# NEONATAL GROWTH AND DEVELOPMENT OF THE BOVINE STOMACH

*E.R. JOHNSON*

Dept of Farm Animal Medicine and Production, The University of Queensland, P.0. Box 125, Kenmore, Qld 4069

## SUMMARY

The growth and development of the weight of stomach parts relative to total stomach weight were studied in 53 Friesian foetuses and calves from 150 days' gestation to 150 days old. In the pre-natal phase of growth, the omasum grew significantly slower, and the abomasum significantly faster, than the total stomach. In the post-natal phase, the rumen and omasum grew significantly faster and the abomasum, significantly slower than total stomach. Most of the post-natal development occurred by the time the calves had doubled their day-old carcase weight (at about 84 days old). The reticulum grew at about the same rate as total stomach over both pre-natal and post-natal phases of the study.

In 5 day-old Shorthorn calves from severely drought-affected dams, the stomach proportions were very little different from 5 day-old half siblings from dams that were not drought-affected.

The growth and development of the bovine stomach is associated with functional roles.
*Keywords:* bovine stomach, neonatal, functional development

## INTRODUCTION

Calves born from cows on inadequate nutrition during pregnancy may suffer severe growth retardation and show poor survival ability (Alexander 1964; Hight 1966). The complexity of this effect has been noted by Joubert and Bonsma (1957) and Hight (1966). Calf birthweight, which is commonly used to assess the severity of maternal undernutrition, gives conflicting results. Joubert and Bonsma (1957) found that birthweight was not influenced by plane of nutrition but Hight (1966) and Tudor (1972) who imposed severe regimes of undernutrition on their cows, produced a large depression in birthweight. Though low birthweight is commonly associated with low survival ability, there appears to have been little attempt to identify specific mechanisms responsible for reduced viability.

The differential development of the post-natal bovine stomach has been clearly described by a number of workers in relation to capacity and weight (Getty 1975; Warner *et al. 1956;* Roy 1969; Asai 1975; Webster 1984) although the influences of dietary stimuli are not clear (Warner *et al.* 1956; Stobo *et al.* 1966). If the widespread functional growth changes which occur in the carcase tissues of bovine foetuses from 150 days' gestation to birth (Johnson 1974) apply also to the development of the stomach, then anatomical and physiological digestive inadequacies could occur in new-born calves of low birth weight from drought-affected cows (Hight 1966).

In the following study, development of the bovine stomach in Friesian foetuses and calves is described and comparisons are made with new-born Shorthorn calves from drought-affected dams.

## MATERIALS AND METHODS

Forty-five half-sib Friesian foetuses and calves and 8 other Friesian calves were studied. Observations were made at 150 days' gestation, 210 days' gestation, 1, 28, 56 and 84 days in the half-sibs, and at 150 days in the other 8 calves. Five day-old half sibling Shorthorn calves were available for study from dams that were not drought-affected and had gained a mean liveweight of 0.9 kg per day over the last 15 weeks of pregnancy. Five day-old Shorthorn calves from drought-affected cows that had lost a mean liveweight of 0.5 kg per day over the same period were also studied. All calves beyond day-old were reared in pens on milk or reconstituted full milk powder with good quality luceme chaff available *ad lib* from day-old. The foetuses, which were taken by Caesarean section as a part of a large growth and development study, and the calves were slaughtered, bled and dressed. The rumen, reticulum, omasum and abomasum were separated, washed and dried with absorbent paper towels before being weighed. Differences in the stomach parts were described in terms of proportion by weight of the total stomach. For each stomach part, tests of significance were conducted between the proportions of succeeding age groups.

## RESULTS

The proportion by weight of the 4 stomach parts relative to total stomach weight is shown for the 6 periods of study in the Friesian foetuses and calves (Figure 1). When the proportions were examined relative to chronological age instead of total stomach weight, the curves of that figure (not shown here) were very similar to those of Figure 1. The proportions of the stomach parts in the 7 age groups of the study are shown in Table 1.

