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Growth, milk intake and behaviour of artificially reared sambar deer (*Cervus unicolor*) and red deer (*Cervus elaphus*) fawns

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SUMMARY

Sambar deer ($n = 8$) and red deer ($n = 8$) fawns were successfully artificially reared to 70 days of age, using ewe milk replacer, at Flock House Agricultural Centre, New Zealand, during 1991. Sambar deer fawns had a lower overall milk consumption than red deer fawns (312 *v.* 359 g DM/day; $P < 0{\cdot}05$), and showed an earlier peak in milk consumption, a faster rate of decline and earlier self weaning. Birth weight as a proportion of dam liveweight was lower for sambar than for red deer, but liveweight gains to weaning (347 *v.* 330 g/day) and 70 day weaning weights (30·0 *v.* 30·4 kg) were similar. The age at which deer commenced a range of activities, including eating forage and ruminating, was similar for both species, except that jumping activities commenced 5 days later in sambar than in red deer ($P < 0{\cdot}01$). Following milk feeding, sambar fawns were less active than red deer fawns. It was concluded that sambar deer fawns can be successfully artificially reared using ewe milk replacer, but that extra precautions are needed to avoid scouring and abomasal bloat, which were more prevalent in sambar than in red deer fawns.

INTRODUCTION

Deer entered a new era, with the commercialization of deer farming in New Zealand (NZ) in 1969. Since then, many other countries have adopted deer farming and the practice is rapidly spreading world wide. To date, most deer species being farmed are temperate deer. Predominantly, in NZ, the species being farmed are red deer (*Cervus elaphus*), with a smaller number of fallow deer (*Dama dama*) and wapiti deer (*Cervus elaphus canadensis*) (Game Industry Board, personal communication). In Italy and Denmark, fallow deer are the main species being farmed, with a lesser number of red deer (Rambotti 1985; Vigh-Larsen 1988), whereas in the United Kingdom, red deer are the principal species being farmed (Milne 1988).

Diversification into farming tropical deer is still in a very early stage, with developments in Australia (Mackenzie 1985; English 1988; Woodford 1991; rusa (*Cervus timorensis*), sambar (*Cervus unicolor*) and axis deer (*Axis axis*)), New Caledonia (Chardonnet 1988; rusa deer), Papua New Guinea (Stewart 1985; rusa deer), Taiwan (Hsia *et al.* 1987; sambar deer), Mauritius (Lalouette 1985; rusa deer) and Thailand (de Vos 1990; axis deer). It appears that, to date, rusa are the most widely farmed tropical deer, followed by sambar and axis deer. Sambar are the largest of the tropical deer. The main attraction of sambar deer is their large body size and body conformation, with very meaty hindquarters. The velvet antlers from adult sambar deer stags could also be a valuable product.

In NZ, sambar deer have been introduced and liberated for almost 120 years (Wodzicky 1950), and have adapted to a wild environment in the coastal Manawatu region. However, the farming of sambar deer has not commenced in NZ, as the number is still very low (300 animals) and they have not been extensively studied or adequately documented in a confined environment. Sambar deer are known for their very temperamental and aggressive nature which, with their large size, has made the yarding and handling of wild adult sambar deer impossible under NZ conditions.

Artificial rearing of several deer species has been conducted with a high degree of success (Fennessy *et al.* 1981, red deer; Long *et al.* 1961; Robbins & Moen 1975, white-tailed deer; Parker & Wong 1987, black-tailed deer; van Mourik 1983, rusa deer), and there is a need to develop similar rearing procedures with

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sambar deer. This is the first step to domesticating sambar deer in NZ and producing animals that can readily be handled.

Objectives of the present research were to develop procedures for the artificial rearing of young sambar deer fawns, to determine the normal body dimensions at birth, to measure milk intake and growth rate of these sambar deer fawns, and to compare them with red deer fawns reared under similar conditions. Some behavioural observations on sambar and red deer fawns during the period of artificial rearing were also documented.

