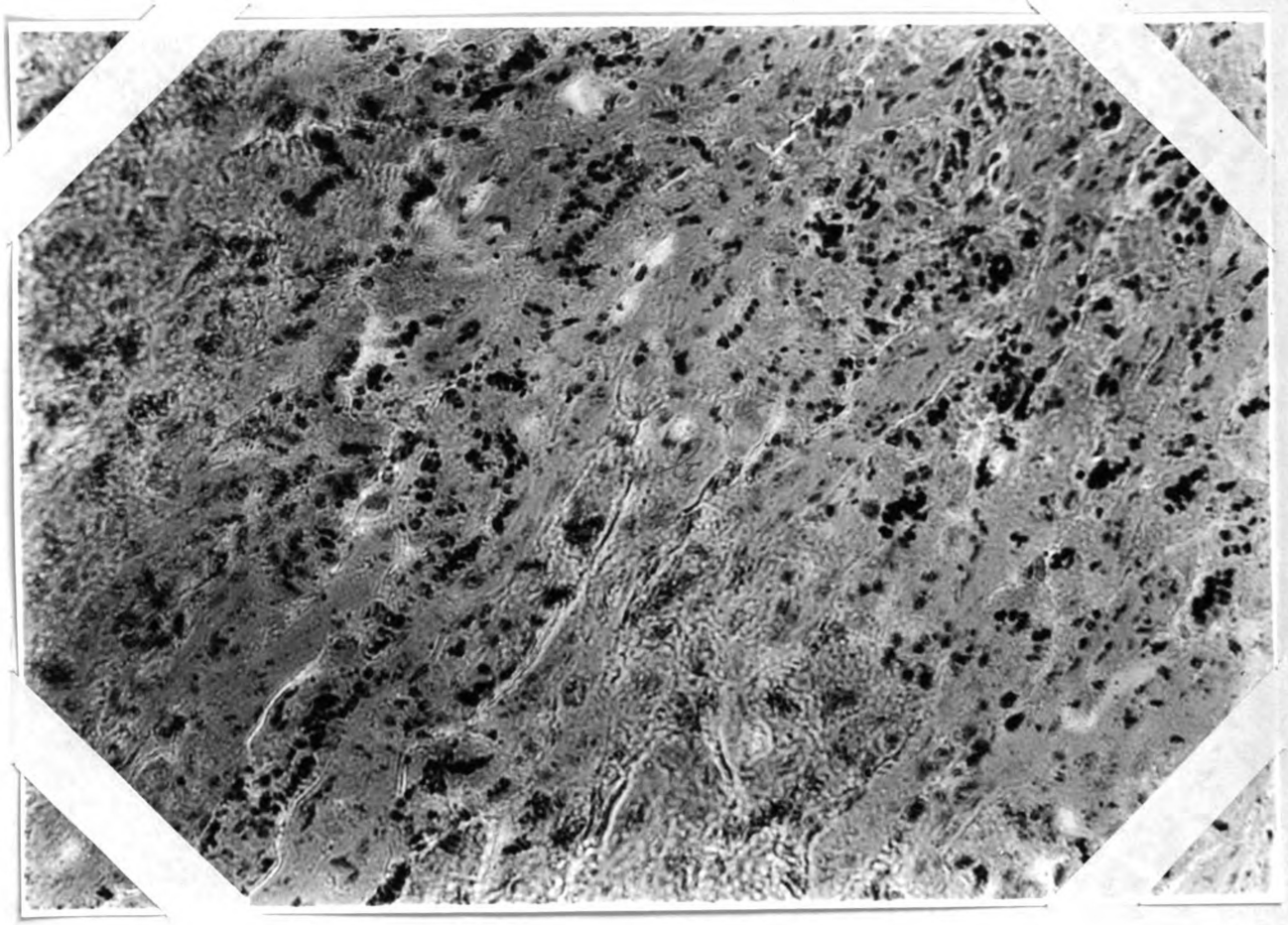

Fig. 43, X 350. Retained Foetal Membranes 30th Day Postpartum Uterus.

(A) probably a chorionic villus, (b) necrotic cells.

ACKNOWLEDGEMENT

I wish to acknowledge my indebtedness to Dr. E. T. Hallman, Professor of Animal Pathology, who made the investigation possible and who has willingly throughout the course of the investigation given me the benefit of his advice and wide experience.

Andrew Waldmere Uren