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RUBBER-VINE (CRYPTOSTEGIA GRANDIFLORA) TOXICITY FOR RUMINANTS

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SUMMARY

On one property in the restricted area of northern Queensland where rubber-vine is eaten by cattle, the usual annual mortality was 5 of 800 cattle mustered off the affected area. This rose to 30 of 1,000 cattle when they were mustered from the same area on which the rubber-vine had been burned the previous year.

Some cattle in the field "drop dead" during exercise, usually after a short gallop or trot. Death is often sudden, with little or no struggling. Necropsy usually shows marked congestion and cyanosis of blood vessels, particularly the cerebral and myocardial vessels. Rubber-vine is present in the ruminal contents.

Feeding trials with cattle showed that after fresh leaves had been minced, soaked in water for 16 hr and both leaves and extract introduced into the rumen, the lethal dose was as low as 0·7 g/kg bodyweight. Although the "dropping dead" syndrome was not reproduced in docile experimental cattle, it was reproduced in a paddock sheep which, over 3 days, received 10 g of minced rubber-vine leaves and their aqueous extract after soaking for 24 hr. The sheep collapsed after galloping 200 yd and died within a minute.

I. INTRODUCTION

This paper describes field and laboratory investigations carried out between 1953 and 1957 into the toxicity of rubber-vine (*Cryptostegia grandiflora*) for ruminants.

Originally a native of Madagascar, rubber-vine is now naturalized in most tropical and subtropical countries. It has been described in Queensland (White 1923), where it grows in many of the coastal streams and around old mining towns, to which it was introduced as an ornamental shrub. Both the Etheridge-Einasleigh-Gilbert and the Walsh-Palmer-Mitchell river systems have large stands of rubber-vine, but the most prolific growth is along the Etheridge River, 25 miles downstream from Georgetown. Here the river is shallow, is approximately 500 yd wide, and contains numerous small islands. Rubber-vine

grows densely over these islands and the trees on the river banks to a height of 40 ft (Figure 1), and forms an impenetrable wall to cattle except at isolated spots.

Fig. 1.—View of the dense growth of rubber-vine which has grown over the trees lining the bank of the Etheridge River downstream from Georgetown.

II. FIELD OBSERVATIONS

(a) History and Clinical Signs

Despite its wide distribution in Queensland, rubber-vine is known to be eaten only in the Georgetown area, where cattle can be seen stripping the leaves from the bushes as high as they can reach (Figure 2). Consumption is higher in the dry season when pasture is mature and of low quality.

Sudden deaths had been known to occur in cattle grazing rubber-vine around Georgetown since 1947. Mortalities were observed in the cattle adjacent

Fig. 2.—A cow eating rubber-vine growing in Georgetown in October 1955.

to Georgetown and on two properties (A and B) on the Etheridge River immediately downstream from Georgetown. The usual history was that cattle "drop dead" during mustering after trotting or galloping 50–200 yd. Some fell so suddenly while moving that they skidded forward due to momentum. Death occurred almost immediately or within several minutes, usually without struggling, although some bellowed or thrashed about with their limbs. None were known to recover.

Sudden deaths during mustering were first recorded on property A by J. W. Ryley in 1949 (Queensland Department of Primary Industres files). Exact annual losses were unknown, but apparently several cattle of approximately 800 pastured on the Etheridge River died each year. In the second half of 1953, large areas of the rubber-vine were burned, and in the first muster of 1954, immediately after the end of the "wet season", one cow died, and 6 weeks later, in a second muster, approximately 30 died. By this time surface water had dried off and cattle were forced to water from the Etheridge River, where they had access to the regrowth of the burned rubber-vine.

In the September 1954 muster, a 680-lb cow, 7 months pregnant and in excellent condition, dropped after trotting 50 yd and died without struggling (case 1).

In the May 1955 muster, one cow died (case 2) and was observed by the author. She was a 600-lb 15-year Shorthorn-Devon cow in poor condition and with a large calf at foot. On the first day of the muster she walked 6 miles and rested overnight. Next morning she walked 1 mile to the cattle yards, rested all day until 6 p.m., and then swam through a plunge dip. She staggered slightly for 10 yd and fell on her right side as she walked into the draining pen. Her tongue protruded. Death occurred within 3 min of collapsing. During this period she made several respiratory movements, her tongue was protruded and pulse and corneal reflexes were absent.

In August 1955, a further four cattle dropped dead during mustering.

Although cattle were mustered frequently on property B, sudden deaths seldom occurred. Details are summarized in Table 1.