MATERIALS AND METHODS

Experimental design

Nine red deer and ten sambar deer fawns were taken from their mothers within 24 h of birth and were artificially reared with ewe milk replacer until weaning age (70 days). Body dimensions at birth (weight, height, girth circumference and length), liveweight gain, milk consumption and behavioural aspects during artificial rearing were recorded.

Location

The study was carried out at the Flock House Agricultural Centre deer farm, Bulls, Manawatu. Annual rainfall is 875 mm with a dry period from January to March (summer), and strong westerly winds during October and November (spring). The mean monthly temperature ranged from 9 to 20 °C

Animals

Red deer fawns

Between 8 December 1990 and 27 December 1990, nine red deer fawns (six stags and three hinds) were acquired within 24 h of birth. The fawns were considered to be late births, with a mean birth date of 14 December 1990.

As the fawns were acquired, they were ear tagged, put into individual pens (1·5 × 2·0 × 0·9 m high), and left undisturbed for 18–24 h before the first milk was offered. The four pens were made from aluminium pipe and located inside an enclosed, concrete floored building (23·0 × 12·0 × 3·5 m high). Each pen floor was covered with sawdust (5 cm thick) and two bales of meadow hay were put in each pen in an L shape, as a hiding place. The sawdust was replaced every week, but any wet or dirty areas of sawdust were removed daily.

Table 1. *Milk feeding regime during the artificial rearing of red deer and sambar deer fawns at Flock House Agricultural Centre, New Zealand during 1991*

Week	Number of feeds per day	Time
1	4	06.00–07.00, 12.00–13.00, 17.00–18.00, 22.00–23.00
2–4	3	06.00–07.00, 15.00–16.00, 22.00–23.00
5–8	2	08.00–09.00, 22.00–23.00
9–10	1	09.00–10.00

After the fawns had spent 3 days in the pens, they were allowed daytime access to the grassed area (20 m²). By 3·0–3·5 weeks of age, all fawns were transferred into a small paddock (300 m²), outside the building, and 3 weeks later they were transferred to a large paddock (0·55 ha) in the deer farm.

Sambar deer fawns

Between 2 January 1991 and 3 September 1991, there were 15 sambar births, of which five fawns died immediately after birth. The remaining sambar fawns (seven stags and three hinds) were taken from their mothers within 24 h of birth and ear tagged. Fawns were put in an enclosed shed and left undisturbed for 18–24 h before the first milk was offered.

The shed floor was made of concrete, and in one corner an area of 2·4 m² was covered with sawdust (5 cm thick) and protected by two bales of meadow hay in an L shape. The sawdust was replaced every week, for the first 2 weeks only. Wet or dirty sawdust was removed daily. Outside the shed was an area of lawn (100 m²). Because some sambar fawns were born during the winter (June–August), a 250 watt infra-red bulb, as a heater, was hung *c.* 80 cm above the sawdust area.

For the first 3 days, the fawns were kept inside the shed during the night and allowed outside during the day. From day 11, the shed was left open all the time and the fawns had total freedom in seeking shelter within the protected area. When the forecast indicated night frosts, the fawns were kept inside the shed. At 4 weeks of age, all fawns were transferred to the deer farm area.

Feeding

Fawns were bottle-fed with ewe milk replacer (Anlamb; Anchor Dairy Company Ltd, Hamilton, NZ), containing 38·5% lactose, 27% milk fat, 3% vegetable oil and 6% minerals (including 1·2% NaCl). The milk powder was mixed with warm (30 °C) water that had been boiled and allowed to cool, giving a 30% w/v mixture.