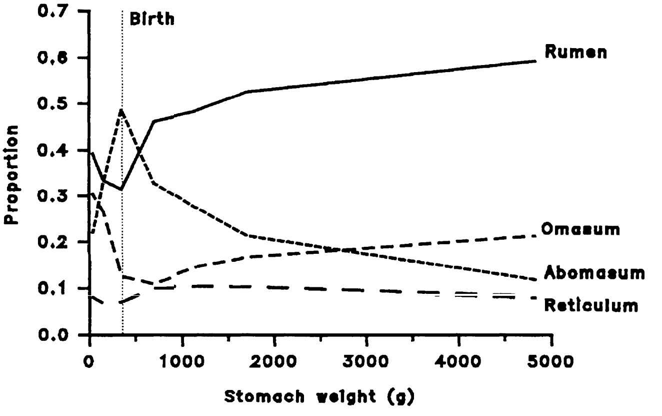


**Figure 1. Proportion by weight of the four stomach parts relative to total stomach**

**Table 1. Change in proportions of stomach parts relative to total stomach weight in Friesian foetuses and calves**

| Age group (days) | Mean total stomach weight (g) | Proportion of total stomach weight | | | |
|---|---|---|---|---|---|
| | | Rumen | Reticulum | Omasum | Abomasum |
| 150 days' gestation | 40 | 39.66 | 8.08 | 30.41 | 21.85 |
| 210 days' gestation | 151 | 33.56* | 6.86n.s. | 26.68* | 32.90* |
| 1 | 347 | 31.68n.s. | 7.31n.s. | 12.60* | 48.41* |
| 28 | 694 | 45.24* | 9.79* | 10.75n.s. | 34.22* |
| 56 | 1141 | 47.92n.s. | 10.05n.s. | 14.29* | 27.75* |
| 84 | 1706 | 51.48n.s. | 10.72n.s. | 15.42n.s. | 22.38* |
| 150 | 4819 | 58.78* | 8.20* | 21.14* | 11.88* |

Significance of difference in proportion of stomach part from that in preceding age group: * P<0.05; n.s. Not significant.

A feature of the pre-natal growth phase was the low priority for rumen, reticulum and omasum to increase their proportions, while that of the abomasum increased greatly. In the 28-day period following birth, the rumen underwent a large increase in proportion, whereas that of the abomasum decreased markedly. From 28 days to 150 days, the rumen grew slowly while abomasal growth declined markedly, in strong contrast to its rapid pre-natal increase in proportion. The reticulum's growth which did not vary greatly over any period of study showed a slight increase from 0 - 28 days. The omasum, which decreased markedly in proportion over the pre-natal growth phase, increased significantly from 0 to 150 days.

Table 2 shows the proportions by weight of the stomach parts in the Shorthorn calves. Although the groups were too small to give a meaningful statistical comparison, there was very little difference in the stomach proportions between groups.

**Table 2. Proportion by weight of stomach parts in Shorthorn day-old calves from drought-affected and non-drought-affected dams**

| Stomach part | Proportion by weight | |
|---|---|---|
| | Drought-affected dams[A] (n=5) | Non-drought-affected dams[B] (n=5) |
| Rumen | 34.3 | 35.2 |
| Reticulum | 7.7 | 7.3 |
| Omasum | 11.7 | 11.6 |
| Abomasum | 46.3 | 45.9 |

[A] Lost 17.8% of bodyweight over last 15 weeks gestation; calf mean birthweight, 20.7 kg; mean total stomach weight, 1010g.
[B] Gained 24.3% of bodyweight over last 15 weeks gestation; calf mean birthweight, 26.3 kg; mean total stomach weight, 990g.

There were no significant differences between the 2 groups of calves for any stomach part.

## DISCUSSION

In the Friesian calves, the proportions by weight of the stomach parts at birth, were generally consistent with the capacities of the stomach parts recorded in the literature (Warner and Flatt 1965; Getty 1975; Webster 1984). The sequential nature of the current study, including a pre-natal phase and 4 stages beyond day-old, demonstrated a functional anatomical developmental pattern in the growth of the bovine stomach.

The very high rate of growth of the abomasum from 150 days' gestation to form almost 50% of stomach weight at birth, confirms the pre-eminent role of this part in the new-born calf (Roy 1969; Webster 1984). Because the abomasum must be capable of digestion at birth, anatomists tend to refer to the rapid pre-natal growth phase as 'functional'. Such a rapid rate of growth suggests a specific physiological stimulus, as yet unidentified. The rapid decline in the proportion of the abomasum after birth suggests that this organ may have performed its major role in digestion by about 28 days.

The rumen, with a low growth priority from 150 days' gestation to birth, showed accelerated growth in the 28 days following birth. Its rate of growth was greater over this period than any other, indicating functional development in an organ that was about to become of major importance in an altered digestive role. However, because little luceme hay was eaten by the calves in the first month of life, it is likely that the rapid growth of the rumen over this period was stimulated by a metabolic factor rather than form of diet. After 28 days, the rumen grew slowly. Over the 300 days of the study, the growth in the rumen and in the abomasum showed a distinct inverse relationship (Figure 1) which agrees with the findings of Warner and Flatt (1965).

Growth in the omasum showed a low priority throughout the pre-natal phase and up to 28 days post-natally, when it began to increase steadily in proportion. Asai (1975), who studied omasal motility, noted that cyclic contractions of the omasal canal first began at 4 to 6 weeks of age and the omasal body began to contract at 8 weeks of age. He believed that the contractions of the omasal canal may be essential for the transference of ingesta from the reticulum even in calves. The increase in proportion of the organ coincided, generally, with this increased period of activity.

