EFFECTS OF A SODIUM SUPPLEMENT ON LACTATING COWS AND THEIR CALVES ON TROPICAL NATIVE PASTURES

T. F. Leche*

ABSTRACT

Ten milking cows with calves were given uniodized salt twice weekly for 12 weeks while another group of ten cows with calves received no supplement. They grazed together on native pasture. Liveweights were recorded weekly. Sodium and potassium levels in saliva, urine and milk of the cows and in drinking water and pasture samples were determined once. Body condition of the cows was assessed at the beginning and the end of the experiment, and pregnancy status at the end only.

On the average, supplemented cows gained 61 kg liveweight and unsupplemented cows lost 23 kg ($P < 0.001$). Calves of the former cows gained 49 kg compared with 35 kg for calves of the control group ($P < 0.05$).

After ten weeks, levels of sodium and potassium in saliva and urine were normal for the supplemented cows but were indicative of severe sodium deficiency for the control cows. The content of these elements in the milk was unaffected by supplementation.

The sodium contents of water and herbage were so low as to make it unlikely that lactating cows could satisfy their sodium requirements from these sources.

Body condition of the salt-fed cows improved ($P < 0.001$) during the period whereas it declined slightly but non-significantly for the others.

It is suggested that the condition known as "nutritional lactation stress" in the highlands of Papua New Guinea may be caused by sodium deficiency.

INTRODUCTION

Lactating cows grazing pastures in the highlands of Papua New Guinea are prone to a disease known locally as "nutritional lactation stress". In the first months of lactation, affected cows rapidly lose both weight and condition, and often die. By this time emaciation is extreme and the coat is dull, rough and sparse. Dehydration is evident.

The disease affects only lactating cows but not all of them. Other stock grazing with them usually appear healthy and productive. It occurs very frequently on some farms and on others not at all.

The calf remains in good condition until the cow dies. The effect of the disease on growth rate of the calf while the cow lives is not known.

*Formerly Senior Animal Production Officer (Cattle), Highlands Beef Research Unit, Goroka, Eastern Highlands Province. Present address: CSIRO Division of Animal Production, Blacktown, NSW 2148, Australia.

The symptoms and circumstances of this disease are suggestive of a primary sodium deficiency. This paper describes an experiment which studied the effects of sodium supplementation on cows displaying typical symptoms, and on their calves.

MATERIALS AND METHODS

Location

The experiment was conducted on the Highlands Beef Research Unit, 10 km south of Goroka, Eastern Highlands Province (6°05' S., 145°25' E.).

The altitude is 1 600 m above sea level.

Mean annual rainfall is 1 675 mm. An average of 650 mm falls between 1st January and 1st April, but in 1976 only 475 mm fell in this period.

Experimental Period

The experiment ran for 12 weeks from 9th January to 2nd April, 1976.

Statistical Design and Methods

A completely randomized design with two treatments was used. The cows, with calves, were randomly assigned to either of two groups of ten cows each.

Weight gains for female calves were adjusted upward by 10 per cent before statistical analysis, to account for the known influence of sex on pre-weaning growth rate (National Beef Recording Scheme 1972).

Treatment effects were tested by Student's 't' test for unpaired observations with equal variances (Steel and Torrie 1960).

Animals

Twenty lactating cows were selected from a herd of Brahman crossbreds, from which all mineral supplements had been withheld for three years.

The cows had given birth to an average of 3.8 calves each by the start of the experiment. Only one was primiparous.

In December, 1975 the cows but not their calves were treated for helminths with 1-tetramisole (Nilverm, I.C.I., Lae).

At the beginning of the experiment, the age of the calves varied from 3 to 27 weeks, with a mean (± standard error) of 18 ± 1.6 weeks. There were 8 male and 2 female calves in the supplemented group and 4 male and 6 female calves in the other group.

Supplementation

One group of cows, with their calves, was given sodium chloride (salt supplemented, SS) whereas the other group (unsupplemented, US) was not.

On Tuesday and Friday mornings the SS cows and calves were placed in a 0.25 ha enclosure, with water available from an earthen dam. At the same time the US animals were grazed nearby, also with water from an earthen dam.

