Observations on the Ovaries of Infertile and Reportedly Infertile Dairy Cattle with Reference to the Pathologic Aspects

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Introduction

Considerable material has been published on mammalian ovaries over the past three hundred years since Reijnier de Graaf first reported on the follicular structures that bear his name. However, the bovine ovary has received relatively little attention. Such work as has been done with cattle has for the most part been either clinical or therapeutic in nature, with pathologic and histopathologic considerations subordinated to a relatively minor role.

It was felt that a study of the bovine ovaries from a histopathological point of view would be of value in developing a broader base for future investigations. The work presented here makes no pretense of being complete, and is only a small contribution to an enormous field, yet within its modest scope certain aspects have been brought to light that show the need for more basic work to determine the facts necessary for the understanding and possible solution of reproductive disorders in cattle.

Review of Literature

Rabl (24) in 1898 published the first accurate histological study of the development of graafian follicle and the corpus luteum in the bovine. Corner (8) in 1919, working with swine, confirmed much of Rabl's work and corrected some minor details wherein Rabl was in error. Elder (10) in 1925 made some excellent observations on the relationship of cystic corpora lutea and corpora rubra to the fertility status of cattle. McNutt (18) in 1926 published a detailed and generally accurate study of the gross and microscopic aspects of the bovine corpus luteum in relationship to the estrus cycle and followed this work with additional material on the corpus luteum of pregnancy in 1927 (19). Hammond (12) in 1927 published a monumental work on the various aspects of bovine reproductive physiology and gathered together in one volume most of the significant observations prior to that date. Quinlan (23) in 1928 investigated tubal and vaginal pathology. Küpfer (16) in 1928 de-
terminated the average sexual cycle of cattle and the periodicity of estrum. Westman (35) in 1928, working with rabbit ovaries, showed that the theca interna cells are incapable of forming a corpus luteum in the absence of the granulosa. Pines (22) in 1931 discovered ganglion cells in the hilar regions of the ovaries of several species of animals, and traced terminations of ovarian nerves to the follicle walls, corpora lutea, and stroma. Cole (7) in 1930 reported on the cellular changes in the vaginal and cervical mucosa of cattle during the estrus cycle and pregnancy. Salazar (26) in 1931 published data on the formation and cellular origins of corpora lutea atretica and the process of atresia as it affects primary follicles. Borug (2) in 1932 made acute observations upon the effect of corpora lutea atretica on immature rat ovaries, producing cellular changes similar to gestation in the subject animals. Wallart (33) in 1934 presented a detailed study of the cellular constituents of the cortical margin and stroma of several species of animals. Seiferle (27) in 1936 studied the formation and function of the interstitial cells of the ovary. Reece and Turner (25) in 1938 determined the relative sizes and functional activity of the right and left ovaries of cattle. Mitchell (20) in 1938 reported on the innervation of the ovaries and fallopian tubes and determined that the nerve supply was chiefly sympathetic, with some visceral sensory and motor fibers, and no parasympathetic. Kaay (15) in 1942 reinvestigated the corpus luteum of pregnancy in cattle and confirmed McNutt’s (19) original observations that regressive changes occurred commencing about the fifth month of gestation. Thygesen (30) in 1949 published data on ovarian adhesions in cattle, their frequency of occurrence, cause, and effect upon fertility. De Lange (9) in 1950 studied the effect of delayed breeding upon fertility in cattle and made a number of histological studies of the ovaries of his experimental animals. Lombard et al (17) in 1951 made some worthwhile observations on the pathology and histopathology of the bovine fallopian tubes. Bone (3) in 1953 studied the pathology and histopathology of the ovaries of infertile cattle. Foley and Reece (11) in 1953 made an intensive study of the histology of the bovine uterus and placenta, and some further observations of the histology of the corpus luteum that tended to confirm earlier work.

