An Overview of Sub-Tropical and Tropical Deer Production Systems

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INTRODUCTION

Tropical and sub-tropical deer production systems have been developed in a wide range of climatic and vegetative regions. The focus of these systems is the production of venison, velvet antler and by-products.

The tropical latitudes are defined by the Tropic of Cancer and the Tropic of Capricorn (approximately 23° north and south of the equator). Most of the tropical deer farming environments have a summer monsoonal climate with defined wet and dry seasons, although the timing and duration of the dry season varies considerably between regions. In contrast, the sub-tropical regions are less clearly defined by latitude. Essentially, they are regions that lie outside the tropical latitudes, but where rainfall is summer dominant, and winters are mild and generally dry. Most sub-tropical environments are at latitudes less than 28°, but there are exceptions. For example, the mid-north coastal regions of New South Wales in Australia, at latitudes of about 30°S, are also arguably sub-tropical.

Deer production systems that have developed in the tropical and sub-tropical regions fit into two broad categories. There are extensive systems where deer are held behind wire but involving minimal husbandry such as in Mauritius (Lalouette 1985). In these situations the deer are typically field shot. There are also intensive systems, as is undertaken in Australia and New Caledonia where the deer are mustered regularly for husbandry purposes, and slaughtered in abattoirs. The situation in some Asian countries is intermediate, in that the deer are often closely confined and fed using ‘cut and carry’ forage systems, but there is an absence of abattoir slaughtering.

The most widely farmed of the tropical species is rusa deer (Cervus timorensis). Rusa evolved as a distinct species in Indonesia and there are up to eight subspecies (Van Bemmel 1949). The two most important sub-species from a farming perspective are Javan rusa (Cervus timorensis russa) and Moluccan rusa (Cervus timorensis moluccensis). Javan rusa are widely farmed in Australia (Woodford and Dunning, 1992), New Caledonia (Le Bel and Dulieu, 1993) and Mauritius (Lalouette, 1985; Bestel, 1993), with lesser numbers farmed in Malaysia, Thailand, Indonesia and the Philippines. Moluccan rusa are farmed in Australia and there was also an attempt at extensive ranching of this sub-species in Papua New Guinea (Fraser Stewart, 1985). There are also herds of rusa in various parts of Malaysia and the Philippines that have been established from Australian-bred animals of combined Javan and Moluccan parentage. Rusa deer can be transported readily both by ship and by air, and this has facilitated their distribution to many countries.

The two other tropically adapted deer species of current farming significance are sambar deer (C. unicolor) in S.E. Asia and chital deer (Axis axis) in Australia (English, 1992; Woodford, 1997).

TROPICAL / SUB-TROPICAL DEER FARMING IN AUSTRALIA

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Two tropically adapted species, i.e. rusa and chital, are farmed in tropical and sub-tropical regions of Australia. There are also two species of temperate origin, i.e. red (Cervus elaphus) and fallow (Dama dama), that are farmed in the sub-tropical regions. Queensland is the predominant state for tropical/sub-tropical deer farming, although there is some farming of rusa and chital deer in New South Wales along the mid-north coast.

Within Queensland, red and rusa deer are the major farmed species. The majority of farms are located in the south-east of the state, in regions of sub-tropical wet and dry zones with largely moderate soil fertility (Sinclair, 1997; 1999). However, farms can also be found as far north as Cairns (approximately 17°S), and in arid zones west of the main divide.

The existence of temperate deer on farms in subtropical Queensland occurs as a result of both historical availability of feral herds for capture and the ability of these species to occupy some sub-tropical ecological niches. Red deer are concentrated at latitudes of 26° to 28°S, where they are able to thrive, particularly in micro-environments that are tick free, as long as supplied feed is of sufficient quality (Woodford et al.1990). Fallow deer in Queensland are currently of less importance and are farmed mainly in the transitional subtropical/temperate zone.

Rusa deer are currently farmed in Queensland as self-replacing herds, being either intensive breeding and finishing units (high stocking rate, medium fertility soils supporting native and sown pastures) or semi-extensive units (low stocking rates and native/sown pastures, medium to poor soil fertility) as described in Sinclair (1999). Intensively managed properties require higher inputs (possibly irrigation) and extensive use of supplementation (grain, conserved fodder). Extensively managed properties are reliant on dryland forage production with more restricted use of supplements and forage crops.
Characteristics of farmed rusa deer include tolerance to cattle tick (*Boophilus microplus*) (but not the Australian scrub tick (*Ixodes holocyclus*)), field resistance to internal and external parasites, ability of breeding stock to maintain themselves on low quality tropical forages, and a gregarious nature (Woodford and Dunning, 1992). However, notable constraints to production are areas experiencing cold winters (increased mortality and low calf survival) and exposure to sheep (where malignant catarrhal fever is a risk).

