SOME PHASES OF BOVINE GENITAL INFECTIONS OF POSSIBLE INTEREST TO THE MEDICAL PROFESSION*

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THERE are no specific venereal infections which are known to be intertransmissible between cattle and people. It is not impossible that certain genital infections of cattle and men, not designated as specific, may be closely allied or identical.

Aside from such considerations, cattle offer in many respects unequalled opportunity for the study of the physiology and pathology of reproduction. Such a study should prove of great value in determining some of the fundamental principles of sex hygiene and disease.

The internal genital organs of adult cattle are readily and intimately palpable per rectum, surpassing in this respect those of any other animal. The ovaries are readily reached, fully exposed and clearly defined. The development and rupture of the ovisac, the concurrent uterine engorgement and the growth and atrophy of the corpus luteum can be traced as clearly as if the removed organs lay before the student upon the table. Estrum is short, sharp and clear and its relation to ovulation, fertilization and menstruation is too clear to afford room for conflict of opinion.

Genital lesions in great abundance and endless variety can be intimately studied from beginning to end. There are slaughtered annually for food many millions of cattle of all ages and both sexes. When slaughtered they are presumably in good physical health at least insofar as affecting the safety of their carcasses for human food. From these the genitalia are procurable immediately after slaughter by bleeding, without opportunity for the postmortem migration of bacteria. They furnish every imaginable variety of genital disease. The females include nonpregnant animals and those pregnant in every stage.

The sexual relations of cattle are under the arbitrary control of the breeder and offer extensive opportunity for the study at close range of the effects of polygamy, polyandria and sexual excess.

The genital infections of animals bear no burden of social stigma and their results find expression in terms of scientific interest or of

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individual or state economy. While specific venereal infections exist, those not so regarded, but rather analogous to, and not clearly separable from, wound infection are of greater scientific interest because they supply a far richer field for studying the fundamental principles involved in genital diseases. In the medical profession the social stigma of syphilis and gonorrhea has perhaps tended to cause students, reformers and the public to look upon genital diseases as the result of trespasses upon statutory, moral and ecclesiastic laws and has probably befogged to some degree the underlying scientific principles of the problem as a whole.

Recent researches have shown that bovine genital infections of the type not designated as specific venereal diseases are essentially universal, that they advance or retire in obedience to laws reasonably well known and that they may or may not cause serious harm depending upon the state of the balance between the infection and the power of resistance offered by the individual.

It is freely admitted that the copulatory organs of all species harbor an extensive bacterial flora which does not as a rule seriously imperil the sexual or general health. In cattle the infections are not at all confined to the copulatory area but generally involve the cervical canal, uterus, oviducts, ovaries, testicles, epididymes and seminal vesicles.

Infections of the cervix are commonly recognizable clinically not later than the second parturition. The cervical mucosa becomes swollen, reddened and prolapses through the os uteri externum into the vagina. Heifers in first pregnancy not rarely develop an indurative cervicitis rendering parturition difficult or impossible. The cervical mucus is often excessive and wholly abnormal. Cultures from the cervical canal generally produce growths. The uterine cavity is less frequently involved, but in a majority of cases, the non-gravid organ yields positive cultures. The gravid uterus is not far behind the non-gravid in its bacterial content.

The intrauterine infection concentrates about the os uteri internum and at the apices of the cornua in close proximity to the tubal openings. At these foci notable lesions occur. At the apices of the cornua there is generally a very limited area of endometritis with the endometrium edematous and its surface encrusted. The lesions are most extensive in the nongravid horn where the chorion is less vascular and comparatively passive. The chorion lying within this area is necrotic, dry and dark yellow or brown as shown in Fig. 1. The extent of the necrosis is variable but is virtually universal.

The lesions at the os uteri internum are less frequent but more important. There also endometritis is present, the involved area varying greatly in extent and the contiguous chorion may be necrotic

as seen in Fig. 1. Occasionally the cervical canal is devoid of a seal and there protrude into the vagina portions of the chorion which are necrotic and rapidly decomposing as indicated in Fig. 2 but further forward (toward the ovary) the chorion is not detached, and the embryo may yet live, but abortion is inevitable unless gestation is nearing its physiological close. The pathological expulsion of the bovine embryo or fetus (except for surgical or artificial abortion) is, so far as known, always due to cervical endometritis.

Apical or cornual endometritis, though frequently extensive, apparently does not tend to cause the uterus to expel its contents. Not infrequently in cows there is observed an intense diffuse endometri-

Fig. 1.—Bovine fetal sac and embryo at about 100 days. *A*, amniotic sac; *Al*, allantoic sac; *1*, necrotic tip of non-gravid horn of chorion; *2*, necrotic area contiguous to the os uteri internum. (From *Diseases of the Genital Organs of Domestic Animals*, by the author.)