In the clinical field, particularly since the isolation of sex hormones, there is a considerably larger body of material, much of it repetitive, dealing with the clinical features of infertility, its diagnosis and treatment, and possible causes of the syndrome. A few of the numerous authors are listed in the bibliography (3, 4, 5, 12, 13, 21, 28, 29, 31, 32, 34, 36, 37).
Materials and Methods

The ovaries used in this work were obtained from cattle slaughtered at local abattoirs and from palpation of living specimens in the Oregon State College dairy herds. A total of 155 cattle of dairy type were examined postmortem. One hundred were examined for the purpose of determining normal morphology and structure, and the remaining 55 because of reported "sterility." Twenty-three of these latter cases were obtained from herds under constant veterinary supervision, while the remaining thirty-two were obtained from slaughter specimens taken at random from farms and dairies in the Willamette Valley. Arbitrarily the owner's definition of the status of fertility of the animals was accepted in making the initial studies as it was felt that this was the only proper way of assessing the overall aspects of the "sterility" problem.

Histories of each animal were obtained in as great detail as possible, and whenever possible the animal was examined antemortem for any visible or palpable abnormalities.

After slaughter the entire reproductive tract was removed, measured, and examined for any evidence of gross lesions. Selected organs and those showing lesions were photographed intact and after being opened (Figures 12 to 15). The ovaries were freed by cutting through their hilar attachments, measured, and washed in a ten per cent formalin solution to free them of debris and surface contamination. They were then divided longitudinally and fixed in ten per cent formalin or Bouin's fluid, and embedded in paraffin after Bensley's (1) technique. Sections were made at eight microns and stained with hematoxylin-eosin and Pollak's trichrome.

Bacterial assay was attempted on ovaries taken from reproductive tracts which showed inflammatory or pyogenic lesions. With one exception, the results were uniformly negative. Smears were made on nutrient agar, blood agar, and beef agar plates, and stab cultures into beef broth and thiol media.

Photographs were made of representative gross and microscopic sections, and tables were constructed to record the data gained from the examination.

Results

The results obtained in this study are shown in Tables I through III and in the comments appended below.

Pathology of the ovarian follicle

Essentially the pathology involving the follicle consisted of the following lesions: (a) failure of follicle development, and (b) cystic follicles.
The failure of follicle development as shown by this study is due to the following causes: senility, infantility, or atrophy. One example of each of these types was found in the animals examined (Cases 9, 32, and 44, Figures 4 and 5).

**Senility**

The ovaries in the senile specimen presented a waxy, yellowish appearance and a rough pitted surface. They were considerably smaller than normal, measuring 25 x 12 x 8 millimeters, and 26 x 14 x 10 millimeters for left and right respectively. There was no external evidence of either developing follicles or corpora lutea. The cut surface revealed a firm, partially fibrosed interior interspersed with numerous bands of fibrous connective tissue. There was a visible demarcation of the cortical and medullary regions, with the cortical region somewhat reduced. No follicular development was visible to the naked eye. The cut surfaces of both ovaries, however, showed numerous “red bodies” formed by old regressed corpora lutea. These were concealed from surface observation by the thickened tunica albugenia and yellow pigmentation.

Microscopically, the germinal epithelium was almost completely missing. In the few places where it remained, the cells had entirely lost their cuboidal character and had become flattened and pyknotic. The tunica albugenia was thickened and the cells were denser and more closely grouped than in young specimens. The cortical area was reduced and the thin fibrous connective tissue strands separating the whorl-like portions of the cortical connective tissue were more apparent. Few primary follicles could be demonstrated, there being less than two follicles per field when examined under low power of the microscope. Such follicles as were seen showed various features of atresia in the great majority of cases. There were considerable numbers of corpora lutea atretica but no evidence of functioning true lutein tissue.

**Infantility**

In the infantile specimen (Figure 5), gross examination revealed the exterior of the ovaries to be very smooth, yellowish-white in color, considerably laterally compressed, and showing no areas or protrusions indicative of either follicular or luteal development. The cut surface revealed a homogenous and apparently fibrous structure that showed no grossly apparent divisions into cortex and medulla. The capsule appeared to be thickened, and the intense vascularization of the hilar portions of normal ovaries was not present. There were no grossly apparent follicular structures.

The germinal epithelium could not be demonstrated; the tunica albugenia was thickened and extensive forming a well-demarcated
Microscopic examination revealed extensive shrinking and pyknosis of the cellular constituents. The germinal epithelium appeared as a thin layer of flattened cells. The tunica albugenia was palely eosinophilic, with the nuclear elements small, dark, and spindle shaped. The cortex showed extensive pyknosis of the connective tissue cells and no demonstrable follicular structures. There was no thickening of the tunica albugenia and no follicular structures could be seen with the naked eye.

