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The Yield of Colostrum and Colostral Gammaglobulins in Beef Cows and the Absorption of Colostral Gammaglobulins by Beef Calves

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SUMMARY

The details of a small study on the volume of colostrum and colostral gammaglobulins produced by beef cows at the first milking immediately after calving and the serum concentrations of passively acquired colostral gammaglobulins attained by beef calves are reported. The mean volume of colostrum and colostral gammaglobulins produced were 2990 ± 2100 (SD) mL and 314.75 ± 211.8 (SD) g respectively. The mean serum concentrations of passively acquired colostral gammaglobulins were 29.9 ± 10.1 (SD) ZST units (n = 40, Ranch A) and 19.2 ± 7.5 (SD) ZST units (n = 42, Ranch B). The main reason for this difference appeared to be nutritional; the cows on ranch B being in much poorer condition and almost certainly producing less colostrum than those on ranch A.

RÉSUMÉ

La production de colostrum et de gammaglobulines colostrales par des vaches de boucherie et l'absorption de ces gammaglobulines par leurs veaux

Les auteurs rapportent les détails d'une étude restreinte, sur le volume de colostrum et de gammaglobulines colostrales produit par des vaches de boucherie, lors de la traite effectuée immédiatement après le vêlage; ils rapportent aussi les concentrations sériques de gammaglobulines colostrales absorbées par leurs veaux. Le volume moyen du colostrum et celui des gammaglobulines atteignirent respectivement 2 990 ± 2 100 (DS) mL et 314,75 ± 211,8 (DS) g. Les concentrations sériques des gammaglobulines colostrales absorbées par les veaux s'élevèrent à 29,9 ± 10,1 (DS) unités TSZ, chez 40 veaux du ranch A, et à 19,2 ± 7,5 (DS) unités TSI, chez 42 veaux du ranch B. La principale raison de cette différence semblait d'ordre nutritionnel; en effet, les vaches du ranch B étaient en bien plus mauvaise condition que celles du ranch A et elles produisaient vraisemblablement moins de colostrum.

INTRODUCTION

The importance of colostrum for the newborn calf is well recognized (7,9,12,16,33); calves with low serum concentrations of absorbed colostral immunoglobulins are very susceptible to infectious disease (6,18,21). Radostits and Acres (23) reported that enteritis was the most common syndrome affecting calves less than two months old referred to the Large Animal Clinic of the Western College of Veterinary Medicine. Furthermore, in a well controlled study to determine the efficacy of various treatments on acute undifferentiated neonatal calf diarrhea, Radostits and others (25) were of the opinion that calves with serum gammaglobulin concentrations of less than 0.5 g/dL were likely to die despite treatment, whereas calves with serum gammaglobulin concentrations greater than 1.5 g/dL responded quickly and did not relapse.

Two major factors influence the absorption of colostral immunoglobulins by the newborn calf; the age of the calf when it receives its first feed of colostrum and the amount of immunoglobulins presented to the calf (11,29). The efficiency of absorption appears to be maximal shortly after birth and declines steadily thereafter with cessation of absorption occurring at about 20 hours postpartum (29). However in some calves this closure can occur as early as 12 hours postpartum (37). The quantity of immunoglobulins presented to the newborn calf is dependent on the volume of colostrum offered and the immunoglobulin concentration of that colostrum.

In dairy cows, both the yield and

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concentration of immunoglobulins in colostrum have been determined frequently (8,10,26,28), but in beef cows these values have been recorded only rarely (13,24). There are also numerous surveys recording the concentrations of passively acquired immunoglobulins (2,4,15,16,18,38), but only one such investigation appears to have been reported for beef calves born under Canadian conditions (3). The present report records the findings of a small study on the yield of colostrum from beef cows maintained under Canadian conditions and the concentrations of passively acquired gammaglobulins in calves born to those cows.