For the first 3 days, the fawns were given a restricted amount of milk (65% of normal intake), to ensure no stomach upset occurred. Thereafter until weaning (70 days) they were fed *ad libitum*. The feeding regime is shown in Table 1. Because the first red deer fawn demonstrated an appetite for soil, moist soil was always available and replaced once it was dried. Samples of milk powder were taken from

Table 2. *Description of the behaviour being observed during artificial rearing of red deer and sambar deer fawns*

Subject	Description
Related to feeding behaviour	
Licking soil	Taking soil either by licking or gnawing the soil surface, or from the soil that was provided.
Nibbling dead forage	Starting to use the tongue or sometimes teeth, through light biting, to 'taste' any dead matter of plant parts (dead leaves, stems, twigs or hay).
Eating fresh forage	Light grazing, where the head jerking was clearly seen when plucking the grasses.
Light ruminating	Rumination lasting for a short period (*c.* 2 min), as indicated by distinct upper and lower jaw and throat movements during mastication and regurgitation.
Light browsing	Actively eating fresh plant leaves in small numbers. Applied only to sambar deer fawns.
Gnawing bark chips	Gnawing the available wood bark chips. Applied only to sambar deer fawns.
Meconium disappearance	When this yellowish gelatinous substance is no longer present in the rectum.
Defecate alone	Defecating automatically, without any help from the operator, in rubbing the rectum area.
Faecal granule	When faeces are produced in pellet form.
Related to environment	
Bound to operator	Actively standing up or coming towards the operator when they were called for feeding.
Running	Running, jumping or chasing each other.
Jumping the fence	Jumping the protected fence (0·95–1·15 m height)
Socializing	When fawns start to stay together as a group. Applied only to sambar deer fawns.

individual batches, for laboratory analysis. As the fawns were released into the paddock, samples of pasture grass were cut to soil level and stored at −20 °C for subsequent nutritive value analyses.

Health

At the time the fawns were acquired, 2 ml of liquid vitamin supplement (Hydrovit; Rhone Poulenc Ltd, NZ) was given orally. Because of heavy infestation with ticks, all fawns from both species were treated with 2 ml Flumethrin (Bayticol; Bayer New Zealand Ltd), longitudinally along the back.

When scouring occurred, milk was omitted for two feeding times, and the fawns were fed solely with high-energy electrolyte solution (Life Aid-P; Vetco Products Ltd, Manukau City, NZ). Milk then gradually replaced the electrolyte solution, until their normal intake had been reached, generally after 3 days. After feeding, all utensils were washed and immersed in antibacterial solution (Milton; Proctor & Gamble Ltd, NZ).

After the fawns had been transferred to the deer farm paddock they were drenched every 3 weeks with Ivermectin (IVOMEC; Merck, Sharpe & Dohme Ltd, NZ), to protect from internal parasites and lungworm. At weaning, all animals were vaccinated against clostridial infections using Tasvax Convax 5 vaccine (Coopers Animal Health Ltd, NZ).

Data collection

Body dimensions at birth (weight, length, height and girth circumference) were measured 1 day after being acquired. Body length was measured diagonally, from front leg pinbone to lateral tuberosity on the rear leg scapula. Body height was measured vertically from the ground to the shoulder, and body circumference was measured immediately behind the shoulder (Sharples & Dumelow 1990). Liveweight was measured weekly for the first 4 weeks, and every 2 weeks thereafter. Milk intake was recorded daily. Behaviour of the fawns was recorded, particularly when the activities shown in Table 2 commenced.

Laboratory analysis

Milk powder samples were analysed for DM, total N and gross energy, whilst forage samples were analysed for DM, total N and *in-vivo* digestibility. Forage samples were freeze-dried and ground to 1 mm diameter (Willey Mill, USA) prior to laboratory analysis. Dry matter (DM) was measured by drying the samples in an oven at 110 °C for 16 h. Total nitrogen (N) was determined by the Kjeldahl procedure, whilst *in-vitro* digestibility followed the method of Roughan & Holland (1977). Gross energy was determined in an adiabatic bomb calorimeter (Gallenkamp; Watson Victor Ltd, UK).