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Cystic follicles

Follicular cysts are one of the principal pathologic conditions associated with infertility. In this study, 16 cases examined had some degree of cyst formation. (Tables I and II.) They consisted of large, tense, fluid-filled cavities ranging from 5 to 42 millimeters in diameter and were not accompanied by a functional corpus luteum in either ovary. (Figures 14 and 15).

Microscopically, the cysts usually showed the presence of a granulosa. In cysts of long standing the granulosa was completely absent, but normally some traces of it remained. The theca externa was thickened and fibrosed and the normal structure of the ovary so distorted that it was impossible to find any clear demarcation between the remnants of the cortex and the medulla. The cortical portion of the ovary was greatly reduced, and the medulla com-
pressed and distorted. The germinal epithelium was ordinarily completely missing, or when present was found only on those portions of the surface not incorporated into the dome of the cyst. The tunica albugenina was uniformly thickened, and in the cyst region was incorporated indistinguishably into the cyst wall. The fluid contents were markedly eosinophilic in character, showing the presence of chromophil granules lying along the inner portion of the cyst wall (Figure 11).

In four instances in this study, cysts were found in which the granulosa was completely missing (Figure 11), the wall being formed entirely of fibrocytes derived from the theca interna, theca externa, and tunica albugenina. Considerable numbers of chromophilic granules were found lying in close conjunction with the inner wall. The vascularization was considerably reduced, the theca interna-apparently losing its function and becoming incorporated into the cyst wall.

The majority of the cases, however, showed more or less normal structure of the wall, with the granulosa being variably affected by erosion or disintegration. All stages were found from a thick layer of cells to a single flattened layer. The vascularization also showed great variation in the number and size of the vessels.

Cystic follicles associated with corpus luteum

Six cases showed cysts associated with an active corpus luteum. The cysts existed in the form of follicles ranging from four to twelve millimeters in diameter, with an average diameter of six millimeters. Grossly, the ovaries were normal in size and color with the exception of Case 18, and all possessed one or more active and well developed persistent corpora lutea. In three cases the corpus luteum occurred in the same ovary as the cysts. In two cases, corpora lutea were found in the opposite ovaries, and in one case cysts were found in both ovaries. Three of the corpora lutea were solid, two were cystic, and one case showed two cystic yellow bodies in the same ovary. (Tables I and II.) In all cases the corpora lutea showed physical characteristics of persistence that corresponded with their histories, being relatively poorly attached to the underlying stroma, having a grossly visible capsule, poor vascularization, and the characteristic yellow-orange color of old structures.

Considerable numbers of "red bodies" were found on cutting, as many as twelve being counted in a single midline section. According to McNutt (18) the presence of "red bodies" is an indication of regressed corpora lutea and a possible indication of the duration of the infertile period. However, some of the smaller of these bodies were marked before microscopic examination and it was discovered
that two out of the five so marked showed definite evidence of being corpora lutea atretica rather than regressed corpora lutea.

This aroused the suspicion that the cysts might actually be either normal or atretic follicles, and a careful check of the ovaries was made to prove or disprove this. The follicles showed a well-defined granulosa surrounding a deeply staining eosinophilic fluid which had coagulated during the fixation process. The theca interna was well supplied with blood vessels, and in two cases a number of erythrocytes had penetrated the granulosa and were lying along the periphery of the liquor folliculi. Occasional spherical chromophilic granules were observed lying on the inner surface of the granulosa. These granules were never demonstrated in normal graafian follicles. Serial sections through the cysts and examination of the cut surfaces under the dissecting microscope revealed no sign of cumuli oophori. Remnants of the zona pellucida were demonstrated in three specimens.

The evidence was considered sufficient to discount the possibility of these structures being normal graafian follicles, but did not discount the possibility of their being atretic.

Further examination revealed that the granulosa was well formed and intact. No evidence was observed of any extensive vascularization, inward proliferation of connective tissue or theca interna cells, or loosening of the granulosa. In the absence of these common characteristics of atresia (Figures 6 and 7), the follicles were considered to be true cysts.

**Pathology of the corpus luteum**

As far as this study is concerned, the pathology of the corpus luteum was relatively uncomplicated. Essentially it is included under two general headings: (a) persistent corpora lutea, and (b) cystic corpora lutea.