Uniodized common salt (Mermaid Butter Salt, Cheetham Salt C., Victoria) was provided *ad libitum* to the SS group for at least one hour on these days. Disappearance of salt was measured as the difference between air-dry weights of the steel containers, with salt, before and after the cattle had access to them. No other mineral supplement was available to any of the cattle, during the experiment.

Pasture Management

Both groups grazed together with other cattle in the herd on natural pasture of *Imperata cylindrica, Themeda australis, Heteropogon* spp. and other species of grasses and weeds. The stocking rate varied between 1.0 and 0.5 beasts/ha depending upon the number of head in the remainder of the herd.

Weighing

On Fridays the cows and calves were weighed before the supplementation treatments were applied.

Assessment of Body Condition

Body condition of the cows was assessed subjectively by the author on 9th January and 2nd April, 1976 on a scale of six levels: 1 = very poor; 2 = poor; 3 = fair; 4 = fairly good; 5 = good; 6 = very good. Plate I shows two cows judged to be in very poor (1) and in good condition (5), respectively.

Pregnancy Status

At the end of the experimental period, an experienced veterinarian estimated pregnancy status in the cows by rectal palpation.

Chemical Analyses

Samples of pasture herbage, cut at 15 cm above ground level, were collected from 1 m^2 quadrats of ungrazed pasture adjacent to the experimental paddock. Two such samples were taken from each of three sites, representing hilltop, valley bottom and intermediate grassland. Herbage was dried at 70°C.

Samples of water were taken from earthen dams used by the cattle. Samples of saliva, urine and milk were collected from cows of both groups at the end of the tenth week.

The contents of sodium and potassium in these samples were determined by direct flame photometry.

RESULTS

Liveweight Changes

Mean liveweights of the cows, and of the calves, at weekly intervals are plotted in *Figure* 1.

The mean (± standard error) increase in liveweight of the SS cows was 61 ± 6.6 kg whereas the US cows lost an average of 23 ± 7.4 kg ($P < 0.001$). The supplemented group gained about 40 kg in the first week of supplementation and thereafter their rate of