Statistical analysis

Body dimensions at birth and behavioural data were analysed using Student's *t*-test. Milk intake, and liveweight gain data were analysed by analysis of variance using a Generalized Linear Model procedure (SAS 1987). The liveweight gain was grouped into three categories, based upon the growth pattern, from age 0–7 days, age 7–28 days and age 28–70 days; for the latter two categories, liveweight gain was calculated as the slope of regression of weight (kg) on age (days).

RESULTS

Table 3 shows the nutritive value of the milk powder being used during artificial rearing and the pasture being grazed by both red deer and sambar deer fawns.

Date of birth and birth body dimensions

The median calving date of the red deer in the study was 14 December 1990 (S.D. 3·8 days), 10 days later than the median calving date of the red deer at Flock House deer farm (4 December 1990). In contrast to red deer, sambar deer calved over a wide interval, stretching from January to September, with the median calving date being 10 June 1991 (S.D. 68·5 days).

During the period of artificial rearing, one red deer fawn (hind) died at the age of 3 days, due to severe scouring. The birth weight of this fawn was also considered very low, being only 4·5 kg. Two sambar deer fawns also died (stags), one at 12 days of age (8·5 kg), due to abomasal bloat, and the other at 9 days of age (9·0 kg), due to severe scouring. Data from dead fawns were not included in the analysis. Sambar deer fawns tended to be bigger in their body circumference (+1·9 cm; Table 4), shorter in body length (−1·1 cm), and lighter in body weight (−0·6 kg) than red deer fawns, but none of these differences was statistically significant. The body height of sambar deer was significantly less (−3·9 cm; $P < 0·10$) than red deer fawns.

Table 3. *The nutritive value of milk powder and pasture being grazed during the period of artificially rearing red deer and sambar deer fawns to 70 days of age*

Content	Milk powder	Pasture
Total nitrogen (% DM)	4·6	3·0
Gross energy (KJ/g DM)	23·6	ND*
In vivo organic matter digestibility (%)	ND	80·3

* ND = not determined.

Table 5. *Mean daily liveweight gain (g/day) for both red deer fawns and sambar deer fawns during the period of artificial rearing at Flock House Agricultural Centre, New Zealand in 1991 (± S.E.)*

Phase	Week	Red deer ($n = 8$)	Sambar deer ($n = 8$)
1	0–1	161 (±140·8)	241 (±99·6)
2	1–4	403 (±66·2)	387 (±46·9)
3	4–10	318 (±47.1)	322 (±34.0)
Overall		330 (±18·8)	347 (±13·4)

Weight changes and milk composition

All red deer fawns and six out of eight sambar deer fawns were weaned at 70 days of age. Early self weaning occurred with two sambar deer fawns, when they refused to take any milk on a daily basis, for 3 consecutive days, at the age of 61 days (hind, 26·2 kg) and 62 days (stag, 32·5 kg), respectively.

The weight gain patterns of both species showed a similar trend, with three phases being recognized; very slow growth in the first week, increased growth from the second until the fourth week and slower growth thereafter. Rate of gain in the three phases was not significantly different between red deer and sambar deer fawns (Table 5), and 70-day weaning weight of sambar fawns (30·0±0·89 kg, S.E.) was similar to that of red deer fawns (30·4±0·89 kg).

Averaged over the 70-day rearing period, red deer fawns consumed significantly more milk than sambar deer fawns ($P < 0·05$) (359·1 g DM/day (S.E. 13·43) *v.*

Table 4. *Median calving date, mean (± S.E.) and range of birth body dimensions of sambar deer and red deer fawns that were successfully artificially reared at Flock House Agricultural Centre, New Zealand during 1991*