Fig. 2.—Impending abortion in cow pregnant 80 to 90 days. Cervix, uterus and ovaries viewed from above, the cervical canal being laid open to show portions of the chorion occupying the canal and extending into the vagina. *1*, an apparently healthy portion of chorion; *2, 3*, necrotic chorion; *4*, lips of cervix; *O*, left ovary; *C*, large cyst representing the right ovary. (From *Diseases of the Genital Organs of Domestic Animals*, by the author.)

tis but instead of causing abortion, it paralyzes the uterus, the fetus dies and undergoes maceration or putrid decomposition.

If the cow is in twin pregnancy the endometritis advancing from the cervix logically involves the basal fetus first. If it dies it will probably not be expelled at once. The presence of the healthy apical fetus inhibits uterine contractions until such period as the infection has killed or seriously injured it, when the two are expelled in quick succession. The basal fetus is smaller than the apical one and perhaps shows maceration. Rarely the two may die in quick succession

and are expelled promptly. Still more rarely the basal fetus is expelled soon after its death and the apical fetus remains to the normal end of pregnancy and is born.

The general conception of the nature of abortion is extremely vague. Abortion is attributed to bad food, mechanical injuries, psychic disturbances, bacteria and other causes, but there is no credible explanation of how so varied a list of factors may each cause the same phenomenon. Such a view leads to confusion in diagnosis, prophylaxis and therapeutics.

My researches indicate clearly that abortion in cows is uniformly attributable to cervical endometritis, which in turn is the result of bacterial invasion. I have examined in the abattoir the uteri of several thousand pregnant cows which had been shipped long distances associated with extreme fright, rough handling and food and water starvation. A number of these showed evidences of impending abortion, always in the form of endometritis radiating from the os uteri internum. I have slaughtered some animals which have aborted following inoculation with the *Bacterium abortus*. In each case an intense cervical endometritis was present. There is no instance recorded in which a cow has been destroyed soon after aborting in which this lesion was not present and in which it did not constitute the sole credible explanation for the disaster. Some veterinarians invoke mechanical injury as a potent cause of those abortions which they cannot attribute to *Bacterium abortus* but rest their assertion upon faith without facts. I had occasion to ship 17 pregnant heifers from Boston, Mass., to Hawaii. Aside from occasionally tumbling over each other in the freight cars the long trip was without incident until transferred at Honolulu to a little interisland freighter which immediately ran into a storm of unusual violence, the vessel being tossed about mercilessly for 32 hours on a sail ordinarily completed in 14. The boat rolled and pitched, the breakers keeping the decks awash and the pregnant heifers were unmercifully thrown about. It was impossible to go among them to feed, water or give other care. They were utterly exhausted when landed but each calved at full term, in a physiological manner and their calves were unusually vigorous and healthy. They did not abort because, and only because, they did not have cervical endometritis. According to my researches no bacterium can directly cause abortion but must first produce an intense endometritis at the cervical end, establishing a peripheral irritation while the ovarian end of the uterus retains its power of effective contraction. This basic lesion having become established, the way is open for the injurious action of a variety of forces. Any psychic, mechanical, bacterial or other factor which lowers the resistance of the pregnant individual may increase the virulence of the

infection upon which the lesion depends and precipitate abortion when otherwise premature birth or birth at full term would have been probable. So among cattle there are observed at times great storms of abortion when in a group of a thousand or more pregnant females more than 90 per cent abort, the immediate cause of which appears to be a bad state of nutrition due to insufficient or unsuitable food but back of all this must be the basic bacterial lesion.

If the principles involved in abortion in cattle as revealed by researches hold true by analogy for woman they tend to clarify the conception of that phenomenon. Probably of greater practical interest this view suggests to the gynecologist that in handling cervicitis in women, the aim should be to eradicate the cervical lesions as completely as possible before fertilization is attempted, not merely to render conception more probable but also to insure the safety of the desired pregnancy.

A highly interesting observation in bovine genital infections is the prevalence of bacteria in the alimentary tract of the fetus which naturally persist at birth. These bacteria are essentially identical with those which exist in the cervix, oviducts, nongravid and gravid

uterus. The evidence indicates quite clearly that the infection is swallowed. As soon as the oral end of the alimentary tract is open the embryo begins to swallow its amniotic fluid. The bovine fetus being heavily covered with hair and this being abundantly shed, the results of this swallowing process are strikingly shown in the meconium at full term as seen in Fig. 3 with its luxuriant content of hair. This filtration process usually keeps the amniotic fluid free from bacteria but it appears clear from their presence in the alimentary contents that, like the hairs, they must have been swallowed, suspended in the amniotic liquid. It is most probable that the penetration occurs through the necrotic areas of the fetal sac at the apices of the cornua and that the bacteria reach the allantoic fluid whence there remains only the very thin amniotic membrane to pass in order

Fig. 3.—Pellet of meconium from new-born calf showing abundance of swallowed hairs. (From An. Rep. N. Y. State Veterinary College at Cornell University.)

to reach the amniotic fluid as shown in Fig. 1 and are then swallowed. Once in the alimentary canal the bacteria may acquire pathogenic force, irritate the mucosa and cause fetal diarrhea, or penetrate the mucosa and reach the blood stream. More commonly they fail to acquire pathogenic force and remain inert in what may be termed a state of inclusion rather than infection.