TABLE 1

MORTALITIES DURING MUSTERING ON PROPERTY B

Case	Date of Death	Sex	Age (years)	Pregnant	Calf at Foot	Observations
1	Nov. 1951	Cow	8	No	2 months	Trotted from cattle yards and fell; died in seconds
2	Mid 1953	Heifer	1	Not known	No	Galloped short distance
3	Oct. 1953	Cow	4	Yes	Yearling calf	Trotted 200 yd
4	1955	Bullock	3	No	No	Trotted 200 yd
5	Oct. 1955	Heifer	2	Yes	No	Trotted 200 yd, fell, struggled, died
6	Oct. 1955	Heifer	2	Yes	No	Trotted 800 yd, fell, died without a movement

(b) Necropsy Findings

Case 1 showed dilatation and cyanosis of the subcutaneous vessels of the brisket and ventral abdomen. The meninges and brain and all vessels in the abdominal cavity except those on the fore-stomachs, urinary bladder and uterus were congested. Multiple submucosal haemorrhages up to 2 cm diam. were numerous in the first 1·5 m of duodenum and scattered thinly through the remainder of the small intestine and rectum. There were a few scattered 5-mm

subepicardial haemorrhages. Rubber-vine fragments were found in the ruminal contents. On microscopic examination, the acute venous congestion in the vessels seen on gross examination was confirmed and generalized congestion of the myocardial capillaries and the brain was found. Scattered perivascular haemorrhages were seen throughout the brain.

Case 2 had only badly worn teeth and interstitial emphysema in the left lung. Histopathological examination showed acutely congested myocardial capillaries and perivascular haemorrhages in the medulla oblongata, hypothalamus, hippocampus and cerebral cortex.

(c) Biochemical and Botanical Examinations

Because these sudden deaths had some similarity to "falling disease" described in Western Australia (Bennetts and Hall 1939), liver copper levels were checked. Case 1 had 6 p.p.m. and case 2, 130 p.p.m. of liver copper. Two apparently normal steers from the property had 72 and 60 p.p.m. copper when sampled in January and September of 1955.

In May 1955, blood samples taken from 40 cattle from four different areas of property A were analysed for phosphorus and copper. In cattle from three paddocks in which there had been no sudden deaths, the blood phosphorus levels ranged from 1·6 to 5·5 mg/100 ml, and blood copper levels ranged from 0·05 to 0·09 mg/100 ml. The cattle in which sudden deaths occurred had blood phosphorus levels of 2·2—4·8 mg/100 ml, and blood copper levels of 0·05—0·08 mg/100 ml. Liver copper levels of two steers slaughtered for meat on property B in January and March 1955 were within the normal range, being 49 and 124 p.p.m.

The ruminal contents of one animal that died on property A in August 1955, and of two cattle that dropped dead on property B in October 1955, contained rubber-vine in concentrations of 0·14, 0·14 and 0·18% (w/w of solid contents).

III. FEEDING TRIALS

Results of feeding trials with 11 cattle, 1 goat and 4 sheep undertaken by the author, and unpublished work by A. L. Clay (Queensland Department of Primary Industries files, 1942) and L. G. Newton (Queensland Department of Primary Industries files, 1950) involving 3 cattle, are reported.

(a) Cattle

Attempts were made to reproduce the field mortalities by feeding rubber-vine collected near the laboratory at Townsville to cattle. Because experimental cattle do not eat rubber-vine readily and repeated dosing by stomach-tube or gelatin capsule is unreliable, ruminal fistulas closed by rubber bungs were used. In early experiments, whole, chopped or minced leaves were introduced