	Red deer ($n = 8$)	Range	Sambar deer ($n = 8$)	Range
Median calving date	14 Dec 1990	9–20 Dec 1990	10 June 1991	6 Jan–1 Sep 1991
Weight (kg)	7·4 (±0·32)	6·5–9·0	6·8 (±0·40)	5·5–8·5
Height (cm)	53·7 (±1·19)	49·3–58·5	49·8 (±1·43)	44·4–55·0
Body circumference (cm)	46·2 (±1·69)	41·3–54·3	48·2 (±1·26)	44·2–54·3
Body length (cm)	40·2 (±1·60)	34·8–46·9	39·1 (±0·97)	36·0–43·1

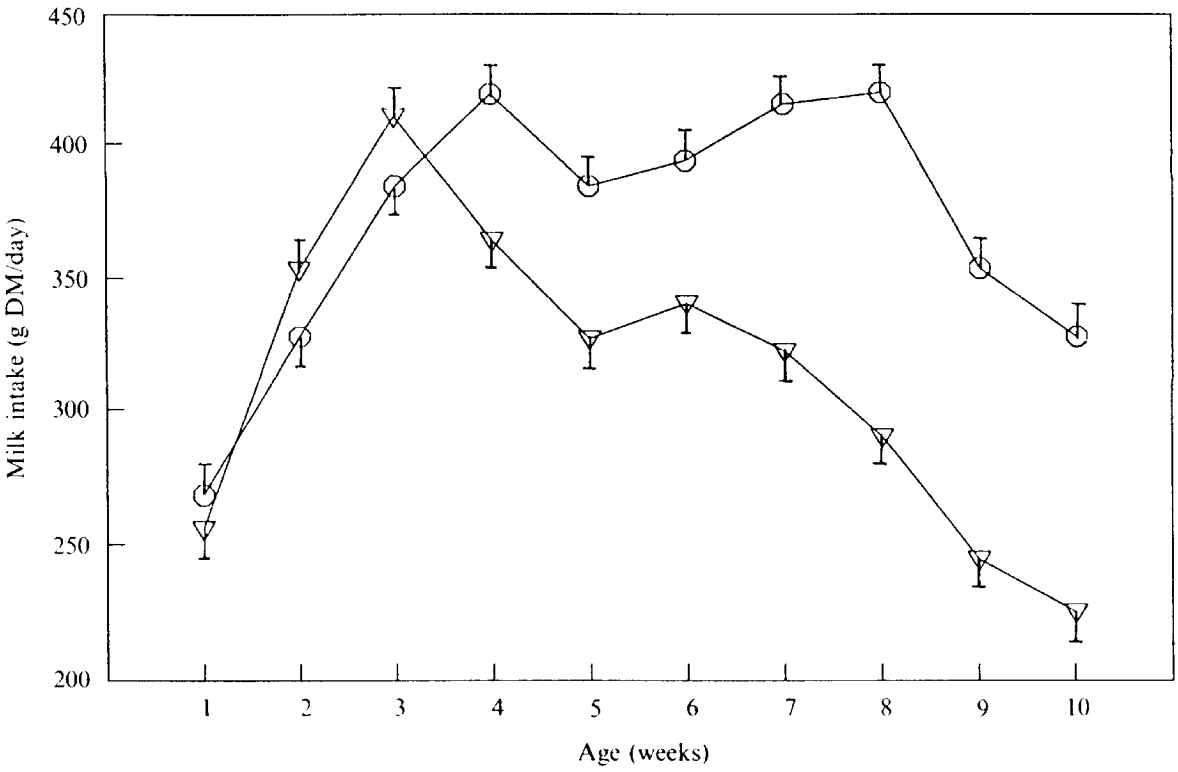

Fig. 1. Milk intake (g DM/day) of sambar deer (▽) and red deer (○) fawns during artificial rearing. Vertical bars represent S.E.S.

