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SOME ASPECTS OF THE BIOLOGY OF WILD SAMBAR IN VICTORIA, AUSTRALIA.

BY

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AUSTRALIAN DEER ASSOCIATION

'Conservation is a state of harmony between man and the land' Aldo Leopold

INTRODUCTION.

At the time of the inception of this research little documented data was available on the sambar *(Cervus unicolor)* in its Victorian habitat. Under the auspices of the Australian Deer Association (ADA) a research project was commenced by the Victorian Division four years ago, following the formation of the ADA Victorian Research Committee.

The hunter members were to be the chief suppliers of specimens and measurements from sambar taken in the field. The film "Sambar who cares?" was produced for the purpose of demonstrating sampling techniques and to show some aspects of sambar hunting methods and sambar habitat.

Sambar deer are the most numerous of the wild deer species present in Victoria. Unfortunately very little research into sambar biology has been conducted by the Fisheries and Wildlife Division of Victoria. The Forestry Commission of Victoria has, through the Deer Advisory Council, conducted a hunter survey on the sambar in the Mount Cole area (O'Bryan 1977). It was thus a case of the hunter's helping themselves to gain scientific data for use in the future of management of this superb game species. The hunter's response has been very gratifying.

HISTORICAL.

The sambar deer in Victoria are the result of various liberations throughout the State between 1857 and 1872 by both private individuals and the Victorian Acclimatisation Society. The origin of some of the stock is obscure, others are known to have been imported from Sri Lanka (Ceylon), India and the Malay Peninsula. A full description is given by Bentley (1978). Subspecies are recognized in India, South East Asia, Southern China, the Philippines, Indonesia, Sri Lanka, and Indonesia showing significant morphological differences but interbreeding readily. There remains significant debate regarding taxonomy issues at this time

Two herds are now established: an isolated small herd in the Mount Cole State Forest Reserve and the main population in the Victorian portion of the Great Dividing Range and pockets in the Strzlecki Ranges and on French Island in Gippsland. This eastern population has been estimated at as little as 3600 (Bentley 1978) or as many as 15000 (O'Bryan 1977, on the basis of one sambar per square kilometre of habitat).

No uniform Australian Subtype has yet evolved although some are of the opinion that a subspecies sambar *(Cervus unicolor australis)* should be recognized (F. Moore pers. comm.). The variants are most obviously distinguished by body size and antler characteristics in the stags, some showing distinctly Indian features, some Malayan, and more showing an intermediate type with an occasional rusa-like head being more likely a product of natural biological variation than hybridisation, although the possibility of such has not been ruled out as rusa deer were released along with sambar (Bentley 1978) during initial introduction. (rusa: *Cervus timorensis*).

Sambar were protected until 1919 after which time they were declared vermin to as late has 1973 when the their status rightfully rose to that of a game species. No closed hunting season is recognized at this time, such is the deer's ability to withstand high and continuous hunting pressure.

THE SAMBAR-GENERAL CHARACTERISTICS.

Sambar are slightly larger in body dimensions than red deer *(Cervus elaphus)*. The general body colour is commonly a uniform dark brown to grey with a lighter buff underside. Golden coloured hairs are spread through the coat over the rump and particularly fringing the peroneum and tail, this being most obvious when the animal is moving away from the observer. Considerable variation occurs from a slate grey to a very dark brown, the latter being particularly common in older stags.

Calves have adult coat colouring (no white spots) with a pronounced dark dorsal stripe which fades during the first few months of life. Being a subtropical species the coat is course and bristle-like, lacking the fine under-fur of the temperate European species. There is a distinct mane-like ruff around the upper part of the neck which along with the dorsal coat and tail hair is erectile. Both sexes, but particularly the stag, have greatly developed pre-orbital glands secreting a brownish-yellow waxy substance presumed to be involved with body scent identity. These glands are capable of being partially everted for aggressive display purposes, hence the Chinese name "four eyed deer" for the species.

The ears are large and bat-like (about half the length of the head) with a lighter outer edge. The simple six -tined antlers of the stag and the forefeet of both sexes function as weapons of offence and defence. The species, in common with other deer, have a well-developed tarsal the gland, the function of which is incompletely understood at present.

There appears to be no fast herd structure. Solitary animals form loose non-permanent family groups spread over a particular area as reported in hog deer *(Axis porcinus)* by Taylor (1969). Tracking sambar with radio collars to establish such facts is beyond the scope of this project. Even stags seem to be fairly nomadic and appear to tolerate other immature stags within their proximity. Most conflicts seem to be settled by display behaviour only, as records of stags with fight injuries are few.

Stags use small trees to rub their antlers preferring only certain species (Bentley 1978): wild cherry *(Exocarpos cupressiformis)* stringybark *(Eucalyptus baxteri)* peppermint gum *(Eucalyptus radiata)* Monterey pine *(Pinus radiata)* Black wattle *(Acacia mearnsii)*

Unlike most European deer, the sambar does not appear to have a regular breeding cycle, and there is no defined rutting period, although some indistinct patterns have emerged (Bentley 1978). These will be dealt with later in this paper.