Under Queensland conditions (and also in New Caledonia and Mauritius), Javan rusa deer show strong seasonality of breeding. Data from the University of Queensland herd collected over 12 years (Woodford (1999) showed that most hinds calve in March and April (the southern autumn), with some calves born through to the start of December (early summer). No full-term calves were born between early December and late February. Hinds calving late in the season tended subsequently to calve at less than 12 month intervals until they achieved autumn calving, and then calved on a 12 month cycle. It was also evident that under field conditions stags only mate when they are in hard antler and that they have a pronounced rut. The synchrony of this rut is considerably stronger in Javan rather than Moluccan stags, and Moluccan herds show a greater calving spread than Javan herds. Both the proximate and ultimate causes for seasonality of breeding in rusa deer have yet to be fully elucidated (Woodford, 1999).

Chital deer are only a minor farmed species in Queensland and tend to be semi-extensively farmed with minimal husbandry (Sinclair, 1997). Field observations in Queensland (Woodford, 1997) suggest they are intermediate to concentrate selective feeders, requiring high nutritional inputs in a farming environment to achieve high level production. Under Queensland conditions, and in contrast to the rusa deer, they show non-seasonality of breeding. When hinds are provided with high quality feed they calve approximately every nine months. However, under poor quality feed conditions their reproductive rate drops markedly. Their inability to perform on low quality tropical/sub-tropical pastures *per se*, concomitant with some behavioural and tractability problems that can impact on meat quality (e.g. the ultimate pH of the meat) when slaughtered in abattoirs, suggest significant constraints for full commercialisation of this species within a farming environment. Nevertheless management strategies for farmed chital appear to be well documented (English, 1992).

**DEER FARMING IN NEW CALEDONIA, MAURITIUS AND S.E. ASIA.**

Rusa deer production systems in New Caledonia are based on a combination of natural runs encompassing native grasses and forbs/browse, and smaller areas of improved pasture supported by strategic feed supplementation, irrigation and green fodder supply. The greatest concentrations of deer (wild and farmed) occur in semi-arid tropical zones of natural grasslands and secondary vegetation (Le Bel and Dulieu, 1993). Similar agro-environmental zones exist in Mauritius (Lalouette, 1985), where farming of rusa is based on dryland production systems utilising native and some introduced pasture species in combination with native forage scrub and planted leguminous fodder trees (*Leucaena leucocephala*). *Leucaena* is also a key nutritional input within rusa feed management systems in New Caledonia (Le Bel and Dulieu, 1993).

Published information on farming systems for both rusa and sambar in the remaining tropical/sub-tropical zones of S.E. Asia remains scarce. Our own observations are that many of the rusa herds are pilot study projects involving up to several hundred animals with high inputs (including ‘cut and carry’ fodder systems) and high stocking rates. However, low input village systems have also been trialed, utilising locally available species for local consumption and trade (Fraser Stewart, 1985). Sambar deer, which are considerably larger than the rusa deer, are also farmed but usually in small groups. The inherent solitary nature of this species, coupled with observed management problems under farming conditions (Semiadi *et al*., 1994), may limit expanded farming of this species. While both red and fallow deer are identified as being farmed in Malaysia (Drew, 1998), climatic stress and environmental constraints limit productivity and survival (K.B. Woodford, unpublished data).

**TROPICAL AND TEMPERATE DEER PRODUCTION SYSTEMS – WHAT IS DIFFERENT?**

The major differences between tropical and temperate deer systems relate to the different biology of the various species and the different agro-environmental zones in which they are farmed. All temperate species of deer have strongly seasonal patterns of reproduction and growth that reflect the climatic seasonality of the environments in which they evolved. However, the tropical species have evolved in a range of environments, some of which are strongly seasonal in regard to rainfall patterns, and others which exhibit considerable variability between years. Consequently, there are considerable differences between various tropical species, and it is not possible to generalise about them. Whereas chital deer when farmed in the tropics and sub-tropics give birth throughout the year, and show no evidence of seasonality of growth (Woodford 1997), this is not the case with rusa deer, particularly the Javan sub-species, which show strong seasonality.

Tropical pastures tend to be of lower feed quality than temperate pastures. As a consequence, it is difficult to obtain high growth rates in young animals farmed under tropical conditions without intensive supplementation. There is a range of alternatives, including leguminous fodder trees and crop by-products.

Temperate systems based particularly on red deer and wapiti/elk produce both venison and velvet antler as commercial products. Tropical deer farm systems are based on species which, apart from sambar deer,
produce less per head velvet antler yield, thereby restricting potential income and increasing harvesting costs (Woodford, 1998). The corollary of this is that rusa and chital deer are farmed mainly for their meat production.

INDUSTRY DEVELOPMENT ISSUES

Throughout much of Asia, and also in Mauritius, the development of tropical deer farming is constrained by alternative land use pressures. In addition, both rusa and chital deer are not well suited to the small-holder livestock systems commonly found throughout tropical regions of Asia on account of their inherent gregarious nature, and a requirement for purpose-built handling facilities which are too costly for small landholders. Accordingly, it is uncertain as to the extent of future industry development.