TABLE 2

RESULTS OF FEEDING TRIALS WITH CATTLE

Date	Trial No.	Body-weight (kg)	Dose (g/kg BW)	Dose (g)	State of Plant	Period of Feeding	Method of Feeding	Result
8.vii.42 Clay* ..	1	?	..	454	Chaffed	48 hr	In bran	No abnormality detected
8.vii.42 Clay* ..	2	?	..	1,135	Chaffed	48 hr	In bran	Anorexia for 5 days, diarrhoea
21.viii.50 Newton† ..	3	180	0·6	110	Finely ground in 800 ml water	One dose	Leaves and extract *via* stomach tube	Bright green diarrhoea for 2 days
14.xii.53 ..	4	200	2·2	454	Finely minced, suspended in 6·8 litres water for an hour	One dose	As trial 3	Anorexia and diarrhoea for 2 days
28.xii.53 ..	5	200	4·5	908	Finely minced, suspended in 6·8 litres water for an hour	One dose	As trial 3	Died within 2 hr with dyspnoea and pale mucous membrane
16.v.54 ..	6	270	..	1,930	Finely minced, collected weekly	61 days	Gelatin capsule perorally	No abnormality detected
1.ii.55 ..	7	385	..	170	Chopped	Two doses of 85g, 24 hr apart	Ruminal fistula	Anorexia for 2 days; no diarrhoea
8.ii.55 ..	8	385	..	456	Chopped	114 g each day for 4 days	Ruminal fistula	Anorexia for 3rd and 4th days but no diarrhoea
16.ii.55 ..	9	385	2·3	908	Fresh leaves chopped coarsely	One dose	Ruminal fistula	Anorexia and very fluid diarrhoea for 2 days
4.iv.55 ..	10	385	5·9	2,270	Fresh leaves chopped coarsely	One dose	Ruminal fistula	Died 12 hr or more after dosing
25.vii.55 ..	11	?	..	14	Whole leaves	2 days	*ad lib.* with bush hay	Refused to eat on day 3 and trial discontinued after day 6

15.x.55	..	12	410	..	3,855	Fresh whole leaves over 25 days. On day 26, 170 g leaves, minced, soaked in 2·5 litres of water for 1 hr	26 days	Ruminal fistula	Exercised daily without result. Diarrhoea on day 9 but ate well. Died on night of day 26 after 170 g
17.x.55	..	13	272	0·6	170	Minced fresh leaves fed immediately	One dose	Ruminal fistula	Anorexia
14.xii.55	..	14	321	0·7	227	Minced fresh leaves in 2·5 litre water extracted 16 hr in refrigerator	One dose	Leaves and aqueous extract through ruminal fistula	Died overnight (i.e. in less than 24 hr)

* Queensland Department of Primary Industries files, 1942.

† Queensland Department of Primary Industries files, 1950.

into the rumen, but later, leaves were minced and soaked in water and both the leaves and extract poured through the ruminal fistula. To try to simulate field conditions, experimental cattle were exercised by a man on horseback. They were docile and would not gallop strenuously; none died during exercise. Details of trials with cattle are summarized in Table 2.

The four animals that died during these trials were necropsied. The cow from trial 5 which died within 2 hr of dosing with rubber-vine showed only a congested abomasal mucosa. The animals from trials 10, 12 and 14, which lived for at least 12 hr after dosing, showed acute myocardial congestion and haemorrhage, as well as scattered haemorrhages throughout the submucosa of the small intestine. Besides these lesions the animal from trial 12 had congested lungs, abomasal mucosa and subcutaneous vessels. Trial 14 steer had congested vessels in the brain, myocardium, lungs and abomasal, duodenal and tracheal submucosae.

(b) Sheep and a Goat

Four paddock sheep which would gallop readily, and a goat, were dosed with minced rubber-vine leaves by stomach-tube. The rubber-vine fed to the goat was collected and fed in Townsville. For all the sheep trials, green succulent leaves were collected daily at 9 a.m. from a plant in the Brisbane Botanic Gardens. Within 1 hr the leaves were minced and suspended in water and 24 hr later sheep were dosed with this watery suspension. Results of these feeding trials are summarized in Table 3.

In trial 5, a sheep died during strenuous exercise, thus simulating a field mortality, and this experiment is described in detail. A total of 10 g of minced rubber-vine was administered over 3 days. The sheep was exercised twice per day, at 10.00 a.m. and 3.30 p.m., by a man on horseback. Exercise started immediately after the wether received the last dose of 2 g of leaves and extract on the morning of day 3. He cantered 400 yd, staggered and fell onto his side, was raised to his feet, cantered a further 400 yd and fell again. No abnormality was revealed on auscultation. In the afternoon of day 3, he cantered 400 yd, stopped with his mouth open and tongue protruded, and then trotted a further 600 yd and refused to move. On day 4, at 10.00 a.m., the wether cantered 600 yd and again showed distress. In the afternoon, he galloped 300 yd, staggered and then stopped with his mouth open. On day 5, after galloping 200 yd at full speed, he stopped with his mouth open and head held low, sank to the ground and died within a minute. Immediately after collapsing, the buccal mucous membrane was pale, the respiration rate, which had been very fast during exercise, became gasping and spasmodic and ceased after 5 respirations in 60 sec. No heart sounds were heard on auscultation.