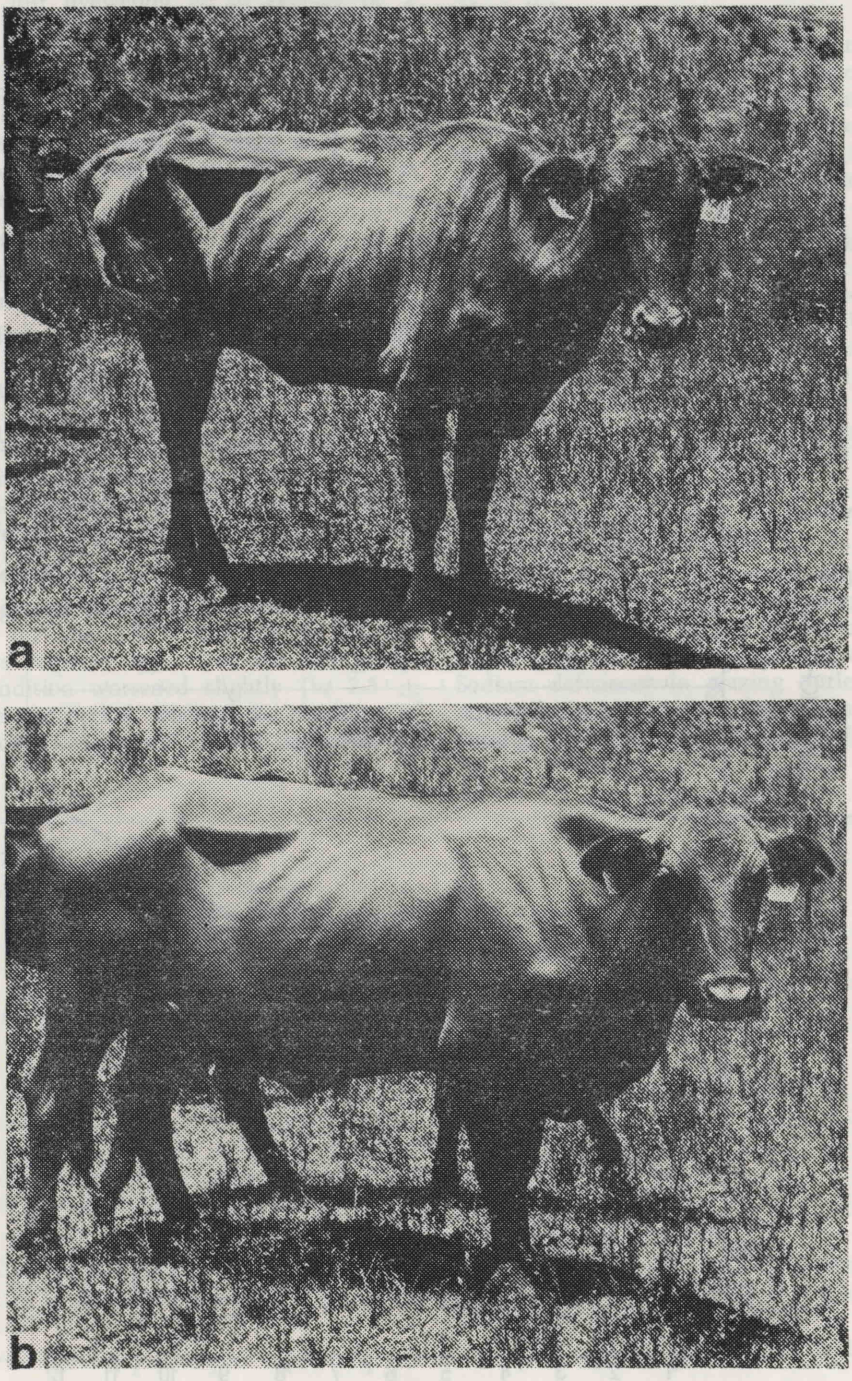

Plate I.—a. Unsupplemented cow judged to be in very poor condition (1).
b. Supplemented cow judged to be in good condition (5)