MATERIALS AND METHODS

Yield of Colostrum and Colostral Gammaglobulins in Beef Cows

The 14 animals in this study were either Hereford (dam) x Aberdeen Angus (sire) or Hereford (dam) x Simmental (sire) cows, the age of which ranged from two to five years. They were held in small corrals surrounded by windbreak fencing and were fed barley or wheat straw *ad libitum* supplemented with either brome-alfalfa silage or artificially dried brome-alfalfa hay. Limited amounts of barley were fed prior to and after calving. Both diets were designed to give similar levels of nutrition; maintenance plus a weight gain of ½ lb per day. A vitamin and mineral supplement was also fed. Immediately after calving the cows were suitably restrained. To ensure complete milk ejection in beef cows which might have been disturbed by the unaccustomed handling, 1 mL of oxytocin was injected intramuscularly. The cows were then completely milked by hand and the volume of colostrum produced noted to the nearest 10 mL. A sample of colostrum was retained for analysis and stored at -20°C. The remaining colostrum was fed to the cow's calf.

The Absorption of Colostral Gammaglobulins

Blood samples from a total of 82 calves on two ranches were collected to determine the concentrations of passively acquired colostral gammaglobulins.

Ranch A — The absorption of colostral gammaglobulins by three groups of calves born to either Hereford, Hereford x Aberdeen Angus, or Hereford x Simmental cows subjected to different postnatal management regimes was determined.

Group A: The 14 calves born to the cows in which the yield of colostrum had been determined were artificially fed the colostrum milked from the cows, either by suckling the colostrum from a nipple-bottle, or by stomach tube. A calf was fed by stomach tube only if it was reluctant to suckle the nipple bottle or if it was considered that insufficient colostrum had been consumed, based on a suggested intake of 7% of a calf's birthweight (31). The birthweight of each calf and the volume of colostrum fed were noted.

Group B: Twelve calves were assisted to suckle colostrum to satiation from their own dams as soon as possible after birth. The weight of each calf was noted before and immediately after suckling and the difference between those two weights was assumed to be the weight of colostrum ingested.

Group C: Fourteen calves were permitted to suckle their dams naturally without interference, except that their weight was noted within four hours of birth.

The blood samples were collected into evacuated containers[1] from the jugular veins. Samples were taken from the calves in groups A and B before feeding the colostrum, and after, at 48 hours of age. The calves in group C were sampled once only when they were between 24 hours and three days of age. The calves were weighed using a spring balance and a canvas harness. Samples of colostrum were available from the dams of the calves of group A as previously stated and samples of colostrum were also obtained from the dams of the calves of group B by milking approximately 20 mL from each teat before the calf had suckled and pooling the four aliquots together. Colostrum was not collected from the dams of the calves of group C.

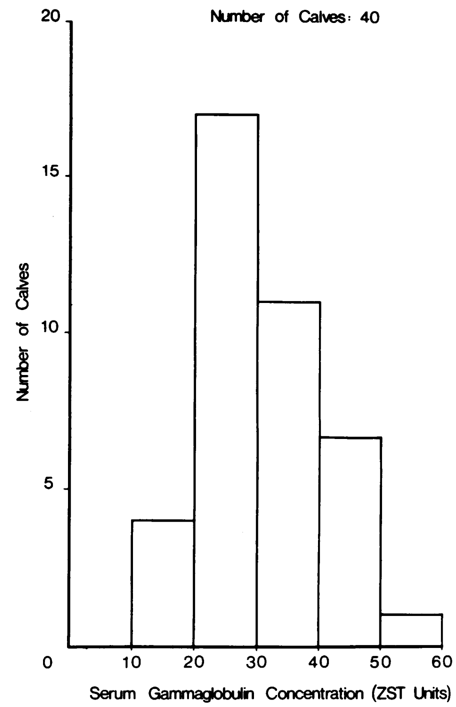

FIGURE 1. The distribution of serum gammaglobulin concentrations of 40 calves. Ranch A.

Ranch B — Blood samples were collected into evacuated containers from 42 calves, when the calves were between 24 hours and three days of age. These calves had been allowed free access to their dams and permitted to suckle normally without interference. The calves were born to either Hereford, Hybrid beef (Aberdeen Angus x Charolais x Galloway) or Hybrid dairy (Holstein x Brown Swiss x Simmental) cows. Twenty-six of the 42 dams were first calving heifers. The cows were fed hay supplemented with a small quantity of rolled barley. No attempt was made to obtain colostrum from any of the cows in this group.