Within northern Australia, biological issues and appropriate farming systems are not major constraints. However, the Australian tropical/sub-tropical deer industry, being both meat product quality and export oriented, faces major problems from inadequate off-farm investment in processing and marketing. The challenge relates to industry development incorporating an integrated whole supply chain approach. Small industry size (< 20,000 head) and an inability to achieve commercial size operations in processing and marketing are major industry constraints.

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THE CHITAL DEER (AXIS AXIS) IN AUSTRALIA

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ABSTRACT: The Indian spotted or chital deer (Axis axis) is one of a number of species of deer being farmed in Australia. Management strategies have been developed to take into account the differences between this deer of tropical origin and the more numerous fallow deer (Dama dama) and red deer (Cervus elaphus) which are of temperate origin. It was found that chital hinds exhibit oestrous activity all year round if unmated, with a mean cycle length of 19.3 ± 3.1 days. Similarly, chital stags can produce semen in all months of the year. However, they do exhibit quite a high degree of synchrony in their antler cycles, with a seasonal fluctuation in semen quality. Most adult stags cast antlers between August and October, and as a consequence there is a major rutting period between January and June. A majority of conceptions occur in those months, with a gestation period of 234 ± 3 days resulting in most calves being born in the second half of the year. However, chital stags do produce viable semen when in the velvet antler phase, unlike deer of temperate origin, and some conceptions can occur in any month of the year when mating is not controlled. These and other factors must be taken into account when devising management strategies for venison production from chital deer, which have a more consistent carcass quality across the year than do temperate deer species.

INTRODUCTION

Chital deer are one of six species of deer found in the wild in Australia (Bentley, 1978). There was early interest in their potential as a farmed species with the trapping of small numbers in Queensland in the early 1970s. Chital are amongst the most attractive of deer, and produce excellent venison, but they soon acquired a reputation as a nervous animal which was difficult to handle in captivity. There were also problems with high levels of perinatal mortality on farms, and it
became apparent that there were both economic and animal welfare issues to be addressed if chital were to be successfully farmed. A program of intensive research on the species was undertaken at the Deer Research Unit, Camden between 1985 and 1995 which resulted in the development of highly successful management strategies for this species under Australian conditions (English, 1991). In particular, there was an opportunity to compare and contrast the needs of chital deer with those of fallow deer (Dama dama), a species of temperate origin and therefore a strictly seasonally polyoestrous breeder with all conceptions occurring in the autumn. This is in marked contrast to chital deer, which were known to produce calves in all months of the year in herds where mating was not controlled in any way. The major thrust of the studies at Camden was to determine the factors which needed consideration in order to farm chital deer as successfully as fallow deer. Thus, studies were conducted on the biology and behaviour of chital deer, including ways to minimise handling problems, on the reproductive physiology of both stags and hinds, and on carcass quality and body composition. There was development of effective programs of artificial insemination as well as ultrasonic foetal ageing and pregnancy diagnosis (Chapple, 1989; Mylrea, 1992; Dradjat, 1996).

**BIOLOGY AND BEHAVIOUR**

The major difference between chital deer and fallow deer is the temperate origins of the latter, whereas chital deer originate in India, Nepal, Bhutan and Sri Lanka (Schaller, 1967). As a tropical species it was believed that their major attribute would be their ability to breed all year round, with the potential for chital hinds to produce 3 offspring in 27 months. This is in contrast to fallow deer which produce 1 offspring annually, with strict seasonality imposed by photoperiodic variation. However, it became apparent that chital deer on farms in southern Australia were not realising this high reproductive potential, due in part to high perinatal mortality. Many calves born in the winter months died within a day or so of birth, especially in very inclement weather. In addition, there were often major problems when attempts were made to handle groups of chital deer on farms, given that such groups almost invariably contained all age classes, including antlered stags. With the timorous nature of the species and their often panic stricken reaction to being closely approached, there were frequent losses from trauma and post-capture myopathy.

During the studies on chital deer at Camden it became apparent that chital deer were quite readily yarded and handled after a suitable “training and taming” process (Harthoorn, 1979), especially once the deer were segregated into appropriate gender and age groups for management purposes. Studies on the physiological responses of chital deer to regular handling confirmed that this taming process did occur (Chapple et al., 1991). To reduce the risks of traumatic injuries during yarding, antler growth should always be prevented by velvet antler removal or surgical polling. Well trained chital deer can in fact be yarded and handled as readily as fallow deer, through identical facilities (English, 1991).