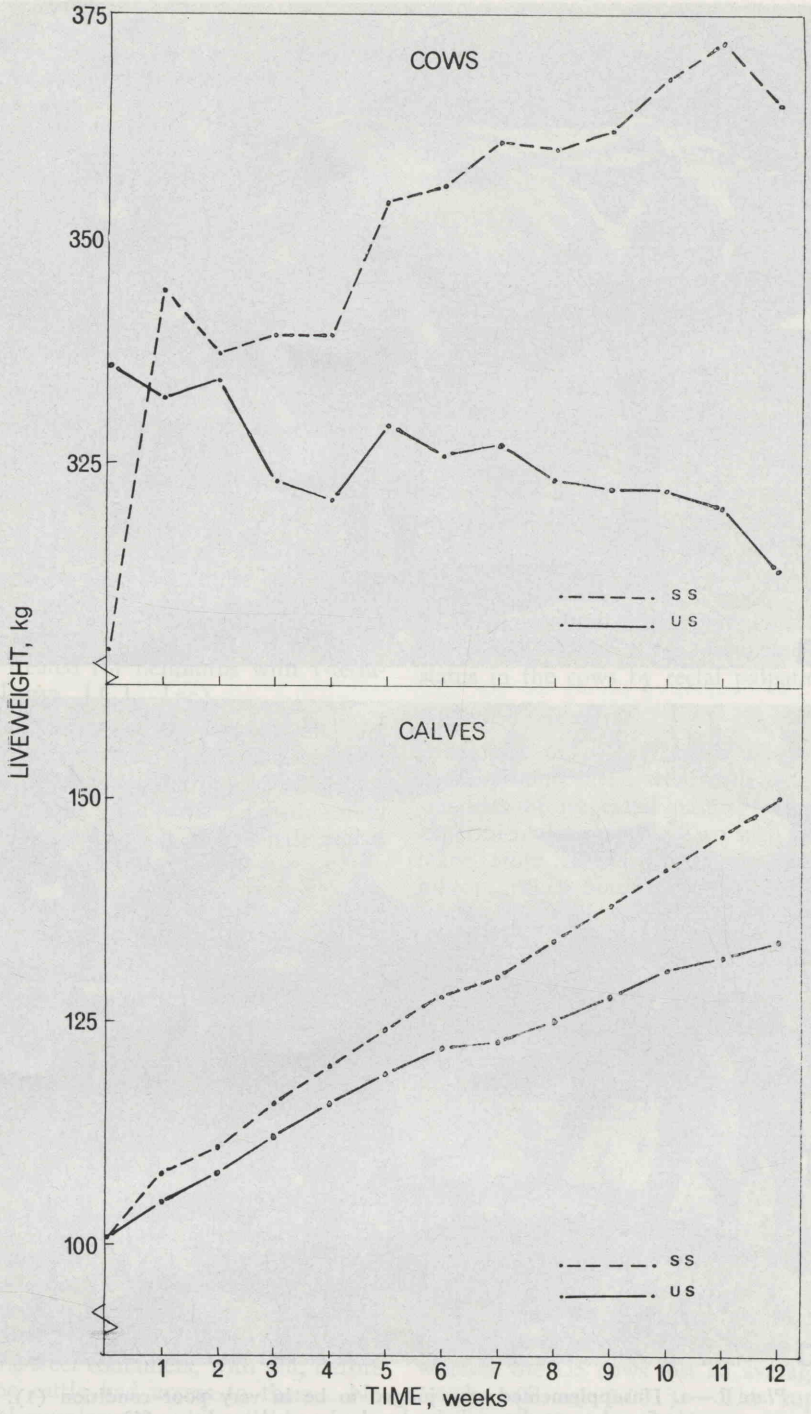

Figure 1.—Liveweight changes during the experiment for supplemented (SS) or unsupplemented (US) cows and calves

gain averaged 2 kg/week. The US cows in contrast, lost liveweight at an average of 2 kg/week throughout.

Calves of SS cows gained 49 ± 2.5 kg, compared with 35 ± 5.0 kg for the US calves ($P < 0.05$). Growth of the latter calves was slower but steady until the sixth week when the growth rate fell to 60 per cent of its earlier value.

Salt Consumption

Consumption of salt by the SS group during the experiment is illustrated in *Figure* 2.

Initially, salt was consumed at a very high rate but after the third supplementation day, consumption fell to a mean of 314 ± 29 g per cow per week. The SS cows ate most of the salt but their calves were seen to eat a little.

Each supplementation day, the cattle showed almost no interest in the salt after one hour, and preferred to graze or drink.

Body Condition

Both groups started in low body condition (2.6 ± 0.2 and 2.9 ± 0.4 for the SS and US cows respectively). For the US group, body condition worsened slightly (to 2.5 ± 0.4) over the period, whereas the condition of the SS cows was judged to have improved (to 4.0 ± 0.3: $P < 0.001$).

Mortalities

In the US group, one cow died in the fifth week and another died in the eleventh week. Both were first found recumbent and unable to stand even with assistance. Post-mortem examinations were not performed but death appeared to have been related to extreme emaciation.

Data for these cows and for their calves have been ignored in calculations. One calf was male and one was female, leaving three male and five female calves in the US group.

Pregnancy Status

Three of ten SS cows were detectably pregnant (1.5, 1.5 and 6 months) compared with one of eight cows in the US group (5 months).

Sodium and Potassium in Pasture, Water, Saliva, Urine and Milk

Pasture herbage contained only a trace (< 0.5 m-equiv/kg dry matter) of sodium. The sodium content of pasture plants usually lies in the range 20 to 350 m-equiv/kg dry matter. Sodium deficiency in grazing cattle has been reported from Australia with pastures containing 3.5 to 8.3 m-equiv/kg (Murphy and