Colostral Whey Gammaglobulin Concentration

Whey was prepared from colostrum using commercial rennet (32). The whey total protein concentration was estimated by the biuret reaction and the gammaglobulin concentration was calculated following electrophoretic analysis on cellulose acetate membranes. The gammaglobulin concentration of the original sample of colos-

[1] Vacutainer, Becton, Dickinson and Company, Rutherford, New Jersey.

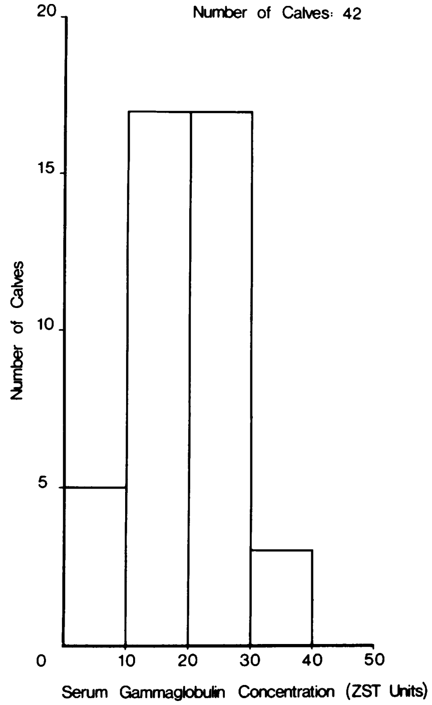

FIGURE 2. The distribution of serum gammaglobulin concentrations of 42 calves. Ranch B.

trum was determined by multiplying the whey gammaglobulin concentration by 0.841 (28).

Serum Gammaglobulin Concentration

The gammaglobulin concentration of the serum was determined by the zinc sulphate turbidity (ZST) test (17). The result obtained by subtracting the value determined for the precolostral serum sample from that of the postcolostral serum sample for the 26 calves in groups A and B was assumed to be the concentration of absorbed colostral gammaglobulins. For the remaining calves only the postcolostral serum sample was available and the gammaglobulin concentration of that sample only is given.

Standard statistical methods were used. Mean values are stated with their standard deviation, and Student's t-test was employed where necessary.

RESULTS

Yield of Colostrum and Colostral Gammaglobulins

The yields of colostrum were determined from seven cows which were fed the straw, brome-alfalfa hay diet and seven cows fed the straw, brome-

TABLE I

YIELD OF COLOSTRUM, COLOSTRAL WHEY GAMMAGLOBULIN CONCENTRATION AND TOTAL GAMMAGLOBULIN IN FIRST MILKING OF BEEF COWS

Cow No.	Breed	Parity	Yield of Colostrum (mL)	Whey γ-Globulin Conc. (g/dL)	Total γ-Globulin (g)
Group 1 — Diet — Straw, Grain, Brome/Alfalfa Hay					
624	H x AA[a]	2	700	16.7	98.3
700	H x AA	1	720	17.1	103.5
618	H x AA	2	1480	15.7	195.4
723	H x S	1	1610	12.2	165.2
600	H x AA	2	2020	17.2	292.1
656	H x S	2	3120	13.7	359.4
474	H x S	4	5930	12.0	598.4
Mean			2225.7	14.94	258.9
SD			± 1830.0	± 2.27	± 177.6
SE			± 691.7	± 0.86	± 67.1
Group 2 — Diet — Straw, Grain, Brome/Alfalfa Silage					
622	H x AA	2	2050	12.6	217.2
547	H x S	3	2180	17.7	324.5
642	H x S	2	2720	15.6	356.8
556	H x S	3	2830	11.5	273.7
412	H x AA	4	3970	16.2	540.8
446	H x S	4	4800	1.7	68.6
480	H x S	4	7730	12.5	812.6
Mean			3754.3	12.54	370.6
SD			± 2010.5	± 5.29	± 241.8
SE			± 759.9	± 2.0	± 91.4