**REPRODUCTION**

It had been noted that chital hinds were capable of producing calves in every month of the year in India (Schaller, 1967), Nepal (Mishra, 1982), Hawaii (Graf and Nichols, 1967) and Texas (Ables, 1977), as well as in Australia, but when data were collected at Camden over several years it was found that there was a preponderance of calves born in the second half of the year (Chapple, 1989). This fitted well with observations made on the antler cycles of chital stags, with a high level of synchrony in their cycles being noted. Most stags cast their antlers between August and October, with the subsequent development of hard antlers and other secondary sexual characteristics and a period of rutting behaviour in January-June. This fitted with observations that showed that chital hinds cycle all year round if unmated, with an oestrous cycle length of 19.3±1.3 days and a gestation period of 234.5±3.0 days.). Moreover, chital hinds were known to conceive quite quickly after parturition, and it was revealed that the interval from calving to conception ranged from 18 to 118 days, with an average of 48.1±27.8 days (Chapple et al., 1993). Subsequent work showed that the first detected oestrus occurred at a mean time of 26.9±3.0 days after parturition. Furthermore, hinds in contact with a stag in this study had a significantly shorter interval from parturition to first ovulation compared to hinds not in contact with a stag (93% compared to 43% respectively). (Mylrea et al., 2000).

Intensive observation of chital stags showed that they were capable of producing viable semen even during the velvet antler phase, although the quality of the semen at that time was reduced (Mylrea, 1992). Thus, while a majority of conceptions occurred when stags were in hard antler, there was always the potential for some hinds to conceive at other times. Thus, in herds where no mating management was practised there were likely to be some young calves in the group at any time of the year. It was this fact that was at the heart of many of the handling difficulties which had been encountered with chital deer, with too many opportunities for misadventure when hinds and very young calves were yarded with larger groups, including adult stags. An obvious solution is to practise some form of restricted mating, to ensure that conceptions do not occur all year round. This should be routinely practised with farmed chital deer, with births timed to coincide with optimum pasture conditions in Spring, and much earlier in the season than can ever be achieved with fallow deer. Not only does this allow the appropriate management of pregnant and lactating hinds and their young calves, with calving avoided in the winter months where perinatal mortality can be high, but it also offers a definite advantage in a venison production system. There is then the potential to produce prime venison at times when it may not be possible with deer of temperate origin.
VENISON PRODUCTION

The weights achieved by growing chital stags are very similar to those of fallow bucks at the same age, with the former at 13-18 months having mean live weights of 42.8±0.7 kg and a dressing out proportion of 60%, compared with a figure of 61% for fallow bucks at 17 months (Mulley and English, 1991). However, there is much less annual fluctuation in live weight and carcass composition in chital stags than is the case with fallow deer. Chital stags exhibit little, if any, annual live weight loss, with only a slight loss (5.5-5.7%) in dominant stags during antler growth (Chapple, 1989). The Camden studies showed that chital stags exhibited an average 5% variation in carcass fat content (range 2.2% to 7.2%) throughout the year, compared to 22% variation in red deer stags (Wallace and Davies, 1985) and a maximum carcass fat content in fallow bucks of 33% (Gregson and Purchas, 1985). Adult chital stags reach live weights of 75-80 kg, with higher fat content in these than those under 24 months. No attempt should be made to market prime venison from older males, but chital deer slaughtered at under 24 months of age have the potential to produce excellent venison of very consistent quality for much of the year.

MORTALITY

The problem of perinatal mortality in calves born in winter was confirmed. There was a 48% death rate in calves born to 45 chital hinds over 4 years at Camden, with the majority of the deaths in the winter months. This compares unfavourably with a rate of 18% in fallow deer fawns at the same location (Mulley, 1989). The most frequent cause of calf death was found to be a complex of mismothering, fox predation and exposure/starvation. Chital hinds are sensitive to the presence of humans when there are very young calves in the herd, and the calves are best ear-tagged at weaning, at about 3 months of age. Chital calves are somewhat smaller at birth than are fallow fawns, with females weighing 3.4±0.5 kg and males 3.6±0.4 kg. They can often move through gaps which will stop fallow deer fawns, which have birth weights of 3.97±0.53 kg and 4.27±0.70 kg respectively (Mulley, 1989), and this may result in mismothering if fences are poorly maintained. Restricting the birth season to those times of the year when weather conditions are favourable for calf survival and when abundant high quality pasture is available for lactating hinds has been shown to greatly reduce the problem of perinatal mortality in chital deer (English, 1991). There is no doubt that the use of chital deer on Australian deer farms can be an effective method of reducing the problem of perinatal mortality in chital deer (Axis axis) in captivity. PhD thesis, University of Sydney, Australia.

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CURRENT KNOWLEDGE OF THE BIOLOGY OF SAMBAR DEER CERVUS UNICOLOR IN CAPTIVITY

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ABSTRACT: The sambar deer (Cervus unicolor) has not attracted many attempts to domesticate it, despite its large body size. Lack of information on its biology and productivity may explain why this species has not been
developed for farming. Thorough studies of the productivity, meat quality and reproduction of the sambar deer are needed. However, current information suggests that this animal is worthy of domestication, either as the pure-bred, or to improve the carcass quality of the rusa deer through hybridization. This paper describes what is known of the biology of sambar deer in captivity.