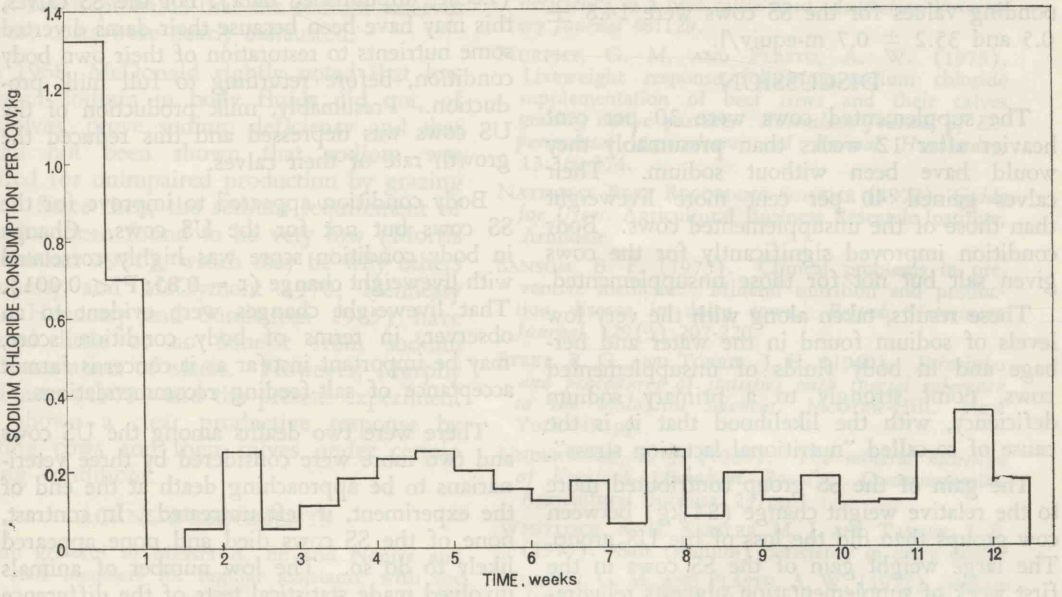

Figure 2.— Salt consumption per cow on supplementation days

Plasto 1973) and 2.6 to 6.1 m-equiv/kg (Hennessy and Sundstrom 1975) of sodium in the dry matter.

The mean content of potassium in the pasture samples was found to be 182 m-equiv/kg.

Drinking water samples contained an average of 0.42 m-equiv/l of sodium and 0.5 m-equiv/l of potassium. The sodium content is extremely low (Murphy and Plasto 1972).

Saliva samples from the SS cows, with 147.7 ± 6.2 m-equiv/l of sodium and 6.1 ± 1.5 m-equiv/l of potassium, were normal. In contrast, the levels for the control cows were indicative of acute sodium deficiency: 32.3 ± 6.6 m-equiv/l of sodium and 70.0 ± 5.0 m-equiv/l of potassium. These differences are significant for both elements ($P < 0.001$).

The level of sodium in the urine of the US cows was markedly depressed in relation to that of the SS cows (0.76 ± 0.11 versus 60.7 ± 11.5 m-equiv/l; $P < 0.01$). The potassium content was lower in the US cows but not significantly (178.1 ± 24 versus 222.6 ± 27 m-equiv/l).

There were no significant differences between groups in the sodium and potassium levels in milk. For the US cows the concentrations of sodium and potassium were 15.5 ± 1.6 and 32.2 ± 3.2 m-equiv/l and the corresponding values for the SS cows were 14.8 ± 0.5 and 35.2 ± 0.7 m-equiv/l.

DISCUSSION

The supplemented cows were 30 per cent heavier after 12 weeks than presumably they would have been without sodium. Their calves gained 40 per cent more liveweight than those of the unsupplemented cows. Body condition improved significantly for the cows given salt but not for those unsupplemented.

These results, taken along with the very low levels of sodium found in the water and herbage and in body fluids of unsupplemented cows, point strongly to a primary sodium deficiency, with the likelihood that it is the cause of so-called "nutritional lactation stress".

The gain of the SS group contributed more to the relative weight change (84 kg) between cow groups than did the loss of the US group. The large weight gain of the SS cows in the first week of supplementation suggests rehydration of tissues, as dehydration is common in severe sodium depletion. Reduced feed intake is another symptom reported in sodium deficiency (Morris and Gartner 1971) and so, greater gut fill, resulting from sodium repletion, may have added to the large weight increase. Whitlock *et al.* (1975) reported a similar sudden weight gain (76.4 kg in 12 days) in a sodium-depleted cow after salt was given. The gradual liveweight increase of SS cows in the last ten weeks of the present work, along with apparent improvement in body condition, is suggestive of real tissue deposition.