Necropsy revealed congestion of the subcutaneous vessels on the right side of the body, the right lung, submucosal vessels of the trachea and first metre of the duodenum. Irregular 10 x 5 mm subpleural haemorrhages were scattered

TABLE 3

RESULTS OF FEEDING TRIALS WITH SHEEP AND A GOAT

Trial	Date	Weight of Sheep or Goat (kg)	Dose (g/kg BW)	Total Weight of Plant (g)	State of Plant	Period of Dosing	Method of Feeding	Result
1	28.xii.53	31, goat	3·89	120	Mature leaves	One dose	Aqueous extract and minced leaves soaked for 2 hr in 2 litres of water, *via* stomach tube	Died in 1 hr
2	13.ix.56	36, wether	0·39	14	Dark-green mature leaves	One dose	Aqueous extract and minced leaves soaked for 24 hr in 500 ml water, *via* stomach tube	Died 36 hr later, overnight; no symptoms seen
3	22.x.56	46, wether	0·15	7	Young green succulent leaves	One dose	As trial 2 above	Collapsed during strenuous exercise 48 hr after dosing. Recovered
4	5.xi.56	46, wether	0·22	10	Very young green succulent leaves	One dose	As trial 2 above	Died 36 hr later during the night. No clinical symptoms seen
5	19.ii.57	36, wether	..	10	Mature dark green succulent leaves	3 doses of 4, 4 and 2 on days 1, 2, 3 respectively	Aqueous extract and minced leaves soaked for 24 hr in 300 ml water, *via* stomach tube	Died on day 5 after exercise. (See text for full description).

over the left diaphragmatic lobe and 10 x 5 mm subendocardial haemorrhages were confined to the left ventricle, where they covered most of the wall and papillary muscles. Besides confirming the gross changes, histopathological examination revealed congested capillaries in the myocardium and throughout the brain. Small perivascular haemorrhages were also present in the medulla, midbrain and cortex.

IV. DISCUSSION

Feeding of rubber-vine to experimental cattle was not satisfactory, apparently due to unpalatability. In trial 11, only 14 g of leaves mixed with bush hay were eaten in 2 days. However, Clay (Queensland Department of Primary Industries files, 1942) induced two stalled cattle to eat 454 g and 1,135 g of rubber-vine leaves mixed with bran without any ill effect being apparent.

Trials 4 and 12 indicate that there may be a cumulative effect. Fresh minced leaves soaked in water for 1 hr did not kill when administered at 2·2 g/kg body-weight in trial 4. But in trial 12, 0·4 g/kg body-weight of similarly prepared leaves killed a steer which had received 3,855 g of fresh chopped rubber-vine leaves over the previous 25 days.

In all sheep and goat trials, the rubber-vine leaves were minced and soaked for 24 hr before being administered by stomach-tube. It is interesting to compare the effect of different dose rates—3·8 g/kg killed in 1 hr, 0·38 g/kg and 0·21 g/kg killed within 36 hr and 0·15 g/kg caused a sheep to collapse during exercise although later it recovered. In trial 5, 10 g rubber-vine leaves administered over 3 days, equivalent to an average per day of 0·9 g/kg, resulted in a sheep dying suddenly during exercise and thus simulating the deaths in cattle at Georgetown.

Field mortalities associated with rubber-vine ingestion reached serious proportions only in the year following the burning of the rubber-vine, when the regrowth proved more attractive to cattle. Possibly the fresh young leaves contained more toxin.

Aebi and Reichstein (1950) have isolated two cardiac glycosides, cryptograndiosides A and B, from rubber-vine. Watson and Thorp (1953) were able to demonstrate that an alcoholic extract of rubber-vine had an extremely toxic cardiac glycoside action on anaesthetized guinea pigs under artificial respiration. Apparently cattle at Georgetown may eat sufficient rubber-vine to interfere with cardiac output only during the most strenuous exercise or they may have developed some tolerance to the cardiac glycosides.

In humans, overdosage of digitalis (a cardiac glycoside) induces anorexia, nausea, vomiting, diarrhoea and abdominal discomfort (Goodman and Gilman 1956). With the exception of nausea and vomiting, which cannot be evaluated in ruminants, all of these signs have been seen in cattle receiving large amounts of rubber-vine. Overdosage of cardiac glycosides raises the blood pressure in

experimental animals, due to both a direct action on the muscle of the blood vessels and central vasomotor stimulation. The experimental and natural cases of rubber-vine poisoning had perivascular haemorrhages, which may have been the result of high blood pressure. The final result of overdosage with cardiac glycosides is death due to cardiac arrest. This could result in sudden deaths as seen in natural cases and the experimental sheep which "dropped dead".

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