Eighteen cases of various forms of pathologic corpora lutea were examined and while they showed no marked variation from normal on intact examination, three marked characteristics of internal form and structure served to differentiate them. The color tended toward orange, the cut surfaces of fresh specimens showed only a slight extravasation of blood, and the development of the fibrous capsule separating the corpus luteum from the underlying stroma was so extensive that it could be observed grossly. The normal ovaries on the other hand showed either an accompanying pregnant uterus in cases of corpora lutea of pregnancy, or a color ranging from old gold to brownish in the fully formed corpora lutea of estrum. In addition the corpora lutea of estrum showed considerable extravasation of blood from the cut surface and a lack of development of
the fibrous connective tissue capsule. Older corpora lutea of estrum showed definite regression and shrinkage, and might be considered similar to persistent forms except for the fact that a functional graafian follicle occurred either on the same or the opposite ovary, while the persistent forms showed marked follicle atresia or cysts.

**Persistent corpora lutea**

Microscopic inspection of persistent corpora lutea revealed the presence of considerable amounts of fibrous connective tissue breaking up the lutein tissue into irregular cell masses. The vascularization was considerably reduced. The lutein cells retained their regular outline but mild regressive changes were apparent. Small vacuoles were found in normal corpora lutea. The nuclei stained more lightly and frequently no distinct nuclear membrane was visible. The blood vessels were reduced in number and their walls appeared to be somewhat thicker. There was a more clear-cut demarcation of the lutein tissue from the underlying stroma of the ovary, the base of the corpus luteum being enclosed in a thick connective tissue capsule.

**Cystic corpora lutea**

Cystic corpora lutea are generally similar in structure to the more normal form of persistent corpora lutea with the exception of the central cyst which is enclosed in a fibrous connective tissue capsule lined with a thin layer of modified connective tissue cells (Figure 10). The central cyst in the specimens studied varied from one to twelve millimeters in diameter.

The cellular structure of the cystic corpora lutea examined microscopically was essentially similar to that of persistent corpora lutea without cysts. Multiple and extensive follicle atresia (Figures 6, 7, 8, and 9) was invariably present in the ovaries.

**Atresia**

Excessive follicle atresia was noted in 15 cases among those studied, but always in connection with some other abnormality, principally persistent corpora lutea. (Tables I and II.) Arbitrarily, it was decided that the presence of more than ten grossly recognizable atretic follicles per midline section was excessive (Figure 8). This may not actually be the case but ovaries with persistent corpora lutea showed this condition while normal ones did not, except for those associated with early pregnancy.

**Pathology of the ovarian stroma**

The two cases (18 and 46) involving three ovaries showed either abscess or adhesion or both. Of the two ovaries which showed simple adhesion, one was complicated by other lesions involving the follicles
and corpus luteum, while the other, except for the adhesions, was essentially normal. Both were associated with infections elsewhere in the reproductive tract, although bacterial infection of the ovary could not be demonstrated in either specimen. The ovaries were adherent to the broad ligament of the uterus by cords of fibrous connective tissue.

The third ovary showed an abscess complicated by adhesions to the broad ligament of the uterus and the pelvic peritoneum. The abscess was so extensive that at the time of examination the exact point of origin could not be determined. It was of bacterial origin, and contained a mixed group of microorganisms, but principally *Micrococcus pyogenes* var. *aureus*. The diseased ovary measured 145 by 208 millimeters and possessed a fibrous capsule 24 millimeters in thickness. The abscess not only involved and destroyed the architecture of the ovary, but also involved the oviduct and portions of both horns of the uterus. Over two liters of foul-smelling grayish fluid, pus, and solid cheesy material were obtained from the affected organs. A considerable amount of fat was deposited around the uterus and ovaries, concealing much of the extent of the lesion. Historically, the condition was caused by an ascending infection from the uterus subsequent to the birth of a calf and failure of the cow to properly clean.

Microscopic studies revealed the adhesions to be bundles of fibrocytes and their processes adhering intimately to the broad ligament of the uterus, and in the specimens where the normal ovarian architecture persisted, to the tunica albugenia of the affected ovary.

Other conditions affecting the ovarian stroma have been reported in the literature but were not seen during this study.