[a]H = Hereford
S = Simmental
AA = Aberdeen Angus

TABLE II

RANCH A — ABSORPTION OF COLOSTRAL GAMMAGLOBULINS: CALVES FED COLOSTRUM ARTIFICIALLY
GROUP A

Calf No.	Breed	Birth-weight (kg)	Volume of Colostrum Fed (mL)	Colostral Whey γ-Globulin Conc. (g/dL)	Absorbed Serum Gamma-globulin Conc. (ZST units)
618	H x AA x Ch[a]	37.0	1430[b]	15.7	14
624	H x AA x S	34.5	690[b]	16.7	19
412	H x AA x Ch	41.0	2800	16.2	21
642	H x S x Ch	37.5	2470	15.6	22
700	H x AA x AA	27.0	710[b]	17.1	23
474	H x S x Ch	35.0	3020	12.0	25
446	H x S x Ch	47.0	4440	1.7	25
600	H x AA x Ch	31.5	1750	17.2	26
723	H x S x Ch	29.5	1560	12.2	28
622	H x AA x Ch	28.0	2000	12.6	30
480	H x S x Ch	39.5	3170	12.5	30
547	H x S x Ch	41.5	2130	17.7	36
556	H x S x S	35.0	2430	11.5	45
656	H x S x Ch	39.0	3050	13.7	45
Mean		35.9	2260.7	13.74	27.7
SD		± 5.6	± 1018.1	± 4.11	± 9.0
SE		± 1.5	± 272.1	± 1.09	± 2.41

[a]Breed of dam placed first, e.g. H x AA x Ch = Hereford x Aberdeen Angus (dam) x Charolais (sire)

H = Hereford
S = Simmental
AA = Aberdeen Angus
Ch = Charolais

[b]Ingested all colostrum available.

alfalfa silage diet. The volume of colostrum produced ranged from 700 mL to 7730 mL and the concentration of gammaglobulins in the whey varied from 1.7 g/dL to 17.7 g/dL (Table I). Thus the total yield of colostral gammaglobulins at the first milking after parturition varied from 63.8 g to 812 g. The mean volume of colostrum produced by the seven cows on the straw, brome-alfalfa hay diet was 2225 ± 1830 mL and that produced by the seven cows on the straw, brome-alfalfa silage diet was 3754 ± 2010 mL, but these two values were not significantly different. Two Hereford x Aberdeen Angus cows which were on the straw, brome-alfalfa hay diet produced the two lowest yields of 700 mL and 720 mL. The mean volume of colostrum produced by the eight first and second calving cows, 1803 ± 867 mL, was significantly less than the mean volume produced by the six older cows, 4573 ± 2048 mL ($p < 0.01$). The Hereford x Simmental cows produced more colostrum than the Hereford x Aberdeen Angus cows; the mean yield of the six Hereford x Aberdeen Angus cows was 1823 ± 1207 mL and the mean yield of the eight Hereford x Simmental cows was 3865 ± 2102 mL ($p < 0.05$).

The Absorption of Colostral Gammaglobulins

Ranch A — The individual results for the 40 calves in groups A, B and C are presented in Tables II, III and IV. The mean concentrations of serum gammaglobulins of the calves in groups A, B and C were 27.6 ± 9.0, 30.9 ± 10.4 and 31.2 ± 10.7 ZST units respectively. None of the calves had a serum gammaglobulin concentration of less than 10 ZST units. The mean volume of colostrum ingested by the calves in group A was 2260 ± 1018 mL. Ten of the 14 calves in this group ingested all the colostrum offered by suckling the nipple bottle; two calves (622, 600) refused to suckle the nipple bottle at all and were given the colostrum by stomach tube; two calves (618, 412) took only about half the colostrum offered by suckling and the remainder was given by stomach tube. The mean weight of colostrum ingested by calves in group B which were assisted to suckle immediately after birth was 1.5 ± 0.45 kg.

TABLE III
RANCH A — ABSORPTION OF COLOSTRAL GAMMAGLOBULINS:
CALVES ASSISTED TO SUCKLE COLOSTRUM TO SATIATION IMMEDIATELY AFTER BIRTH
GROUP B