A large proportion of aborted fetuses suffer from diarrhea prior to their death and many premature calves are born smeared over with feces. Occasionally a calf born at full term shows that it has had diarrhea as a fetus and the phenomenon may still be active at the time of birth. Some calves are born at full term suffering severely from sepsis and quickly perish.

Most calves are born apparently healthy and vigorous but many of them break down in a few hours to a few days with profuse diarrhea. The probability of the advent of diarrhea depends upon several factors. It is most probable in calves, the dams of which have severe uterine infection as indicated by slow parturition owing to uterine inertia as the result of severe intrauterine infection, and in those dams which showed marked clinical evidences of extensive endometritis and of placentitis as indicated by placental retention. The attack of diarrhea is favored by the early feeding of large quantities of milk, especially if it has been boiled. The phenomenon is best avoided by feeding the raw milk of the mother.

The diarrhea of the newborn is exceedingly interesting because in large herds of dairy cattle the calves are usually removed from their dams either immediately at birth without being allowed to suck or at some period within ten days. The calves are then assembled in large numbers in a calf barn where they are in more or less intimate contact, fed from a common stock of milk by a caretaker without knowledge of, or belief in, the importance of the transmission of bacteria from one individual to another. The entire group in a given establishment is accordingly quite uniformly exposed to any infection carried by any one calf. The result is that in many herds of large size essentially all calves born suffer in varying degrees from diarrhea or from digestive disturbances falling short of this but evidenced by pasty, ill-smelling feces which adhere to the hair and skin of the tail and buttocks. It is not rare to see a mortality of 100 per cent for several months in succession and of 30 per cent extending over a number of years. It is often complicated with pneumonia, pyemic arthritis, pyemic abscesses in the liver, spleen, spinal canal and elsewhere. It is found by experiment that the diarrhea and the associated phenomena may be largely averted by denying the calf all milk or other food for a period of 24 to 48 hours and in the meantime facilitating the emptying of the alimentary tract so that a minimum number of the bacteria included at birth shall remain to multiply in, and decompose the food given. On the same ground, when milk is given, it is in very small amount, not exceeding 2 per cent of the body weight.

Researches have also shown that diarrhea may be largely prevented, or when present, overcome by giving the so-called calf scours

serum, which consists of the blood serum of horses, after the animal has been rendered highly resistant to the introduction of large and virulent doses of the living bacteria presumed to cause the diarrhea. Each progressive step in the researches provides new interest. It is found that while as a rule the raw milk of the mother is the best natural security against diarrhea and that boiled milk tends to cause virulent diarrhea in many calves, those which are born without bacteria in the alimentary tract, or in which the bacteria are very few, as evidenced by an easy birth at full term and a rapid expulsion of the fetal membranes, the calf will grow splendidly upon boiled milk from the first. Or if the alimentary tract of the calf is badly infested with bacteria and boiled milk would probably cause fatal diarrhea, if the horse serum is given liberally the boiled milk may be fed with good results. A further step in the researches shows that when diarrhea is present, it may often be controlled by the hypodermic or intravenous introduction of the blood serum, or the noncoagulated blood or by the transfusion of the blood of the dam.

These data lead to the conclusion that the diarrhea of newborn calves is fundamentally due to bacteria included within the alimentary tract at birth. During pregnancy, the same bacteria may cause fetal diarrhea or sepsis and play an essential rôle in the morbid illness precedent to abortion. In large herds it cannot well be that all calves carry, into postnatal from prenatal life, bacteria which will inevitably cause diarrhea. Observation makes it clear that the disease may have either pre- or postnatal origin.

There has been much discussion in the medical profession regarding the dangers of cow's milk as a food for infants. It has been regarded as definitely inferior for the infant to that of its mother, and the question of whether it should be fed raw, pasteurized or boiled has caused controversy.

The researches upon calves seem to shed much light upon this question. The evidence obtained indicates that while the alimentary tract of the calf commonly carries from the uterus of its dam bacteria in a state of inclusion which possess high pathogenic powers, the fetal blood possesses no adequate protective substances against these bacteria because the placental filter has barred their entrance from the maternal blood. The milk of the mother carries protective substances in a degree which largely meets the demand of the newborn and when the milk is taken as food, the protective substances contained tend to prevent the bacteria in the stomach and intestines from acquiring pathogenic force. But if the milk is boiled the protective substances are destroyed and diarrhea tends to follow. If, however, the calf carries no bacteria in its digestive tract when born, or if such antibodies are experimentally supplied from other sources, boiled milk can be fed with excellent results.