**Discussion**

The pathology of the ovaries studied fell into three major categories; pathology of (a) the ovarian follicle, (b) the corpus luteum, and (c) the ovarian stroma. Frequently there was an overlapping of lesions and associated pathology of other portions of the reproductive tract. (Tables I and II.)

The most obvious fact that presents itself in this study is that 31 per cent of the animals sent to slaughter for "infertility" from unsupervised herds were actually pregnant. This indicates strongly that much of the infertility problem is due to the fact that pregnant animals are not recognized by their owners. After the elimination of these animals, the findings in supervised and unsupervised herds show a close correlation, varying but slightly in the major categories.

Another variation is shown by those specimens which were not pregnant yet showed no visible lesions. Four such cases were found
in animals slaughtered from supervised herds, while six were found in the unsupervised animals. Probably some of these latter animals could have been successfully bred, and professional diagnostic and therapeutic measures would have been advisable.

**Pathology of the ovarian follicle**

Failure of normal development in the senile specimen involved only the ovaries. Examination of other aged specimens (not in connection with this work) has revealed that the reproductive tract is apparently normal in size and shape in animals which are not diseased. The ovaries of the specimen examined in this study showed a functional failure apparently due to exhaustion of the reproductive capacity as indicated by their small size, lack of germinal epithelium, and insignificant number of primary follicles.

According to Bourg (2) evidence obtained from a study of rat ovaries indicates that numerous corpora lutea atretica produce similar modifications in the reproductive tract to those found in pregnancy, including an inhibition of follicle development. This might possibly have been the case here, although the exhaustion of reproductive capacity through age was probably the primary factor (36). However, it does seem odd that the follicles which remained did not develop into graafian follicles in at least one or two instances.

**Infantile**

The microscopic evidence gave rise to suspicions of freemartinism but the history of the animal produced no corroborating data to support this suspicion. Certainly the lack of follicular development is a condition not encountered in the normal immature animal (36) and the designation of “infantile” could only be applied to the gross appearance of the reproductive tract.

**Cystic follicles**

Follicular cysts have been mentioned by many authors (4, 5, 13, 14, 32, 36) as a cause of infertility and secondary symptoms of masculinity and nymphomania in cattle. However, most of the articles deal with the condition from a clinical standpoint and are relatively useless from a histopathological point of view. De Lange (9) states that in his work with unbred cattle, the cystic ovaries found were of two types: (a) those possessing a granulosa, and (b) those which merely consisted of a fluid-filled sac of fibrous tissue. Both types as described by De Lange were found in this study (Figure 11). However, a somewhat different method of classifying cysts was used here: (a) uncomplicated follicular cysts, and (b) cysts associated with a developed corpus luteum.
Uncomplicated Follicular cysts

These cysts are easily recognizable in the living animal by their large size and characteristic tense feel on palpation.

Rupturing the cysts leaves a shrunken flabby sac composed principally of medullary stroma, fibrous connective tissue, and blood vessels. Fixed specimens in which the cyst fluid has been coagulated can be cut with reasonable assurance of retaining the internal architecture more or less intact. Such specimens usually reveal other smaller cysts associated with the larger ones. Some of these smaller cysts are deeply buried in the connective tissue separating the bases of the larger cysts. In the cases examined during the course of this study and in routine practice, usually not over two large cysts are found per ovary. Possibly the size and pressure of the larger cysts prevents the smaller ones from growing. These small cysts are probably the source of recurrent cyst formation in affected animals after the contents of the large ones have been expressed by manipulation or surgery.

Cysts associated with a corpus luteum

Only one mention of this particular condition was found in the literature reviewed. Stalfors (28), in a survey of 286 cattle, reported various reproductive disorders which he grouped as follows:

<table>
<thead>
<tr>
<th></th>
<th>Alone</th>
<th>With ovarian cysts</th>
<th>With persistent CL</th>
<th>With cysts and persistent CL</th>
</tr>
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<tbody>
<tr>
<td>Uterine catarrh</td>
<td>10</td>
<td>12</td>
<td>29</td>
<td>36</td>
</tr>
<tr>
<td>Persistent CL</td>
<td>92</td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ovarian cysts</td>
<td>53</td>
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This report is particularly interesting in that it recognizes the fact that cysts may be associated with persistent corpora lutea in a relatively large number of cases.