The more rapid growth of the SS calves probably was due to increased milk production by their dams rather than to a direct effect of sodium supplementation on the calves. The level of sodium in milk is maintained until depletion is severe (Gunther 1970; Murphy and Plasto 1973; this experiment) and even milk production is unaffected in the early stages (Underwood 1966; Gunther 1970). Indeed this is why the milking cow is more likely to become sodium-deficient compared with dry cows and male cattle.

Calves of both groups grew slower (0.58 and 0.42 kg/day for the SS and US calves, respectively) than the mean pre-weaning growth rate of calves (0.73 kg/day) from similar, salt supplemented herds on this station (Leche, unpublished data). For the SS calves, this may have been because their dams diverted some nutrients to restoration of their own body condition, before returning to full milk production. Presumably, milk production of the US cows was depressed and this reduced the growth rate of their calves.

Body condition appeared to improve for the SS cows but not for the US cows. Change in body condition score was highly correlated with liveweight change ($r = 0.85$; $P < 0.001$). That liveweight changes were evident to an observer, in terms of body condition score, may be important insofar as it concerns farmer acceptance of salt-feeding recommendations.

There were two deaths among the US cows and two more were considered by three veterinarians to be approaching death at the end of the experiment, if left untreated. In contrast, none of the SS cows died and none appeared likely to do so. The low number of animals involved made statistical tests of the difference inappropriate.

For the same reason, results of the pregnancy diagnosis were not tested. However, they favoured the SS group in that three of the ten SS cows were pregnant compared with one of eight US cows. Further, two of three pregnant SS cows had conceived since supplementation began. It can be shown that a random sample from a fertile herd in these conditions should show about 40 to 45 per cent pregnancy at any time. Therefore, the pregnancy rate for each group was poor and specially so for the US group.

The daily dietary sodium requirement of a 500 kg cow producing 7 kg milk/day has been estimated at about 10 g for maintenance and 6 g for the milk (Gunther 1970; Sansom 1973; Aitken 1976). From the levels of sodium in the water and herbage, the cows of this experiment would not likely have received more than 5 per cent of this requirement from these sources. Unsupplemented lactating cows in these conditions could be in deficit about 15 g sodium/day. As the mobilizable reserves of sodium in a cow are about 200 g (Gunther 1970), it is clear that these reserves could be depleted within several weeks after calving. The levels of sodium and potassium in saliva and urine of the US cows are typical of severe sodium deficiency (Murphy and Connell 1970; Murphy and Plasto 1973; and Whitlock *et al.* 1975) and it seems probable that the sodium reserves of these cows were nearly exhausted.

In 1968, McDonald rightly noted that low levels of sodium in body fluids did not, of themselves, prove sodium deficiency and that it had not been shown that sodium was required for unimpaired production by grazing cattle. Since then, the sodium requirement of steers has been found to be very low (Morris and Gartner 1971), which may be why others (Hennessy and McClymont 1970; Hennessy 1971; Hennessy and Sundstrom 1975) have reported little or no benefit from sodium supplementation of steers. However, Murphy and Plasto (1973) and the present experiment have shown a clear productive response by lactating cows and their calves under certain grazing conditions.

ACKNOWLEDGMENTS

I am grateful to Messrs A. Efi and Nonisa and other staff members for regular assistance with the cattle.

Special thanks are due to Ms Jayne Potter of the Central Veterinary Laboratory for analyses of saliva, urine, milk and water samples; to Ms B. Dick of the Chemistry Laboratory for analyses of pasture samples; and to Dr Joanna McKerrow for pregnancy diagnoses.

REFERENCES

GUNTHER, G. (1970). The mineral metabolism of the dairy cow with special reference to the provision in the diet of minerals formulated to meet the needs of the high-yielding animal. *Veterinary Medical Review, No.* 2, 71-89.

HENNESSY, D. W. (1971). Wanting salt and needing salt. *Australian Meat Research Committee Review* No. 3,14.

HENNESSY, D. W. AND MCCYMONT, G. L. (1970). Effect of water, nitrogen and potassium loading on sodium retention by cattle on a low sodium intake. *Proceedings of Australian Society of Animal Production*, 8:207.

HENNESSY, D. W. AND SUNDSTROM, B. (1975). Na;K ratio in saliva of beef cattle grazing kikuyu dominant pastures. *Journal of Australian Institute of Agricultural Science,* 41:59-60.