It is to be remembered that the milk of a cow may, and often does, contain the same bacteria as her uterus and hence the same as those in the intestinal tract of the calf. The location of the mammary glands of the cow render it almost unavoidable that portions of any discharges from the genital tract find their way into the milk. They flow from the vulva down along the tail and thighs to the mammae and teats and frequently gain the orifice of the teat canal, pass into the gland and cause mammitis. When the fetal membranes are retained and hang down against the milk glands, infection of the posterior quarters is especially probable. Hence, while the milk of a cow apparently carries valuable protective substances against the bacteria in the digestive canal of her calf at birth, it also is extremely

Fig. 4. —Preputial tufts of calves at about 85 days. On the left is shown the matted tuft, stained black, of a dairy calf fed in the ordinary manner on mixed raw milk; on the right is the clean tuft of a calf taken from same herd and fed upon boiled milk. (From An. Rep. N. Y. State Veterinary College at Cornell University.)

liable to contain the same bacteria in more or less dangerous proportions.

That cows' milk regularly contains bacteria which profoundly affect the general health and appearance of calves is quite conclusively shown experimentally. If an apparently healthy bull calf, born in an ordinary dairy herd is fed in the prevailing manner upon raw milk, the tuft of hairs about the sheath opening, at first clean and of the color of its contiguous coat, soon becomes stained black and matted together as shown in Fig. 4. The staining and matting persist throughout life. But the other calf shown in the same figure, taken from the same herd and cared for as nearly as possible in the same manner, except that all milk fed to it had been boiled, shows the tuft of hairs clean, unstained and separate. I have repeatedly tried

this experiment and can find no explanation for the striking difference except that the one was fed on raw, the other on cooked milk. At one time there was so strong a belief current that a calf could not be grown upon boiled milk that the accuracy of my work was doubted.

I then took two calves from their dams at birth and fed them exclusively upon milk held at 30 pounds pressure in an autoclave for one-half hour. The milk was browned to a coffee color by the high temperature. The calves were exceptionally vigorous and grew rapidly as indicated by Fig. 5.

These data regarding calf infections at once raise the question whether they are peculiar to the species or whether they illustrate a common principle and that the genital tract in all its parts and the alimentary tract of the included young are constantly threatened and

Fig. 5.—Calf at about 85 days grown upon autoclaved milk. The preputial tuft is clean but wet from recent urination.

commonly invaded by bacteria of pathogenic power. So far as researches in domestic animals have gone, the data are in harmony for all. Horses, sheep, goats, swine, dogs and cats suffer like cattle but the studies in these infections have not gone so far and cannot be pursued so readily. Sterility and abortion of adults and diarrhea or other equivalent of the newborn are common alike in all.

The analogy is not confined to mammals. In the domestic fowl there is a common bacillary invasion of the ovary from which the ova acquire infection. The egg may fail to hatch, but usually incubation is completed with the bacilli persisting in the alimentary tract and yolk sac, where soon after hatching they cause a fatal diarrhea resulting in annual losses which poultry producers compute in millions of dollars.

Members of the medical profession apparently do not believe that genital infections are so common in people. They recognize of course the frequency of syphilis and gonorrhea, which cause an appalling

degree of disease and suffering and great interference with reproduction. In these diseases the uterus and the fetus are presumably invaded by the specific organisms but it seems to be believed that aside from these the uterine cavity and the included fetus and its membranes are commonly sterile. This view is possibly influenced by a belief that the uterus and embryo *should* be germ free. Some may believe that the placental arrangements more effectually bar infection from the gravid uterus and fetus of woman than of the cow. There are considerable variations in placental arrangements in different species of domestic animals but each fails to perfectly exclude infection from the uterus or to guard the embryo. In some respects the placental arrangements of the mare appear more perfect as a bacterial barrier than the placental structures of woman. In the latter the uterine cavity lined by the decidua vera persists until mid-term, while in the former the chorion at once comes into relation with the endometrium throughout by means of active placental structures. The only apparent advantage of the placental arrangement in woman is the comparatively inactive layer of decidua reflexa separating the uterine cavity from the chorion, but infection in the uterus and fetus is common and destructive in the former. In each, as in all mammalia, the uterine cavity has three openings which persist throughout pregnancy, the os uteri internum and the two openings of the oviducts. These canals afford the chief bacterial foci in all species from which infection may invade the uterus and embryo. The opportunities for the study of infection in the gravid uterus and the alimentary tract of the fetus are so infinitely superior in cows that this fact possibly explains in part the difference of view. It is not improbable that the view of the medical practitioner that the digestive tract of the newborn child is bacteria-free is based partly upon a study of the meconium near the anus. The study of bovine fetuses in the abattoir shows that culturable bacteria are most numerous in the stomach and fewest at the posterior end of the rectum. Consequently if the medical practitioner bases his conclusion upon a study of the rectal meconium he may fall into error.