Calf No.	Breed	Birthweight (kg)	Weight of Colostrum Ingested (kg)	Colostral Whey γ-Globulin Conc. (g/dL)	Absorbed Serum Gammaglobulin Conc. (ZST units)
18	H x S[a]	44.7	1.0[b]	20.7	15
139	H x S	35.9	1.0[b]	15.1	21
478	H x S x Ch	47.3	2.2	16.8	21
426	H x AA x S	42.5	1.6[b]	14.6	22
104	H x S	34.1	1.4[b]	16.4	28
416	H x AA x Ch	42.0	1.0	12.3	28
509	H x AA x S	37.5	1.0	17.3	31
567	H x S x Ch	36.1	1.8[b]	20.0	33
573	H x S x Ch	46.8	2.1[b]	17.0	37
604	H x AA x Ch	31.8	2.05	12.9	43
530	H x AA x Ch	37.5	1.4	15.7	44
511	H x AA x Ch	39.0	1.5	11.9	48
Mean		39.6	1.50	15.89	30.9
SD		± 5.0	± 0.45	± 2.77	± 10.4
SE		± 1.4	± 0.13	± 0.79	± 3.0

[a]Breed of dam placed first, e.g. H x AA x Ch = Hereford x Aberdeen Angus (dam) x Charolais (sire)

H = Hereford
S = Simmental
AA = Aberdeen Angus
Ch = Charolais
[b]Ingested all colostrum available.

TABLE IV
RANCH A — ABSORPTION OF COLOSTRAL GAMMAGLOBULINS:
CALVES ALLOWED TO SUCKLE WITHOUT INTERFERENCE
GROUP C

Calf No.	Breed	Birthweight (kg)	Serum Gammaglobulin Concentration (ZST units)
650	H x S x S[a]	49.5	11
481	H x S x Ch	40.0	21
405	H x AA x Ch	37.5	23
529	H x AA x Ch	32.0	25
151	H x S	32.0	26
70	H x AA	36.0	26
489	H x S x Ch	36.5	30
637	H x AA x Ch	41.0	32
216	H x AA	36.5	34
461	H x S x Ch	48.5	35
667	H x S x Ch	31.0	37
440	H x A x Ch	41.0	40
522	H x A x Ch	46.5	43
525	H x A x S	31.0	55
Mean		38.5	31.2
SD		± 6.3	± 10.7
SE		± 1.7	± 2.8

[a]Breed of dam placed first, e.g. H x AA x Ch = Hereford x Aberdeen Angus (dam) x Charolais (sire)

H = Hereford
S = Simmental
AA = Aberdeen Angus
Ch = Charolais

The mean time from birth to completion of suckling by the calves in group B was 48.5 ± 17.5 minutes. The distribution of the serum gammaglobulin concentrations of the 40 calves of ranch A is presented in Figure 1, and the mean serum concentration of these passively acquired gammaglobulins was 29.9 ± 10.1 ZST units.

The calf which had the lowest serum gammaglobulin concentration (Calf 650, group C, 11 ZST units) required traction at birth and its mother had difficulty in standing after parturition. With a birthweight of 49.5 kg it was also the heaviest of the 40 calves investigated at ranch A.

Ranch B — Blood samples were collected from 42 calves. The serum gammaglobulin concentrations ranged from 3 to 37 ZST units and the mean value was 19.2 ± 7.5 ZST units. Five of the 42 calves had gammaglobulin concentrations of less than 10 ZST units. The distribution of the gammaglobulin concentrations is presented in Figure 2. The mean serum gammaglobulin concentration of the 42 calves on ranch B was significantly lower than that of 40 calves on ranch A ($p < 0.001$).

The mean serum gammaglobulin concentration of 26 calves born to first calving cows was 19.4 ± 7.7 ZST units and mean concentration of the 16 calves born to multiparous cows was 19.1 ± 6.7 ZST units. There was no significant difference between those two values. Two of the five calves with ZST values of less than 10 units were born to multiparous Hereford cows which had very large bulbous teats, and the remaining three calves were born to first calving heifers.

DISCUSSION

The absence of transplacental transfer of antibodies in the calf necessitates that it ingests a sufficient quantity of colostral gammaglobulins soon after birth. It has been suggested that the newborn calf requires a minimum of 80 g to 100 g of colostral gammaglobulins to prevent hypogammaglobulinaemia (10,13,19). Therefore, both the yield of colostrum and the concentration of gammaglobulins have to be adequate.