INTRODUCTION

Of the three tropical deer species which have a potential to be farmed (i.e. rusa, Cervus timorensis, sambar, and chital, Axis axis), the sambar deer is the largest animal and has the widest natural distribution, stretching from Sri Lanka, India, Malaysia, Indonesia, Myanmar to The Philippines (Whitehead, 1993). There is no obvious reason why this animal has not been attractive to domesticate. Most of the information available on sambar is from ecological studies and observations of the wild deer, and lack of data on their productivity, meat quality and biology in captivity, may have hindered the domestication of this species. People have also questioned their nervous and flighty behaviour. Although the sambar deer is much less developed as a farm animal compared to rusa and chital deer, it is probable that this animal has the same potential for farming as the other species.

REPRODUCTION

In their natural habitat, in Nepal, Myanmar and India, peak calving incidence occurs in June-July and October-November. Simon (1943) noted that captive Indian sambar tended to have definite periods of antler shedding, calving and mating, whereas in the wild there was much variation in these activities. Little is known of their calving pattern in the tropics. Current, but limited, data from captive animals indicate that calves are born all year around with mating occurring throughout the year. This is in contrast to the rusa or the Bawean deer (Axis kuhlii) (Semiadi and Subekti, 1996). In the southern hemisphere, peak calving of sambar deer is from April to August.

The peak mating time for wild Nepalese sambar occurs when the stag population is in transition from a high proportion in velvet antler to a majority in hard antler (Mishra, 1982). This indicates that stags in velvet antler could have sufficient libido for mating, as has been observed with captive sambar (G. Semiadi, unpublished). In chital (Mylrea, 1992) and rusa stags (A. Santoso Drajet, pers. comm.) fertile spermatozoa (although of low quality) can be detected during velvet. Judging from the first peaks of testosterone and progesterone, sambar stags attain their first puberty at 445 days and hinds at 407 days (Semiadi et al., 1995a). Asher et al. (1997) reported that hinds attained puberty between 7-19 months of age, at an average liveweight of 95.2 kg (range 72-107 kg).

Chapple (1989) suggests that unmated tropical hinds have a continuous oestrous cycle throughout the year. This has been shown clearly in chital and sambar hinds (Chapple et al., 1993; Asher et al., 1997). During oestrus, tamed sambar hinds will stand still in the paddock or be reluctant to move when approached by man. The tail is erect, sometimes showing a wagging movement. At a certain time, hinds in oestrus will tend to stay away from the rest of the group. Studies of 12 pairs of consecutive cycles showed that the sambar hind has an oestrous cycle of 18.6 days (range 15-23; SD 2.15), with an oestrus length of 20.5 h (range 9.5-29; SD 8.24) (Semiadi, 1997). Hsia et al. (1987) and Asher et al. (1997) have reported oestrous cycles of 20 days.

Hsia et al. (1987) reported gestations of 240-270 days, while studies of Bangladeshi zoo animals gave gestations averaging 215.4 days (range 210-222, n=8; Awal et al., 1992). Calving rates of farmed sambar in New Zealand were between 80-85 % (G. Semiadi, unpubl.), and the average calving interval was 329 days (SD 29.7 days) (Semiadi et al., 1994).

The life expectancy of the sambar is ten years, with a maximum of about 24 years (Ashby and Santiapillai, 1986). Anecdotal reports from West and East Kalimantan indicate that optimum reproductive performance of sambar stags in the wild is between 7-10 years old. After this age, stags tend to be unable to defend their territory and harems.

Hybridization between rusa and sambar deer has been reported by van Mourik and Schurig (1985) who indicate that the offspring are fertile. This strategy could be used to boost the quality of the rusa carcass, similar to the utilization of wapiti stags in NZ red deer farming, but this has not been widely used. Attempts to hybridize sambar with red deer through artificial insemination is economically not viable if we want to produce a new generation of deer for production purposes. The success rate of this hybridization was very low, only 1 %, and the fertility of the offspring remains unknown (Muir et al., 1997). It is hard to accept that natural mating takes place, as the species have different social behaviours.

BODY SIZE AND MEAT PRODUCTION

The birth weight of sambar calves born under New Zealand pastoral conditions was 7.8-8.1 kg (Semiadi et al., 1994). Birth weights recorded in a Bangladeshi zoo were between 4.8-6.3 kg, or 2.9 % of the dam’s live weight (Awal et al., 1992), and averaged 10.3 kg (range 7-12.3) at an Indian zoo (Acharjiyo and Mishra, 1980). In New Zealand, artificially reared sambar weighed 30 kg when weaned at 70 days, and growth had averaged 347 g/d (Semiadi et al., 1993). At 160 days these stags weighed 49.5 kg, and hinds at 128 days weighed 36.6 kg. At 371 days old sambar stags can be 100.3 kg and hinds at 310 days old can be 80 kg (Semiadi et al., 1995a). The overall growth rate from 6 to 18 months was 138 g/d (Semiadi et al., 1995a). Sambar deer attained slaughter weight (100 kg for stags and 80 kg for hinds) 42 days and 90 days, respectively, earlier than red deer (Semiadi et al., 1995a).