Table 6. *The mean age (± S.E.) at which red deer fawns and sambar deer fawns commenced selected activities during the period of artificial rearing. Unless otherwise stated, the age was measured from the date of birth of individual animals*

Activity	Red deer	*n*	Range	Sambar deer	*n*	Range
Related to feeding behaviour						
Licking soil	3·4 (±0·33)	8	2–5	3·3 (±0·37)	8	2–5
Nibbling dead forage	9·7 (±0·99)	6	7–13	10·0 (±1·10)	8	5–14
Eating fresh forage	20·0 (±1·15)	6	17–25	19·0 (±1·51)	7	13–23
Light ruminating	33·2 (±2·48)	5	25–38	36·0 (±2·21)	5	30–42
Gnawing bark chips	—*	—	—	18·0 (±3·42)	4	11–27
Light browsing	—*	—	—	21·3 (±2·06)	4	16–26
Meconium disappearance	5·0 (±0·37)	6	4–6	5·0 (±0·45)	6	4–7
Defecate alone	5·1 (±0·35)	8	4–7	5·4 (±0·38)	8	4–7
Urinating	3·1 (±0·34)	7	2–4	3·4 (±0·26)	8	2–4
Faecal granule	26·2 (±2·65)	5	17–32	29·4 (±2·29)	5	24–36
Related to environment						
Bound to operator†	3·0 (±0·38)	8	2–5	3·3 (±0·49)	8	2–6
Running	9·5 (±1·34)	6	6–14	10·0 (±1·53)	6	6–16
Jumping the fence	20·3 (±0·33)	3	20–21	25·3 (±0·88)	3	24–27
Socializing	—*	—	—	37·6 (±1·67)	5	33–43

* No observations were made.
† Time counted from the first day the fawns were acquired.

312·1 g DM/day (S.E. 12·00), respectively; Figure 1). Milk consumption in red deer fawns increased from the first until the fourth week, remained steady until the eighth week, and then declined sharply. In contrast, sambar deer fawns had their highest milk consumption at the third week of life which progressively declined thereafter, with values for week 7 ($P < 0·10$), week 8 ($P < 0·01$) and weeks 9 and 10 ($P < 0·05$) being significantly lower than for red deer fawns.

Behaviour and health

In general, the age at which both species commenced the selected behavioural activities was not different (Table 6). Only the time when the fawns commenced jumping the protected fence was significantly different, red deer fawns starting earlier (−5 days; $P < 0.01$) than sambar deer fawns.

Even though there was no significant difference between red deer fawns and sambar deer fawns in the age at which running commenced, casual observations showed that red deer fawns tended, at a similar age, to spend more time running and walking than sambar deer fawns. At an early age, red deer fawns remained active after feeding, whereas sambar deer fawns would go to a hiding place after feeding.

Scouring occurred in four red deer fawns (two acute, two very mild) and in seven sambar deer fawns (three acute, four very mild). In general, red deer fawns showed the symptoms of scouring at 4·3 days after being acquired (range 2–6 days) and sambar deer fawns at 5·4 days after being acquired (range 2–9 days). Those animals which were observed to consume soil tended to have only minor scouring problems. Substituting 50% of ewe milk replacer with commercial homogenized cows milk for 1 week, followed by a 70:30 ratio for a further 2 weeks and then returning to 100% ewe milk replacer, proved to be helpful in preventing the occurrence of scouring in sambar deer fawns.

Two sambar deer fawns experienced abomasal bloat. One died within 9 h after bloating, but the other was saved after being treated with 20 ml liquid paraffin, given orally.

DISCUSSION

The present study demonstrated that the success of artificially rearing sambar deer fawns (8 out of 10) was similar to that of artificially rearing red deer fawns (8 out of 9), with the overall success rate being similar to that for a range of other deer species (red deer, Fennessy *et al.* 1981; rusa deer, van Mourik 1983; white-tailed deer, Robbins & Moen 1975; and black-tailed deer, Parker & Wong 1987). It also indicated the early development of grazing behaviour in both red deer (19 days) and sambar deer (20 days) fawns (Table 6). Conditions in the present study differed from other artificial rearing systems in that the fawns were allowed to behave as naturally as possible in developing their grazing behaviour, by being allowed access to an outdoor environment as early as 3 days of age.