There would be considerable difficulty in differentiating the cysts associated with persistent corpora lutea from normal or atretic follicles in the living animal or in a postmortem specimen. Hammond (12) cites a physical criterion for differentiation of cysts from normal follicles. If the follicle exceeds 15 millimeters in diameter it should be considered to be cystic. He further states that smaller cysts are very similar to normal follicles but that their fluid contents tend to be more yellowish.

While this may be true in many cases, functioning graafian follicles as large as 20 millimeters and cysts as small as 5 millimeters in diameter have been observed during the course of this study.
Size alone, therefore, cannot be considered to be diagnostic. A more adequate criterion is microscopic examination.

The condition of cysts occurring together with persistent corpora lutea allows a possible explanation for those cases encountered where a cow exhibits nymphomania yet reveals a persistent corpus luteum on examination, and for those cases of persistent corpora lutea which subsequently develop cystic ovaries after the yellow body has been removed.

**Pathology of the Corpus Luteum**

**Persistent corpora lutea**

A persistent corpus luteum is one which remains in a functional condition beyond its normal involution time. Such structures are characterized generally by relatively large size, yellow to yellow-orange color, soft or doughy feel, and looseness of attachment to the underlying ovarian stroma. The diagnosis of persistent corpus luteum is made from a study of the animal's history and examination of the ovaries and reproductive tract. Historically, the affected animal will show persistent failure to come into heat, and on examination a large, soft and usually easily expressed corpus luteum will be found in one or both ovaries.

A number of authors (4, 5, 10, 13, 32) have published excellent articles revealing the clinical aspects of persistent corpora lutea and the histological aspects of normal corpora lutea, but the literature contains very little about the pathology or histopathology of this structure. McNutt (17 and 18) and Hammond (12) in particular, give excellent descriptions and references pertaining to normal corpora lutea. Zschokke (37) states that persistent corpora lutea are produced by excessive use of certain feeds such as rye, malt, brewer's grains, and sugar beet silage. He did not, however, obtain this information from experiment, but based it upon information gained from routine practice. Hammond (12) reviews the differences in various forms of corpora lutea and states that the structure of the normal forms shows no essential difference from the abnormal, except that the degeneration of the corpora lutea of estrum occurs at a much earlier date. This latter statement was not confirmed by the results of this study.

**Cystic corpora lutea**

According to Williams (36), Chambers (4) and Elder (10), the presence of a cystic corpus luteum is an indication of infertility. McNutt (18 and 19) states that it remains apparently without interfering with normal development and involution. Hammond (12)
states that it has not been shown that they are associated with sterility, derangement of the estrus cycle, or pregnancy and that they are essentially physiological rather than pathological.

The cases examined during this study tend to confirm the findings of Williams (36) and Elder (10) as no cysts were found in the examination of corpora lutea of pregnancy and estrum, while eight cases of single or multiple cystic corpora lutea were found in specimens reportedly infertile. Furthermore the condition was observed four more times during the preliminary examination of one hundred animals for the purpose of determining normal morphology and structure. None of these animals was pregnant. In twenty-three animals which were found to be pregnant during the course of this phase of the study, in eleven pregnant animals examined for “sterility,” and one hundred and three pregnant cows subsequently examined, no cystic corpora lutea were found. Since the original writing, seventeen additional cases of cystic corpora lutea have been found. None of these animals was pregnant.

It seems reasonably safe to conclude that the presence of a cyst in a corpus luteum is an indication of abnormality and detrimental to fertility. The apparent mechanism by which persistent and cystic corpora lutea produce infertility is tied up in the hormone complex shown in Figure 3. The lutein cells, while apparently reduced in efficiency, still produce enough progesterone to interfere with the normal functioning of the ovary-pituitary complex, thus resulting in the formation of atretic follicles and more rarely in the formation of follicular cysts.

Atresia

It cannot be said with certainty that atresia in itself exerts a detrimental effect upon fertility. The senile ovary previously mentioned might be indicative of the fact that atresia can be a self-perpetuating process, but with a senile structure under consideration any conclusions derived therefrom would be doubtful at best. However, it is felt that the condition should be taken into consideration in making any postmortem examination for infertility.