In the present study the volume of colostrum produced at the first milking ranged from 700 mL to 7730 mL with only two cows giving less than 1000 mL. In comparison with the other, limited, investigations into yields of colostrum in beef cows, the yields in this study are relatively high. Logan (13) recorded yields of colostrum from 22 Hereford cross cows milked immediately after calving which ranged from only 100 mL to 3500 mL with a mean of 1113 mL. In another report 75% of two year old Hereford cows produced less than 750 mL of colostrum immediately after calving (24). It is possible that the use of exogenous oxytocin resulted in a more complete evacuation of the udder (5). However, the yields recorded in this study may also reflect the influence of the Simmental breed, a recognized dual purpose animal. Selman (28) recorded a mean yield of 7.0 liters of colostrum from 20 Ayrshire cows, and Kruse (10) demonstrated that cows of the Danish Red breed produced significantly more colostrum than cows of either the Danish Black and White breed or the Jersey breed with mean yields of 7.5 kg, 5.3 kg and 3.2 kg respectively. Furthermore, first lactation heifers of the Danish Red and Danish Black and White breeds produced significantly less colostrum than older, multiparous cows. In the present study the eight first and second calving cows produced significantly less colostrum than the six older cows, but this was much more likely to be a breed effect as five of the six older animals were Hereford x Simmental cows.

Although diet has not been demonstrated to have any effect on the concentration of gammaglobulins in colostrum (13, 36), it does have a marked influence on the yield of colostrum. In his investigation into the yield of colostrum in beef cows, Logan (13) found that cows which had been outwintered with no supplementary feeding produced significantly less colostrum (592 ± 392 mL) than similar cows, housed and fed grass silage *ad libitum* (1655 ± 1107 mL), and thus significantly less total immunoglobulins. The wide variation in the concentration of immunoglobulins in colostrum has been noted previously (8,10,13,26, 29), but the concentrations of colostral gammaglobulins in this investigation are higher than most surveys. The very low whey gammaglobulin concentration (1.7 g/dL) in the colostrum from cow 446, a multiparous Hereford x Simmental cow which gave 4800 mL colostrum, cannot be explained. Such low values are not infrequently found, and are often due to leakage of colostrum before calving (22) but this did not happen in this instance.

From examination of the results of the calves fed colostrum artificially, it is clear that, given the opportunity, the newborn calf can consume considerable volumes of colostrum in the first hour of life. One calf, 446, suckled nearly four and a half liters of colostrum. As mentioned above, this colostrum had a very low gammaglobulin concentration, but probably as a result of the large volume ingested the calf still had a 48-hour serum gammaglobulin concentration of 25 ZST units. Even omitting the four calves of group A fed part or all of their colostrum by stomach tube, the mean volume of 2367 mL ingested by the remaining ten calves accords well with other studies (31).

However the mean weight of colostrum of 1.5 kg consumed by those calves which were assisted to suckle to satiation represented only 3.78% of their birthweight, compared to just over 7% in a previous study (31). This low figure may be due to the inaccuracy of weighing the calves with a spring balance and harness or to the fact that six of the 12 calves suckled all the colostrum available. The calves in group C which suckled their dams with no interference absorbed adequate colostral immunoglobulins, although the mean figure of 31.2 ZST units would have been slightly reduced if a precolostral serum sample had been available, but only by approximately 2 ZST units. Calf 650 which had a ZST value of 11 units required traction at birth and its mother had difficulty in rising after birth. Both these events undoubtedly combined to delay the time of first suckling with a consequent deleterious effect on absorption (11,29,37).

Comparison of the two distribution histograms reveals that a much higher proportion of the calves sampled on ranch B (52.4%) had less than 20 ZST units, compared with ranch A (10%), and that just under 12% of the calves on ranch B were severely hypogammaglobulinaemic. Two of the severely hypogammaglobulinaemic calves were born to cows with pendulous udders and large distended teats, both of which delay the time of first suckling and can result in hypogammaglobulinaemia (14,15,30). However, at least on visual inspection, the greater volume of colostrum produced by the cows on ranch A appeared to be the major difference between the two ranches. This may have been due to either the influence of breed (10) or, much more probable in this instance, the effect of nutrition (13).