Birth date, body dimensions and birth weight

The scattered timing of calving with sambar deer is typical of tropical deer in general (Loudon 1991), and certainly also applies to rusa deer and to axis deer (Mackenzie 1985; Mylrea 1991). Photoperiod may not be the primary source driving the reproductive cycle in tropical deer, as it is in temperate deer (Barry *et al.* 1991).

The lack of major differences in body birth dimensions was surprising, considering that in the wild, adult sambar deer are bigger than red deer. So far, no comparable data can be gained from other studies. Limited comparative data with sambar deer born in an Indian zoo indicated that in the present study, sambar deer fawns were shorter in body height (50·5 *v.* 55·1 cm, respectively) and lighter in birth weight (6·2 *v.* 9·7 kg, respectively) (Acharjyo & Mishra 1980). Comparisons with other tropical deer are given in Table 7. The ratio of fawn birth weight to dam liveweight appears to be lower for tropical deer than for temperate deer, particularly for sambar deer.

Other factors may also have contributed to the low sambar birth weight found in the present study. Historically, the entire New Zealand (NZ) sambar deer herd is descended from a single pair of liberated animals (Harris 1971), and their genetic pool has never been increased through further introductions.

Temperate deer naturally mate in late autumn, when the feed availability is relatively low, and graze on lush green pasture in spring, when the fetus is in a stage of rapid growth. This does not occur with the sambar deer in NZ. Indeed, the calving time of the present sambar deer was concentrated close to the end of winter (Table 4), suggesting that during late pregnancy, the nutritional status of sambar was considerably poorer than red deer at a similar stage of pregnancy. This may have contributed to reduced development of the fetus and low birth weights.

Weight changes and milk intake

The timing set for weaning in the present study was 70 days of age, rather than being weight dependent. Wild red deer wean their offspring at 6·5 months of age, when the calves reach body weights of 37 kg, or *c.* 4 times their birthweight (Lee *et al.* 1991). The present study resulted in a ratio of weaning weight to birth weight of 4·1:1 (S.E. 0·18) for red deer and 4·4:1 (S.E. 0·21) for sambar deer. This suggests that artificial rearing could produce the potential weaning weight of wild animals within a shorter period of time.

Lower daily weight gain of both red deer and sambar deer fawns in the first week could possibly be due to restricted feed intake in the first 3 days of their life. The decline in daily weight gain in the third phase appeared to correspond with animals consuming more forage and less milk. The overall daily gain of red deer fawns in the present study was close to the daily gain of red deer fawns nursed naturally at improved pasture (330 *v.* 324–369 g/day, respectively) (Loudon *et al.* 1984), but below the weight gain of red

Table 7. *Birth weight (kg) and the proportion (%) of fawn birth weight to dam liveweight in several tropical deer species compared with red deer*

Species	Fawn birth weight (kg) Mean	Fawn birth weight (kg) Range	Approximate dam liveweight (kg)	Fawn birth weight as a percentage of dam liveweight		Authors
Red deer (*Cervus elaphus*)						
Hinds	7·9	—	84·9	9·3		Loudon *et al.* 1983
	7·6	—	86·0	8·8		Loudon *et al.* 1984
	9·2	—	100[1]	9·2	7·8	Loudon *et al.* 1989
	7·4	6·6–9·0	100[1]	7·4		Fennessy *et al.* 1981
	6·0	3·9–8·3	100[1]	6·0		Kelly & Whateley 1975
	6·5	—	102[2]	6·4		Present study
Stags	9·4	7·4–12·0	100[1]	9·4		Fennessy *et al.* 1981
	6·4	4·1–9·1	100[1]	6·4	7·8	Kelly & Whateley 1975
	7·8	7·0–9·0	102[2]	7·7		Present study
Sambar deer (*Cervus unicolor*)						
Hinds	6·2	5·5–7·5	143[3]	4·3	4·7	Present study
Stags	7·2	6·0–8·5	143[3]	5·0		
Javan rusa (*Cervus timorensis*)						
Hinds	4·0	3·5–4·5	75	5·3	6·0	Mylrea 1991
Stags	5·0	3·0–7·0	75	6·7		
Chital (*Axis axis*)						
Hinds	3·4	3·1–3·9	50	6·8	7·0	Mylrea 1991
Stags	3·6	3·3–4·0	50	7·2		