There is considerable variation in the adult size of different sambar subspecies. The Indian sambar is the heaviest and tallest, and wild stags can weigh up to 275 kg. In Indonesia the Sumatran sambar tends to be lighter and thinner than the Kalimantan sambar. In
Bangladesh stags have been reported to weigh between 200-215 kg and hinds between 182-203, at 3-5 years old (Awal et al., 1992).

There is no data on carcass production or the quality of sambar venison. Data from wild animals killed by local people in East Kalimantan gave an average carcass weight of 105 kg for hinds and 115 kg for stags (Sukmaraga, 1982). The meat from sambar deer tends to be less tender than that of rusa deer (G. Semiadi, unpublished).

**NUTRITION**

The natural diet of sambar deer is believed to be dominated by browse, as in their natural habitat the animal prefers dense and swampy forest. Numerous reports indicate that the animal can easily adjust its feeding habits to local conditions (Santiapillai et al., 1981; Dinnerstein, 1983; Ngamponsais, 1987; Stafford, 1995; Semiadi et al., 1995b). During our intensive studies of nutrition, sambar adapted very well to a pelleted concentrate diet with high metabolisable energy (ME) (12.2 MJ/kg DM) and protein contents (18.1% DM basis) (Semiadi et al., 1995a).

In young (less than 2 years) sambar fed high quality feed, daily DM consumption ranged from 1.42-1.63 kg, equivalent to 52-56.3 g DM/kg0.75 (Semiadi et al., 1995a). ME for maintenance was 474 kJ/kg0.75.d (Semiadi et al., 1998), and for gain was 26.5 MJ/kg LWG for stags and 24.9 MJ/kg LWG for hinds (Semiadi et al., 1995a).

**MANAGEMENT**

Problems have been experienced in handling sambar stags when confined in individual cages, especially during the rut, when cages can be damaged. Although confinement in very small enclosures has been reported from Taiwan (Hsia et al., 1987), it would be unrealistic to attempt to confine adult sambar stags in a small area if velvet antler is not removed or the stags are not castrated. Ample space (6 stags/ha) is required if adult stags are to be put in one paddock but without antler management. Fights resulting in the death of one of the combatants occur occasionally during the rut. There has been no experience of damage to fences by rutting stags, but trees will be damaged.

Behavioural problems have occurred in mixed-sex groups of adults stocked at 12 and 18 per ha, with more than one adult stag in each group. On two occasions stags died from antler wounds. Stocking rates increase than one adult stag in each group. On two occasions stags died from antler wounds. Stocking rates increase more than one adult stag in each group. On two occasions stags died from antler wounds. Stocking rates increase near 5000 wild sambar are killed each year and the carcasses sold in open market. Some hunters also hand-rear captured fawns, and tether them and let them graze in the field. In many cases, tamed stags are killed before 3 years of age because of their aggressiveness toward people. A number of people have been hurt or killed by these stags during the rut. This clearly shows a need for better understanding of the behavior and biology of sambar deer.

**UTILIZATION OF SAMBAR DEER**

The high body weight of the sambar deer clearly suggests that the animal is a meat producer. The nervous behavior is their natural instinct, and can be handled in captivity through proper management. Appropriate modifications to fencing and yarding, and in mustering methods, from standard “red deer farming” need to be developed.

Under New Zealand pastoral conditions, sambar have shown their ability to perform very well (G. Semiadi, unpublished data). Sambar deer have long been farmed in Taiwan, where they are 48% of the farmed deer population (Hsia et al., 1987). A tropical deer industry using sambar as the basic genotype, together with a small number of chital deer (S. Srikhao, pers. comm.) has been under development in Thailand since 1992.

In Indonesia in 1990 the Animal Husbandry Director General established a Center for Sambar Captive Breeding in East Kalimantan, with the aim of establishing a sambar deer farm for local people. The people in this region have long hunted sambar for their family protein consumption or income source. Unofficial reports from East Kalimantan mention that nearly 5000 wild sambar are killed each year and the carcasses sold in open market. Some hunters also hand-rear captured fawns, and tether them and let them graze in the field. In many cases, tamed stags are killed before 3 years of age because of their aggressiveness toward people. A number of people have been hurt or killed by these stags during the rut. This clearly shows a need for better understanding of the behavior and biology of sambar deer.