The reticulum, always the lesser of the stomach parts, showed a relatively low growth priority over both pre-natal and post-natal growth phases, forming only 7 to 11% of stomach weight at any stage. From birth to 28 days it grew at its greatest rate, a period at the end of which Asai (1975) found that reticular contractions began.

Butterfield and Berg (1966) found that adult muscle weight distribution in cattle was established by the time the calf had doubled its total muscle weight, which occurred at about double birth weight. This bovine growth principle which Butterfield (1966) ascribed to functional necessity seems to apply also to the growth and development of the stomach parts. Except for the abomasum, which was still regressing in weight, the bovine stomach, at double day-old carcase weight (at about double birth weight, or approximately 84 days of age) had generally established adult proportions. Because the development of the stomach parts is generally complete by about 84 days of age, the early weaning of calves on to a herbage diet,, sometimes practised in Northern Australia, seems anatomically justified.

Because only 5 Shorthorn calves were involved in each dam group's nutritional treatment, no firm conclusions could be drawn. However, there were virtually no differences between the proportions of the stomach parts between the calf groups despite the extreme feeding regimes of the dams and the fact that the mean weight of calves from the drought-affected cows was 20.7 kg compared to 26.3 kg in the cows not drought-affected. Both Hight (1966), who studied Angus cows, and Tudor (1972), who studied Hereford cows, considered that the 17.0% liveweight loss over the last 98-130 days of gestation placed their cows at the limit of their nutritional tolerance. The day-old calves from their nutritionally deprived Angus and Hereford cows weighed 20.0% and 21.9% less, respectively, than those from dams on a high plane diet. Although the drought-affected Shorthorn cows in the present study lost 17.8% of their bodyweight over the last 105 days' gestation and their calves weighed 21.3% less than those from cows on adequate feed, the proportions of the stomach were almost the same in both groups.

If this small group of calves does represent what happens in cattle, it conflicts strongly with findings in sheep where lamb birthweight is relatively easily influenced by maternal undernutrition (Joubert 1956; Everitt 1968). Observations in the Shorthorn calves of this study, which should be repeated with satisfactory numbers, suggest that functional anatomical development in the calf stomach is quite resilient to severe maternal undernutrition.

## ACKNOWLEDGEMENTS

I thank Mr. D.A. Baker, Miss L.M. Knott and Mr. M. Fisher for technical assistance.

## REFERENCES

ALEXANDER, G. (1964). *Proc. Aust. Soc. Anim. Prod. 5:* 113-22.

ASAI, T. (1975). *Jap. J. Vet. Sci. 37: 603-7.*

BUTTERFIELD, R.M. (1966). *Aust. Vet. J. 42: 87-90.*

BUTTERFIELD, R.M. and BERG, R.T. (1966). *Proc. Aust. Soc. Anim. Prod.* **6:** *298-304.*

EVERITT, G.C. (1968). *In* "Growth and Development of Mammals", (Eds G.A. Lodge and G.E. Lamming) pp. 13 l-57 (Butterworth: London).

GETTY, R. (1975). *In* "Sisson and Grossman's The Anatomy of the Domestic Animals", 5th Edition (Saunders: Philadelphia).

HIGHT, G.K. (1966). *N.Z. J. Agric. Res. 9: 479-90.*

JOHNSON, E.R. (1974). *Aust. J. Agric. Res. 25:* 1037-46.

JOUBERT, D.M. (1956). *J. Agric. Sci., Camb. 47: 382-428.*

JOUBERT, D.M. and BONSMA, F.N. (1957). *Sci. Bull.*, Dept. Agric., Union of South Africa, No. 371.

ROY, J.H.B. (1969). *In* "Nutrition of Animals of Agricultural Importance", (Ed D. Cuthbertson) pp.645-48 (Pergamon Press: London).

STOBO, I.J.F, ROY, J.H.B. and GASTON, H.J. (1966). *Br. J. Nutr. 20:* 171-88.

TUDOR, G.D. (1972). *Aust. J. Agric. Res. 23: 389-95.*

WARNER, R.G. and FLATT, W.P. (1965). *In* "Physiology of Digestion in the Ruminant", (Ed R.W. Dougherty) pp.24-38 (Butterworth: Washington).

WARNER, R.G., FLATT, W.P. and LOOSLI, J.K. (1956). *J. Agric. Fd. Chem. 4: 788-92.*

WEBSTER, J. (1984). *In* "Calf Husbandry, Health and Welfare" (Granada Publishing: London).