[1] Typical value assumed for NZ farmed red deer hinds.
[2] Typical value for Flock House red deer hinds.
[3] Weight of the present sambar deer hinds in 1989.

deer fawns reared naturally on red clover swards (430 g/day) (Niezen *et al.* 1993), suggesting that the genetic potential for growth had not been attained under artificial rearing.

Compared with the data of Fennessy *et al.* (1981) on red deer fawns of a similar age (9 weeks), the body weights of red deer fawns in the present study were heavier (28·0 *v.* 23·0 kg). The previous study used simulated deer milk containing a high proportion of cow's milk. Deer milk is rich in fat, protein, lactose and total dry matter (Robbins & Moen 1975; Robbins *et al.* 1987), with red deer milk containing 8·5% fat and 7·1% protein (Robbins 1983) and one sample of sambar deer milk taken from a shot hind containing 11·1% fat and 9·8% protein (Slee & Presidente 1981).

The milk intake pattern of red deer in the present study showed a sharp decline at 8 weeks of age, which differed from the general trend of milk intake in hand-reared fawns (Arman *et al.* 1974; Parker & Wong 1987; Robbins *et al.* 1987). Those authors reported that peak milk consumption occurred over the first 3–4 weeks, and then declined. Relative to red deer, sambar deer fawns showed a reduced dependency on milk feeding, with their lower overall level of milk intake, earlier peak intake, faster rate of decline and earlier self weaning. As liveweight gains were similar, young sambar deer may have commenced consuming a higher quantity of forage earlier than red deer.

Behaviour and health

Very few hand-rearing reports mention the importance of providing dirt/soil, whereas the present study showed that soil was the first solid matter to be consumed by the animals. Indeed, some fawns started licking the soil as early as 2 days of age. Some animals, both red and sambar fawns, showed a high appetite for soil, and this could play an important role in the early development of rumen function, as facultative microbes could be introduced into the rumen. Moore & Cowie (1980/81) also mentioned the habit of licking soil in red deer fawns, but no explanation was given. Rusa deer showed an interest in consuming lucerne hay, freshly cut grass and soil at around 12 days of age (van Mourik 1983).

An earlier study with white-tailed deer showed that they became true ruminants at around 15 days of age or at 25 kg body weight (Short 1964), whereas with black-tailed deer (*Odocoileus hemionus columbianus*), ruminating activity was first detected at 50 days of age

(range 36–58 days) (Parker & Wong 1987). In the present study, red deer fawns commenced light ruminating at 32 days of age and sambar deer fawns at 36 days of age and, at this point, milk feeding could be restricted.

Differences in activity between the two species could be due to the natural instinct of the sambar deer fawns to hide from predators in their natural habitat. Socializing behaviour in sambar deer could indicate the time fawns 'feel safe' enough to escape from any predators. In the present study, sambar fawns started to socialize at 38 days of age, and at this time they were already capable of kicking, jumping, struggling and running with speed and strength.

The present study showed a considerably higher proportion of animals showing signs of scouring in sambar deer (7 out of 8) than in red deer (4 out of 8). Abomasal bloat was the second problem faced in artificially reared sambar deer and usually occurred when the fawns drank too fast and too much. Treatment with liquid paraffin, to stimulate defecation, may indirectly release some of the gas from the stomach.

It is concluded that sambar deer fawns can be successfully artificially reared, and that under our circumstances this is a first step in the domestication of this species for commercial deer farming.

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