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BIOLOGY AND PRODUCTION

ATTRIBUTES OF THE FARMED RUSA

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ABSTRACT: Rusa deer were introduced to Queensland in the 1970s and 1980s, and they now are about half of the farmed deer herd. Rusa tolerate the subtropical climatic and disease environments. Rusa venison has a low fat content and is acceptable to consumers. Protein and energy requirements are similar to values for other tropical deer. Growth may be limited by the low protein content of tropical grasses during winter. Rusa deer could contribute to the diversity of the Australian livestock industries.

DISTRIBUTION AND GENERAL BIOLOGY

Rusa deer (Cervus timorensis) are an Indonesian species, members of the Sunda sambar subspecies, and with eight subspecies (Grzimek, 1972). Although present taxonomy locates rusa within the genus Cervus, genetic analysis using blood proteins (Emerson and Tate, 1993) suggests that the sambar (C. unicolor) and rusa should be grouped together, and separately from the other cervinae. Hybrid-isation between sambar and rusa gives a viable offspring (Van Mourik and Schurig, 1985).

Javan rusa (C. t. rusa or C. t. timorensis) are widely farmed in the subtropics, with herds of several thousands in Mauritius, Malaysia, New Caledonia, Reunion Island and Taiwan (Maudet, 1999). There are feral rusa in Papua New Guinea and Javan Jaya (Stewart, 1985; Kilmaskossu 1990).

Javan rusa were introduced into Australia in the early 1900s (e.g. to Sydney’s Royal National Park in 1907; Bentley, 1978), and came to Queensland via Victoria in the late 1970s and early 1980s. The smaller Moluccan rusa (C. t. moluccensis) was introduced to the Torres Strait in 1912 (Bentley, 1978) and a nucleus herd was brought from there to Queensland in 1980.
(Hart, 1986). Rusa deer have increased in popularity so that they and the red deer (Cervus elaphus) are now the two major farmed species in Queensland (Sinclair, 1997a). Most Queensland rusa are Javan or Javan × Moluccan hybrids. There have been preliminary studies of the Timor deer (C. t. florensis) as another possible farmed species (Bale-Therick et al. 1996).

**REPRODUCTION**

Rutting (mating) in Javan deer lasts for about 3 months (late June to late September). Javan rusa may calve throughout the year but most are born in autumn (Woodford and Dunning, 1992; Maudet, 1999), after a 249 ± 3.1 (mean ± SE; Van Mourik, 1986) or 253 ± 1.0 (Woodford and Dunning, 1992) day gestation, which is independent of the calf’s sex. Moluccan rusa have a second calving peak in spring. Javan rusa hinds calve each year, at intervals of 366 ± 6.8 days (Van Mourik, 1986), or between 280 and 400 days depending on the previous calving date (Woodford and Dunning, 1992). Calving rates are over 90 % (Mackenzie, 1985; Van Mourik, 1986; Woodford and Dunning, 1992). Reproductive success is greatly influenced by hind nutrition during the rut: 95 % calving for hinds on improved pasture v. 57 % for hinds on native grass (Le Bel et al., 1997). However, overfat hinds may experience dystocia (J. McCosker, pers. comm.). Calves are normally weaned at 3.5 to 4 months. Mature hinds wean over 85 % of calves born (Woodford and Dunning, 1992). Juvenile stags initiate antler (pedicle) growth at 5 to 7 months, when they weigh 30 to 35 kg (Woodford and Dunning, 1992; Puttoo et al., 1998). Stags cast their antlers in February/March, begin to grow velvet antler in March/April, and are in hard antler during the rut.

**HEALTH**

Rusa deer are susceptible to a range of environmental and disease challenges. Le Bel et al. (1997) and Woodford and Dunning (1992) reported 26 % and 11 % perinatal losses, respectively, due to cold stress, abandon-ment, stillbirths and abortions, predation, and accident. Clinical cases have been reported of Johne’s disease (NZ; Gumbrel, 1986), leptospirosis (New Caledonia; Desvals et al. 1993) and malignant catarrhal fever (Queensland; Tomkins, et al., 1997). Parasitism of rusa deer was reviewed by Presidente (1984). Endoparasites infect rusa deer, but infection rates are to low to moderate (e.g. 3 to 13 %, Gill et al., 1986), and they do not often display clinical signs. Rusa deer are apparently resistant to liver fluke, and yersiniosis (Gill et al., 1986; Jerrett et al., 1990). They may carry, but are not good hosts for, Boophilus microplus (Desvals et al., 1993) and ticks do not effectively transmit Babesia or Anaplasma from deer to cattle (Owen, 1985).

**GROWTH, AND VENISON PRODUCTION AND QUALITY**

Javan rusa in Queensland are about 5 kg at birth (Woodford and Dunning, 1992), and grow to 90 kg (hinds) to 140 kg (stags) at maturity. New Caledonian rusa are slightly smaller – mature males weigh approximately 102 kg (Le Bel et al., 1997; Le Bel, 1999). Target weights (modified from Sinclair, 1999) for Queensland Javan rusa are 35 and 30 kg (stags, hinds) at 5 months, 65 and 60 kg at 13 months, and 140 and 90 kg at maturity. Autumn-born Javan rusa stags grow steadily throughout their first year (150 to 200 g/d), but more slowly in their second year, especially during winter (20 to 45 g/d) (Woodford and Dunning, 1992; R. Sookharea, pers. comm.). Weaner stags fed a grain-rich, 17.5 % protein, ration grew at 160 g/d (Puttoo et al., 1998). This may be a practical upper limit to stag growth.