Bradley and others (3) determined the serum gammaglobulin concentrations of the newborn calves in a large beef herd which had experienced calf mortality rates as high as 20% in previous years. Although the method of estimating the gammaglobulin concentrations differed, the values recorded by Bradley and others (3) are comparable with, or even higher than, those attained in the present study on ranch A (16). Those authors concluded that acquired gammaglobulin concentrations were irrelevant in predicting the incidence of diarrhea in calves. However, during the calving season in which the investigation was performed, no deaths were attributed to diarrhea and this may indicate that changes in management had occurred.

Management practices can reduce the occurrence and severity of neonatal diarrhea (24,27) but without adequate serum concentrations of acquired gammaglobulins, the successful treatment of neonatal diarrhea is almost impossible (25). Thus the ingestion of sufficient colostral gammaglobulins during the immediate postnatal period is essential for the survival of the newborn calf. This necessity becomes even more compelling with the increasing use of prepartum maternal vaccination against the microbiological agents associated with neonatal calf diarrhea (1,20,33,34).

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BOOK REVIEWS

Small Animal Dermatology. Third Edition. G.H. Muller, R.W. Kirk and D.W. Scott. Published by W.B. Saunders Company, Toronto. 1983. 889 pages. Price $104.30.

This book is an extensively revised version of the second edition and must still rank as the "bible" of clinical dermatology. While it retains some of the old features of the second edition, it has been almost completely rewritten. With the addition of Dr. Scott as the third author, the writing style has become less formal and more relaxed, resulting in improved readability.

There is an expanded and well-detailed section on dermatohistopathology, a field heretofore somewhat overlooked in dermatology texts and a subject which is well served by the authors. Throughout the book, the authors repeatedly stress the importance of proper drug dosages, especially with regard to antibiotics, a common fault among practitioners.

Particularly helpful to practitioners are the practical tips and hints sprinkled throughout the text, along with an excellent section on the use of steroids. Many of the newer experimental drugs are also discussed.

The authors devote 110 pages to immunological diseases, an indication of the importance attached to this subject and of just how far this particular field has progressed over the last few years. It is a timely and well-organized section, particularly the section on autoimmune disorders and should do much to clear up some of the confusion that is often associated with immunological skin disorders.

The authors have set out to improve the practice of dermatology among veterinarians; their book will go a long way towards achieving that goal. *B.P. Pukay.*

Comparative Diagnosis of Viral Diseases. IV Vertebrate Animal and Related Viruses. Part B — RNA Viruses. Edited by E. Kurstak and C. Kurstak. Published by Academic Press, New York. 1981. 694 pages.

This book deals with the RNA viruses of vertebrates, including picornaviridae, reoviridae, ortho, and paramyxoviridae, coronaviridae, togaviridae, bunyaviridae, arenaviridae, rhabdoviridae, retroviridae, and "unclassified" viruses. In general, each chapter is written in an interesting manner with different topics (antigenic composition, pathogenesis, immunity, clinical signs, laboratory diagnosis, etc) clearly separated and identified, but as with any book written by multiple authors attention to these different areas varies.

As this book was published in 1981 most of the references quoted are pre-1979 and the reader will have to seek more recent reviews of specific areas for up to date information. For example, there are 23 recognized serotypes of bluetongue virus, and 13 H antigens of influenza virus. Rinderpest is now quite widespread in Africa and not limited to specific areas. The tissue culture serum neutralization test for demonstration of antibodies to vesicular stomatitis is not described and neither is the growth of EIA virus in established cell lines. No control methods are described for lymphoid leucosis in poultry. No mention is made of the use of live rabies virus vaccine for the control of wildlife rabies in Europe. The possibility of vaccine production using recombinant DNA technology (as applicable to FMD, for example) is not mentioned.

However, there is also a wealth of information in this book, the references cited are in significant numbers and photographs are usually of excellent quality. Some chapters could have benefitted from critical editing to reduce length and repetition, but others, such as those dealing with canine distemper and rinderpest, foot and mouth disease, equine infectious anemia, the coronaviruses and bunyaviruses to name only a few, are excellent. Likewise, the chapter on influenza describes this complex subject in a very clear and precise manner.

In general, this volume will be of considerable value both as a reference text and as an "interesting reading" book for anyone, student or graduate, who is interested in animal virus diseases. It is a useful complement to previous editions of this series, and will be a very useful addition to most libraries on veterinary medicine. *P.R. Ide.*