Follicle atresia is present in both normal and abnormal ovaries. The essential point of difference is the relative frequency of occurrence of atretic as compared with normal follicles, and the presence of a normally functioning corpus luteum. Although atresia can occur at any stage of follicle development, it occurs most frequently prior to the development of the zona pellucida by the ovum, and thus fails to result in the production of corpora lutea atretica (26). After this stage, the presence of large numbers of atretic follicles and the presence of numerous corpora lutea atretica should be looked upon
with suspicion. Unfortunately this study was not designed to fully develop this phase, and only arbitrary conclusions can be drawn regarding its relationship to the ovarian portion of the infertility syndrome.

It can be theorized that the atretic follicle can play a part in the development of infertile ovaries. Assuming that the process of involution of the atretic follicle can be halted after the destruction of the ovum has been accomplished, it is quite possible that the theca interna can continue to secrete follicular fluid, in which case the atretic follicle could become a cyst.

In addition, excessive numbers of corpora lutea atretica which are formed by the normal involution of large follicles can exert a detrimental action on the ovary. Since these structures are cellurally similar to normal corpora lutea, and their hormonal action has been indicated (2), it is possible that their combined activity may be such that they can suppress the production and activity of FSH and LH by the anterior pituitary, and thus promote the further formation of atretic follicles and supersede the function of the normal corpus luteum.

Furthermore, through their progesterone activity, the corpora lutea atretica may further the retention of normal corpora lutea which may be present in the ovary, producing a condition of persistent corpus luteum. This condition is reasonably common in infertile animals encountered in practice. It has been noted that there is a marked increase in the number of recognizable atretic follicles and corpora lutea atretica in the ovaries obtained from animals possessing persistent corpus lutea. It is reasonably certain that these structures are the result of the hormonal action of the corpus luteum inhibiting FSH production (32) as such conditions can be observed in normal ovaries of early pregnancy. However, there may be a good possibility that these numerous corpora lutea atretica exert a detrimental influence on non-pregnant animals whose ovaries have lost the critical endocrine balance essential to normal function.

It will be noted that the interactions and origins of hormones (insofar as they are known) which affect the reproductive tract (Figure 3) involve a condition of balance and relationship which can be altered by the excess or diminution of one or more of the hormonal substances. By substituting a cystic follicle, a persistent corpus luteum, or perhaps multiple corpora lutea atretica for normal structures there can be set up in the ovary a vicious cycle of events which conspire to support and maintain an infertile condition. The significance of atretic follicles and corpora lutea atretica in the ovaries is well worthy of further investigation.
Pathology of the Ovarian Stroma

The pathological processes involving the ovarian stroma are apparently few in number and rare in occurrence. Thygesen (30) cites an incidence of less than one per cent. In the 155 cases studied here and another 45 studied subsequently only two (cases 18 and 46) showed lesions involving tissues other than follicles or corpora lutea.

Summary and Conclusions

The results of the examination of the ovaries and genital tracts of 55 dairy cattle slaughtered for infertility reasons are described and tabulated.

The pathology of the infertile bovine ovary can be conveniently broken down into three major categories: (a) pathology of the ovarian follicle, (b) pathology of the corpus luteum, and (c) pathology of the ovarian stroma.

Inadequate employment of professional service resulted in the needless sacrifice of 31 per cent of the animals sent to slaughter for infertility.

The presence of cysts associated with corpora lutea was found in 14 per cent of the nonpregnant cattle slaughtered for infertility reasons.

The opinion that cystic corpora lutea have an adverse effect upon fertility was upheld in this study.

A proposition that excessive follicle atresia may be a contributing cause to other ovarian disorders was advanced.

Further study of the process of atresia and the effect of excessive follicle atresia and formation of corpora lutea atretica upon the normal bovine ovary is indicated.

The pathological processes which involve the ovaries of dairy cattle are generally of a reversible nature. Those processes which are irreversible call for the sacrifice of the animal since she is no longer a productive unit. Processes which for practical purposes can be called irreversible are (a) recurring follicular cysts, (b) ovarian infections, (c) adhesions.

Cystic corpora lutea are not found in pregnant cattle and are usually associated with persistence of the corpus luteum and impaired fertility.