MCDONALD, I. W. (1968). The nutrition of grazing ruminants. *Nutrition Abstracts and Reviews,* 38(2):381-400.

MORRIS, J. G. AND GARTNER, R. J. W. (1971). The sodium requirements of growing steers given an all sorghum grain ration. *British Journal of Nutrition,* 25:191.

MURPHY, G. M. AND CONNELL, J. A. (1970). A simple method of collecting saliva to determine the sodium status of cattle and sheep. *Australian Veterinary Journal,* 46:595.

MURPHY, G. M. AND PLASTO, A. W. (1972). Sodium deficiency in a beef cattle herd. *Australian Veterinary Journal* 48:129.

MURPHY, G. M. AND PLASTO, A. W. (1973). Liveweight response following sodium chloride supplementation of beef cows and their calves grazing native pasture. *Australian Journal of Experimental Agriculture and Animal Husbandry,* 13:369-374.

NATIONAL BEEF RECORDING SCHEME (1972). *Guide for Users.* Agricultural Business Research Institute, Armidale.

SANSOM, B. F. (1973). Clinical problems in preventive medicine. Mineral nutrition and production disease in dairy cows. *British Veterinary Journal,* 129(3):207-220.

STEEL, R. G. AND TORRIE, J. H. (1960). *Principles and procedures of statistics with special reference to the biological sciences.* McGraw-Hill. New York. 481pp.

UNDERWOOD, E. J. (1966). *The mineral nutrition of livestock (Farnham Royal).* Commonwealth Agricultural Bureaux. 237pp.

WHITLOCK, R. H. KESSLER, M. J. AND TASKER, J. B. (1975). Salt (sodium) deficiency in dairy cattle;

MURPHY, G. M. AND PLASTO, A. W. (1972). Sodium deficiency in a beef cattle herd. *Australian Veterinary Journal,* 48:129.

(Accepted for publication November, 1976.)

Plasto 1973) and 2.6 to 6.1 m-equiv/kg (Hen-
nessy [illegible] dry matter [illegible]

The mean content of potassium in pasture samples was [illegible] 82 m-equiv/kg.

[illegible] of [illegible] of potassium [illegible] low (Murphy and Plasto 1973).

[illegible] ± 6.2 m-equiv/l of sodium and [illegible] m-equiv/l [illegible] m-equiv/l of sodium and 7[illegible] of potassium. These differences [illegible] for [illegible]

The level of [illegible] US cows was markedly [illegible] in relation to [illegible] 60.7 ± 11.3 m-equiv/l, P < 0 [illegible] potassium [illegible] but [illegible] 222 [illegible]

There [illegible] between [illegible] levels [illegible] trations of sodium and potassium [illegible] ± 1 [illegible] ponding values for the SS cows [illegible] 0.5 and 35.2 ± 0.7 m-equiv/l.

There [illegible] heavy [illegible] would have been without sodium. [illegible] calves [illegible] than those of the unsupplemented cows. [illegible] condition improved significantly for the cows given [illegible]

The [illegible] levels of sodium found in the water and herbage [illegible] cows [illegible] deficiency, with the likelihood that [illegible] cause of [illegible]

The [illegible] to the relative weight change [illegible] between the cow [illegible] The large weight gain of the SS cows in the first [illegible] tion of tissues, as dehydration [illegible]

severe sodium depletion. Reduced feed intake [illegible]

[illegible] replacement [illegible] increase [illegible] similar [illegible] given [illegible] SS [illegible] body condition [illegible] deposition.

The [illegible] probably [illegible] by [illegible] sodium [illegible] level [illegible] depletion [illegible] and [illegible] milk [illegible] Indeed [illegible] with [illegible]

Calves [illegible] and [illegible] respectively [illegible] growth [illegible] similar [illegible] (Leche [illegible]) this may have been [illegible] more nutrients to restoration of their own body condition [illegible] duction [illegible] US [illegible]

That [illegible]

[illegible] seemed to be approaching death at the end of the experiment. [illegible] none of the SS cows died and none appeared [illegible] involved made statistical tests of the difference [illegible] supplementation.