The common existence of infection in the gravid uterus of the cow induces the veterinarian to assume the probable presence of infection in the puerperal uterus and to take measures to anticipate its explosion instead of awaiting clinical evidences of disease. Apparently the medical practitioner generally prefers to abstain from invading the puerperal uterus lest he introduce extrinsic infection. Writers upon obstetrics and gynecology make it clear that the medical practitioner is frequently disappointed by unexpectedly finding alarming puerperal infection which he attributes to faulty technic in excluding it, when if the analogy holds true the error may some-

times well be a failure to anticipate injury from an intrauterine infection persisting from pregnancy. The plan outlined for the prophylaxis of puerperal infection in cattle is amply justified by clinical experience, just as clearly, I believe, as is the practice of the obstetrician when he instills silver nitrate solution into the eyes of the newborn to guard against the possible presence of the gonococcus. The analogue of the one-child sterility of the gynecologist is highly destructive in heifers but so far as at present shown may be reduced to a negligible amount by assuming the probable presence of important intrauterine infection in each animal.

VITAL STATISTICS OF 18 HEIFERS GIVEN ABORTION BACTERINS IN FIRST PREGNANCY, WITH THEIR FEMALE PROGENY.									
NUMBER	BIRTH	1912	13	14	15	16	REMARKS		
1	09	A					Destroyed 10.9.12. Gangrene of uterus. Decomposition of Foetus		
2	09	A					Died of metritis		
3	11	A					Slaughtered on account of sterility		
4	10	A		A			Slaughtered on account of sterility		
5	10	A	A	S			Slaughtered on account of sterility		
6	10	X B	B H		B		Slaughtered on account of sterility		
6A	14					B			
7	10	A	S 2	D			Died of metritis		
8	11	H					Slaughtered on account of sterility		
8A	12			A			Slaughtered on account of sterility		
9	10	B					Retained afterbirth. sold on account of inefficiency		
10	11	B	B				Sold on account of bad udder. Gangrene. Half amputated		
11	11	A	B	B	B		Sold on account of low dairy efficiency		
12	10	A	H	B			Died of Indigestion 1915		
12A	13				H	H			
13	10	H	B	H	B		Sold - efficient		
13A	12			A	H	B			
14	10	H		B	B	B			
14A	12				H		Sold. efficient		
15	10	B	H		B B		1913 Heifer died 2.10.14		
16	10	A	B	B	B	H			
17	10	A	H	B	B	H			
17A	13				B	S			
17B	15								
18	10	A	H	H	H	B	1914 Heifer died from Indigestion		
18A	13					B P			

Died or Killed	10
Sold in breeding Condition	5
(Remaining in Herd of Dairying age)	11

Died or Killed ---- 10
Sold in Breeding Condition 5
(Remaining in Herd)
(of Dairying age) 11

—Chart showing Influence of *B. abortus* Bacterins Upon the Prevalence of Abortion.

Fig. 6.—Chart showing low fertility in group of heifers severely ill from diarrhea as calves and carrying severe genital infection until adult age. (From An. Rep. N. Y. State Veterinary College at Cornell University.)

The assumption also that the newborn calf carries pathogenic bacteria in its digestive tract at birth, paves the way for prophylactic measures of great value and makes it possible to generally control the devastating diarrhea and associated phenomena. In doing this, however, precautions against postnatal infections are not abated.

One of the most intensely interesting studies in bovine genital diseases is the influence of prenatal or early postnatal infections upon the fertility of the individual as an adult. Some wideawake breeders promptly destroy prematurely born calves because in their experience they are largely sterile, or if females and they conceive, they probably abort. My clinical observation approves this stand as well as the destruction of calves born at full term but unable to stand up

promptly because of sepsis due to prenatal infection. In many large herds virtually all calves suffer severely from diarrhea and pneumonia and when the surviving females reach breeding age, sterility is common, abortion in first pregnancy is a scourge, retained fetal membranes is very prevalent and unless energetic preventive measures are promptly applied, one-calf sterility is severe. Thus in Fig. 6 a group of 18 heifers representing the entire heifer crop in the herd for the year, all of which suffered severely from diarrhea as calves and were due to calve in 1912 and which ideally should have increased in 1916 to 49 females of breeding age, had decreased to 16 or a deficit from the ideal of 67.3 per cent. In a large herd shown in Fig. 7 where calves suffered severely from diarrhea and pneumonia, out of a group of 593 heifer calves 31 per cent died early and 27.8 per cent eventually became pregnant, of which 44.1 per cent aborted. A change was made in the rearing of calves by which the disease was ameliorated and out of 904 heifer calves, 44.1 per cent conceived as compared with 27.8 per cent and of those in which pregnancy had terminated, only 9.8 per cent aborted instead of 44.1 per cent while

Calf Scours and Pneumonia, and Abortion and Sterility in Herd B.											
Time Covered	Heifer calves born		Died of Scours and Pneumonia	Sold as Sterile	Killed account Tuberculous	Miscellaneous Deaths	Sold for Veal	Conceived	Pregnancy terminated		In Herd Pregnant
									calves	aborted	
May 1 1909 to Aug 31 1912 40 months	593	%	184	8	36	57	118	170	95	75	0
		%	31	1.4	9.4	9.6	19.9	27.8	55.9	44.1	0
Sept. 1 1912 to Oct 31 1916 50 months	904	%	203	6	13	58	0	382	203	22	157
		%	22.4	0.6	1.3	6.4	0	44.2	90.2	9.8	17.4

—The Relationship of Calf Dysentery and Pneumonia to the Prevalence of Abortion in First Pregnancy.