Venison is the major commercial product of rusa deer. Growth rate and carcass fat content determine the profitability of venison production. Queensland processors require animals for slaughter (Sinclair, 1997b) which are in good to prime condition, have 3 to 8 or 12 mm subcutaneous fat at the 12 rib, and importantly will yield a minimum 35 to 40 kg carcase, preferably more than 50 kg. As the dressing percentage of rusa deer is between 51 and 64 % (Woodford and Dunning, 1992; Sookharea et al., 1993; Le Bel, 1999), this corresponds to liveweights of 70 to 80 kg. Slaughter before 15 months of age takes advantage of the steady first-year growth and ensures that stags are sold before the onset of the first rut with its possible behavioural problems.

Attributes of rusa venison were reviewed by Dryden (1997). In brief, rusa carcasses yield more lean meat than cattle, and typically have little fat (e.g. 5.2 to 9.6 % in carcasses of entire rusa stags, Sookharea et al., 1995a). Subcutaneous fat in rusa stags varies seasonally and with age (see Dryden, 1997), and is undetectable by ultrasound in animals younger than 13 months. Possibly because of its low fat content, venison does not always score highly for organoleptic properties (Sookharea et al., 1993). Venison is rich in polyunsaturated fatty acids (Sookharea et al., 1995b), perhaps because much of the carcase fat is structural.

**NUTRITION**

Daily voluntary dry matter (DM) consumption (of roughage/concentrate, and roughage-only, diets) varies between 52 and 160 g per kg metabolic liveweight ($W_{kg}^{0.75}$), with most values between 55 and 75 g/kg $W_{kg}^{0.75}$ (see Dryden, 1999). Limited data suggest that appetite is highest in autumn and winter (R. Sookharea, pers. comm.). There is evidence (Hmeidan and Dryden, 1998) that the consumption of digestible dry matter (DM) in rhodes grass may be limited by low palatability.

Digestibilities *in vivo* of grass and legume hays are generally between 60 and 70 % (Hmeidan and Dryden, 1998; Puttoo and Dryden, 1998). Rumen volatile fatty acid profiles of stags given lucerne, barley, and Rhodes grass hays, either alone or supplemented with cereal grain-based concentrates are similar to those of other domestic ruminants (Puttoo and Dryden, 1998). Rusa weaners selected diets with 73 to 88 % cereal grain-based concentrate (the remainder was low-quality sorghum hay) and tolerated this diet with no digestive problems (Puttoo et al., 1998). Substitution of
barley grain for hay is greater at higher levels of supplementation: in the short term, barley grain replaces hay with substitution rates of up to 0.51 kg/kg (M. Hmeidan, pers. comm.). Substitution increases with the level of concentrate offered, and may not be important when the concentrate is less than 20 or 30 % of the total diet.

The metabolisable energy requirements of rusa deer are similar to those for the sambar, but may be 10 % less than those of red deer (see Dryden, 1999). The requirements for maintenance and growth are 0.504 MJ/kg\(^{0.75}\)d\(^{-1}\) and 32 MJ/kg gain, for housed stags (Hmeidan et al., 1999). Studies of growth (Puttoo et al., 1998) and N kinetics (Tomkins and McMeniman, 1996) indicate that the protein requirement of rusa weaners (6 to 12 months) is approximately 15 % of the diet DM. A lower-protein diet (10 v. 17.5 % DM) reduced growth (127 v. 158 g/d, male and female deer; 91 v. 161 g/d, males), food conversion efficiency (8.2 v. 5.2 kg DM/kg LWG), and delayed the start of spike antler growth (Puttoo et al., 1998). From preliminary data, rusa deer need 25 g ruminally available N/kg OM apparently digested in the rumen (Schuring and Dryden, 1996; M. Hmeidan, pers. comm.).

Poor growth during winter may be the major limitation to the productivity of pasture-fed deer. Growth may be limited by inadequate pasture growth and protein content, but possibly not by pasture digestibility.

CONCLUSIONS

Rusa deer are reasonably fecund, tolerant heat, and resist many of the diseases prevalent in northern Australia. Management of these animals is not difficult, notwithstanding their reputation for difficult behaviour. They perform well on subtropical grasses, although these will require protein, and possibly energy, supplements during winter. Rusa venison is well accepted by consumers, and is generally not fat, especially if the deer are slaughtered before their second winter. Rusa deer can make a valuable contribution to the diversity and resilience of Australian livestock production.

REFERENCES


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