The employment of professional diagnostic and examination services would eliminate a considerable percentage of unnecessary slaughter of normal and pregnant animals because of “sterility.”
References


| Condition                        | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | Total |
|---------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Pregnant                        | X | X |   | X |   |   | X |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Not Pregnant                    |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| No Visible Lesions              |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Cystic Follicle Without CL      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Cystic Follicle With CL         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Infanile                        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Semi                            |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Atrophic                        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Many Atrophic Follicles         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Normal Corpus Luteum            |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Cystic Corpus Luteum            |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Persistent Corpus Luteum        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Multiple Corpus Lutea           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Adhesion                        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Adhesions                       |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Anomaly                         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

Table 1. Postmorten conditions encountered in 32 reportedly infertile dairy cattle from private herds not regularly utilizing veterinary service.
Table II. Postmortem conditions encountered in 23 reportedly infertile animals from state-owned herds regularly utilizing veterinary service.
Table III. Percentage Comparison of Compiled Pathology

<table>
<thead>
<tr>
<th></th>
<th>With veterinary supervision</th>
<th>Without veterinary supervision</th>
<th>Combined totals</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Cases</td>
<td>Per cent</td>
<td>Cases</td>
</tr>
<tr>
<td>Total number</td>
<td>23</td>
<td>100</td>
<td>32</td>
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<tr>
<td>Pregnant</td>
<td>1</td>
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<tr>
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<td>96</td>
<td>22</td>
</tr>
<tr>
<td>Total possible pathology</td>
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</tr>
<tr>
<td>No visible lesions</td>
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<td>18</td>
<td>6</td>
</tr>
<tr>
<td>Visible lesions</td>
<td>18</td>
<td>82</td>
<td>16</td>
</tr>
<tr>
<td>Cystic follicles</td>
<td>8</td>
<td>36</td>
<td>8</td>
</tr>
<tr>
<td>a. With CL</td>
<td>2</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>b. Without CL</td>
<td>6</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>Nonfunctional</td>
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<td>5</td>
<td>2</td>
</tr>
<tr>
<td>a. Senile</td>
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</tr>
<tr>
<td>b. Infantile</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>c. Atrophic</td>
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<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Excessive atresia</td>
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<td>36</td>
<td>7</td>
</tr>
<tr>
<td>Persistent CL</td>
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<td>45</td>
<td>8</td>
</tr>
<tr>
<td>a. Cystic</td>
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<td>4</td>
</tr>
<tr>
<td>b. Not cystic</td>
<td>6</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>c. Multiple cystic</td>
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<tr>
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<tr>
<td>Anomaly</td>
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Figure 1. Names and descriptions of the various structures of the bovine ovary and sequence of events in the ovulation cycle.

Figure 2. General structure of the bovine ovary.
Figure 3. Hormone relationships of pituitary and genital organs.
2. Figure 4. Cortex of atrophic ovary 120x H&E showing loss of germinal epithelium
dense and thickened tunica albugenia, and atretic primary follicles.

Figure 5. Cortex of infantile ovary 120x H&E showing lack of germinal epithelium
atretic primary follicles and ovigerous cords.
Figure 6. Atretic Graafian follicle 80x H&E showing loosened free floating ovum with degenerated nucleus and granulosa proliferating into the follicle cavity.

Figure 7. Atretic graaian follicle 80x H&E showing degenerating ovum with partially collapsed zona pellucida, degenerating cumulus oophorus and corona radiata, loosening and inward proliferation of the granulosa.
Figure 8. Midline section of ovary, 3x H&E showing excessive follicle atresia. Note the collapsed granulosae in the atretic follicles.

Figure 9. Atretic developing follicle 400x H&E showing inward proliferation of follicular cells and degenerated ovum with collapsed zona pellucida.
Figure 10. Cystic corpus luteum 120x H&E showing cyst fluid, layer of flattened cells lining cyst, connective tissue cyst wall, and lutein cells.

Figure 11. Follicular cysts 120x H & E showing variations in lining of cyst. (Left), granulosa still existing. (Right), granulosa completely eroded away.
Figure 12. Abnormal reproductive tract. Animal showed anestrus. Note persistent corpus luteum in left ovary and enlarged atonic uterus.

Figure 13. Opened view of Figure 12. Note persistent hymen, swollen condition of uterine mucosa and cyst on right oviduct.
Figure 14. Abnormal reproductive tract. Animal showed nymphomania. Note flaccid atonic uterus and cystic ovaries.

Figure 15. Opened view of Figure 14. Note the nodular development of the uterine mucosa, and the excessive amount of fluid in the uterine cavity.