Fig. 7.—Chart showing influence of the health of young calves upon their fertility as adults. (From. An. Rep. N. Y. State Veterinary College at Cornell University.)

17.4 per cent were still pregnant and 27 per cent unbred. A careful study revealed no other reason for the great increase in reproductive efficiency except the improved health of the young calves. These are in entire accord with general observations.

In harmony with this we have found that in experimental calves slaughtered at from 8 to 12 weeks old, those which were vigorous at birth and remained healthy, generally yielded no bacterial growths from cultures made from the cervix, uterus, oviducts or ovaries. On the other hand, cultures were generally obtained from these organs in calves which had suffered from diarrhea or pneumonia, and these cultures corresponded generally with the bacteria commonly found in the gravid uteri of cows. So the conclusion logically followed that diarrhea and pneumonia in calves being due to prenatal, or to early postnatal infection by the same organisms, the bacteria have an affin-

ity for the genital tract. The diarrhea opens a gateway to the blood stream, the bacteria lodge in the genital tract of the calf and lie dormant until puberty. Then in the heifer they invade the ovary from the oviduct through the crater in the ruptured ovisac, cause cystic degeneration of the corpus luteum, which leads to irregular ovulation and consequent irregular menstruation. The intermenstrual pause is irregular and the quantity of menstrual blood variable. With these are associated sterility, abortion, etc. If the analogy holds true even in part, it opens to the medical practitioner a highly interesting and important field of inquiry which has apparently received scant attention. It suggests additional reason for the more careful handling of children, not alone with a view to lowering infant mortality but also to guard the powers of reproduction and through these the general health.

There is a tone of uncertainty in medical literature regarding the part played by the man in sterility and abortion. It is clear of course that destructive disease of the testes or occlusive lesions of their excretory ducts render him sterile. His ability to transmit syphilis and gonorrhea is unquestioned. But outside of these there appears to be no definite understanding. The gynecologist busies himself chiefly with the genital organs of woman and incidentally studies the man but is frequently not clear in his conclusions as to which of the pair is responsible for sterility or abortion. There appears to be a marked general tendency to regard the woman as the chief obstacle instead of regarding husband and wife as equal partners in the problem of procreation.

The polygamy of cattle breeding affords a far better opportunity for observation because the influence of the male can be studied in a large group of females and compared with that of another male in the same herd. Thus in a purebred herd reproduction had been satisfactory for several years when the establishment purchased a young, unused male as an outcross for the heifers sired by the old bull. The young bull came from a herd where the calves suffered much from diarrhea. As soon as he was put into use, trouble, in the form of sterility, abortion, metritis and retained afterbirth, began among his cows while the old herd sire continued to breed satisfactorily. After two years I examined the young bull and discovered a large, indurated abscess of the left seminal vesicle with rectal adhesions, as shown in Fig. 8. The median sagittal section in Fig. 9 shows that the abscess has ruptured into the rectum at 6'. Evidently the bull had been ejaculating bacteria with his semen, but when the abscess formed the contamination of the semen ceased to be possible from all that part of the left gland anterior to the posterior abscess wall.

The result of copulation by this bull is well shown in Fig. 10. In

1918 the original herd sire, designated No. 1, bred satisfactorily, the herd increment being 96.3 per cent. Bull No. 2 then came in. During 1919 and 1920 No. 1 continued to breed well, showing a herd in-

Fig. 8.—Abscessation of left seminal vesicle seen from above. (For explanation of numbers, see legend of Fig. 9.)

crement of 90.0 and 93.3 per cent respectively. During the same period No. 2 showed a high rate of sterility, very high abortion rate (23 per cent) and an abundance of metritis. His herd increment was 46.16 per cent and 57.14 per cent respectively or a trifle over 50 per cent of that of the old sire.

The metritis recorded represents only those cases where it was severe and attracted definite clinical attention.

After bull No. 2 had been killed and it was attempted to breed his cows to No. 1 and to two young bulls, it appears that the infection which the bull had ejaculated in his semen had acquired an enduring

Fig. 9.—Section through abscess of seminal vesicle shown in Fig. 8.
1, Pelvic urethra and prostate; 2, prostatic body; 3, ampulla of right vas deferens. 3', cross section of right ampulla; 4, 4, right seminal vesicle; 5, 5, left seminal vesicle; 6, portion of rectum adherent to vesicle; 7, urinary bladder; 8, section through left seminal vesicle showing numerous pus areas; 9, large abscess; 10, section through sclerotic abscess wall; 11, fistula extending from the abscess cavity 9, into the rectum at 6'.

pathogenic habitat in them. In 3 cows bred to No. 1, not previously bred to No. 2, each conceived with a single coitus while in 15 females which had been bred to No. 2 there was a sterility of 33.3 per cent which with an abortion rate of 6.7 per cent reduced the calvings to 60 per cent.

The picture I have drawn of bovine genital infections, as an endless infection chain might well suggest the possibility of a parent transmitting such contagion to its progeny, and depressing their reproductive powers. Few data are available. In Fig. 11 the breeding records of three sires in one herd are recorded. Bulls Nos. 1 and 2 were of low fertility, averaging one calf for each 3 copulations while No. 3 was of high fertility. The female progeny of No. 1 have averaged 1.8 calves each, No. 2, 1.9 each, and those of No. 3, 3.7 each. The ratio of calves per female for No. 3 equalled the combined reproduction of Nos. 1 and 2. There are many cross currents of infection

BREEDING RECORDS OF HEALTHY AND DISEASED BULLS IN A PURE BRED HERD													
YEAR	BULL	NUMBER COWS	COPULATION	STERILITY		ABORTION		CALVES		METRITIS ⁽¹⁾		AVERAGE DURATION OF GESTATION IN DAYS (2)	HERD INCREMENT % (3)
				NUMBER	%	NUMBER	%	NUMBER	%	FATAL	RECOVERS		
1918	1	27	40	1	3.7	0	0	26	96.3	0	0	285.96	96.3
1919	1	20	22	2	10.0	0	0	18	90.0	0	5	285.06	90.0
1920		15	20	2	13.3	1	6.7	14	93.3	0	0	282.79	93.3
1919	2	13	19	1	7.8	3	23.1	9	69.2	23.1	15.5	278.44	46.16
1920		21	30	4	19.0	5	23.8	12	57.1	0	19.0	276.0	57.14
1921	1(a)	3	3	0	0	0	0	3(4)	100.0	0	0		
1921	1(b)	15	22	5	33.3	1	6.7	9(5)	60.0	0	0		
1921	3(b)	6	7	6	100.0								
1921	4(b)	3	3	2	66.7	0	0	1(6)	33.3				

Fig. 10.—Chart showing breeding record of diseased (No. 2) bull of Figs. 8 and 9, compared with the healthy bull (No. 1).

(1) Only marked clinical cases of metritis or retained fetal membranes included; (2) abortions not included; (3) herd increment calves added by birth minus cows dead of genital infections; (4) two had calved and one was pregnant; (5) pregnant at date of report.

in a large herd where polygamy and polyandria are profuse, so that a given stream of infection cannot be accurately traced for a long distance but the limited available data seem to indicate that chronic genital infections are transmitted with a considerable degree of fidelity except scientific measures are taken to control them. In cattle as in men, there are family lines which owing to low fertility tend to become extinct. It is ordinarily attributed to some hazy weakness of reproductive powers. Researches in cattle appear to indicate that in them the explanation lies in the intensity of the genital infection present and its transmission to the progeny.

In the discussion of reproduction and sex hygiene there is frequently heard the term *sexual excess* but so far as I know, no attempt has been made to define it concretely. The polygamy of cattle breeding enables one to observe the direct effects of the frequency of copulation upon the male. In Fig. 11 there is shown a wide variation in the frequency of coitus by the three bulls. No. 1 was evidently highly infected and became useless early. His reproductive efficiency was very low and fell rapidly after he had reached the summit of copulation in his fourth breeding year. No. 2 was looked upon as the most valuable sire and was used far more than the other two combined

CHART OF THREE BULLS IN A LARGE HERD													
Number	YEAR	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	TOTAL	FEMALE PROGENY
1	COPULATIONS		4	21	48	77	45	16	2			213	32
	% CALVES		50	48	40	34	22	19	0			33	
2	COPULATIONS	8	39	82	117	73	106	106	86	64	10	691	85
	% CALVES	100	33	34	32	27	39	27	26	28	90	32	
3	COPULATIONS	23	70	61	37	35	6	0	3	2	1	213	44
	% CALVES	83	54	33	41	40	0	0	33	0	0	50	
													CALVES PRODUCED BY FEMALE PROGENY

Fig. 11.—Breeding chart of three bulls showing decline of fertility with comparative fertility of their female progeny.

and during several years made more than 100 copulations per annum. They were distributed throughout the year but the breeding was heaviest during the spring. At times certain bulls made 2 and rarely 3 copulations a day. All three bulls (as well as 11 others in the herd) show a somewhat even decline in fertility from the beginning and it appears to be hastened as the number of copulations per annum advances. No. 3, being rather unpopular as a sire, was not so extensively used. His fertility was higher and better maintained, his progeny were more vigorous and far more fertile, and in the second generation he far outranks the other bulls. These fragmentary data appear consistent and so far as can be seen are in accord with general clinical experiences. The frequency of coitus, the fertility, the

security of pregnancy, puerperal infection and fertility of progeny are interdependent.

In studying breeding bulls it is found that the most available data are obtainable from the palpation of the seminal vesicles and the examination of the spermatozoa. Important lesions of the testicles and epididymes are often unrecognizable by palpation. When these become clinically evident the bull is usually hopelessly and completely sterile, but as a rule he is not dangerous, because the lesions inhibit ejaculation and hence the infection remains imprisoned. It is the bull of low fertility that is most frequently dangerous to the female. He is also in peril of becoming hopelessly sterile unless prompt sexual rest is provided.

Fig. 12.—Seminiferous tubules showing desquamative orchitis without clinical evidences. In one tubule some spermatozoa are still being formed; in the other the destruction of the germinal epithelium is much advanced.

The two outstanding means for recognizing these dangers are changes in volume, consistency or sensitiveness of the seminal vesicles or abnormalities in the spermatozoa. Sexual activity when it reaches four to seven copulations per week as a rule is soon reflected by the condition of the seminal vesicles but important lesions have already occurred in the mucosa of these before the abnormalities are palpable.

The abnormalities in the spermatozoa may vary widely. Defective motility or total nonmotility indicates high virulence of infection in the seminal vesicles or elsewhere in the course from the testicles to the urethra. Usually the first signal of danger is an increase in the number of defectively formed spermatozoa, such as abnormal form or size of the head. When the abnormally formed spermatozoa reach

about 70 to 90 per thousand, the fertility becomes recognizably low, the pregnancy insecure and the cow is liable to reveal clinical evidences of cervicitis, salpingitis and cystic degeneration of the corpus luteum.

The testicles of such bulls show interesting histological changes. Fig. 12 shows two contiguous seminiferous tubules. In one the germinal epithelium is partly destroyed but spermatozoa are still being formed; in the other the destruction is much farther advanced and its products are chiefly debris and bacteria. In Fig. 13 the destruction is further advanced and the germinal epithelium almost totally destroyed. Such lesions are not clinically recognizable.

Clinically the average bull cannot with safety make nearly 100

Fig. 13.—Orchitis with almost total destruction of the tubal epithelium.

copulations per annum. Individual sires doubtless may rarely exceed this with safety but this cannot be told except by taking the risk of doing serious injury, both to the prospective fertility of the bull and to the genital health of the cows with which he copulates.

I have not attempted to discuss the identity of the infections mentioned. Most bacteriologists who have studied the problem of reproduction in cattle have limited their researches to one microorganism, the *Bacterium abortus* of Bang and have ignored all other bacteria as of no consequence. The infections here discussed have not, so far as known, any relation to the *Bacterium abortus*. The most prominent organism observed by the very few workers who have paid any attention to the genital flora as a whole, is a streptococcus of the viridans group. There also occur micrococci, staphylococci, bacilli, spirilla, etc. None of them are at present recognized as specific but

rather as belonging to that group of infections which may be designated *general* and not readily distinguishable from the bacteria of wound infection. In a sense they apparently repeat in the genital tract analogous bacteria normally resident upon the skin, virtually harmless upon the unbroken surface with high potentiality for harm when a wound occurs.

The important point is that sexual excess has in cattle a concrete meaning. The data are as yet fragmentary but capable of unlimited extension by research. *(For discussion, see page 563.)*

THE TREATMENT OF PUERPERAL SEPSIS BY THE USE OF MERCUROCHROME INTRAVENOUSLY WITH A REPORT OF ANIMAL EXPERIMENTATION IN THE CHEMICAL DISINFECTION OF THE BLOOD*

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THE subject of puerperal sepsis and its treatment has been the cause of acrimonious discussion within the medical profession since the days of Hippocrates. Most of this discussion has been upon the etiology and the predisposing factors in the causation of this condition. Arnold Lea has a very clear cut and a delightful description of the historical side of this controversy. He speaks of "puerperal infection as the general term applied to all infected conditions which arise from the entrance of organisms into wounds of the generative tract in connection with labor or the puerperium," and further states that "all cases of fever during the puerperium, unless clearly attributable to some extraneous cause, should be considered as forms of wound infection." Polak in his monograph on "Pelvic Inflammation" states; "we know from clinical experience that the presence of decidua or a piece of placenta retained in the uterus will not cause endometritis unless infection is also present," and also that "puerperal fever is primarily due to infection of the obstetrical wound by microorganisms."

Mercatus, writing in 1570, was apparently the first observer to mention putridity of the lochia as an essential feature of the disease. In 1843 Oliver Wendell Holmes published his classical essay on the contagious nature of the condition.

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