Because of their extremely cautious habits, sparse distribution, solitary behaviour and their difficult habitat, detailed observation is almost impossible in the wild. Consequently there are many gaps in our knowledge of the species. They prefer heavy cover and are predominantly nocturnal feeders particularly in disturbed areas. Proximity to human habitation however does not seem to deter the sambar's presence (M.Draisma, personal observation)..

ECOLOGY.

In its native habitat the natural predator on the sambar is the tiger and man. In Victoria man, the dingo and wild dogs fill this necessary role, the latter two possibly being predatory mainly on juveniles. The Victorian habitat consists mainly of wet eucalypt forest in mountainous terrain, with small rocky rivers, fern or blackberry gullies and rarely, small grassy flats. Unlike the New Zealand experience with red deer, the sambar, after over 100 years of continuous habitation, seem to have had little impact on their environment. The dominant eucalypts are relatively unpalatable and there seems to be no direct competition with the other two major herbivores, namely the black-tailed wallaby *(Wallabia bicolor)* and the eastern grey kangaroo *(Macropus giganteus)*. Regrowth from existing forestry practices is an important aspect of habitat maintenance for sambar deer.

METHODS AND MATERIALS

Since the hunters themselves were to supply the data and the project had limited financial means, severe restrictions were placed on the format and the equipment used. To their credit, the co-operation from the hunters yielded an excellent response. Trade secrets such as methods and areas hunted and other sambar data has been traditionally difficult to obtain. This coupled with the knowledge that, should hunters be asked to go through a complex and time consuming sampling routine, no data would be forthcoming, led to the following scheme.

SAMPLE KIT.

Designed as a cheap robust means of collecting, transporting and delivering samples for the project. These consisted of the following:

. 303 ex-Army ammunition box
Set of labels
Simple bimetal strip thermometer
Electrical insulation tape lid seals
Two half-litre clip top plastic jars
Two 50 ml plastic jars
several polythene bags
Hacksaw blade
Pencil
Fibreglass measuring tape
500 ml of 12% formol saline in a plastic bottle
Four hunt report sheets (see appendix C)
Instructions card with Beaufort scale (see appendix A)

No provision was made for obtaining fresh whole blood, serum or other fresh organs as considerable time delay in returning samples was usually the case. Sample boxes had to be opened with some caution as occasional decomposed unpreserved specimens were at times encountered. No provision was made for weighing carcasses or organs because of the practical difficulties involved.

SAMPLES OBTAINED

All were preserved the in 12% formalin:

- rumen content sample
- Faecal sample
- Skin sample
- Bone sample
- Reproductive sample
- Lower jaw

Other information supplied was:

- Body dimensions
- Antler data and measurements
- Hunting method
- Data taken
- Abnormalities noted

RUMEN CONTENT SAMPLE

Both random and selected recognizable pieces of ingesta sufficient to fill a 500ml jar were collected. A method of tray and point analysis after the establishment of a set of reference specimens would be suitable as described by Bentley (1978) and Taylor(1971). To date treatment of some 80 samples held in this manner has not been possible. Gross qualitative examination of 15 samples has given some results. Grass fibre seems to make up a very large part of the contents, contrary to general hunter opinion that sambar are mainly browsers. This biased observation is possibly due to the ease of detecting browse sign on shrubs as compared to grazing sign.

FAECAL SAMPLE

Six to twelve faecal pellets were collected, director from the rectum and preserved in formalin. Examination using a variety of methods was undertaken to cross check the efficacy of the different methods. Insufficient nematode ova were detected to warrant using a McMaster egg count. Methods used were:

Flotation with 50% glycerol, saturated sucrose solution, and saturated sodium nitrate ($NaNO_3$) solution. samples with flotation time of one hour.

Filtration through three layers of surgical gauze followed by centrifugation for five minutes at 2000 rpm on samples, aspirate the sediment and examine.

Ether shake method. Samples were examined using Ritchie's formalin-ether sedimentation. Suspend in 10% formalin, filter through wet gauze, add 3 ml ether and shake vigorously, centrifuge for two minutes at 2000 rpm, aspirate debris and fluid at the bottom of the tube and examine this under a cover slip at low power.

Zinc sulphate floatation. Suspend in saturated $ZnSO_4$ solution, filter through gauze, centrifuge at 2300 rpm for 1 minute, allow to stand for 30 minutes, remove several drops from surface, and stain with iodine on a clean slide.

These methods are all quantitative examinations.

SKIN SAMPLE

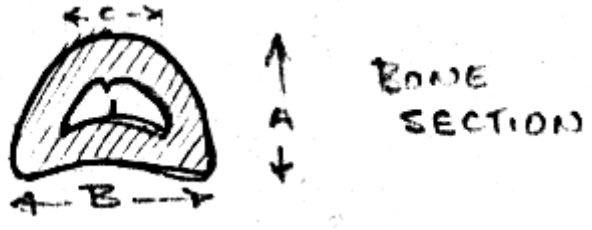
A 3x2 inch (8x5 cm) piece of skin was taken from the dorsum of the withers. Coat length was measured to the longest hair on the sample (in centimetres). Skin thickness was measured from the centre of the sample (in the centimetres).

The hair coat, skin surface and the accompanying formalin was carefully examined for external parasites, their eggs or larvae.

Additionally, specimens from any other cutaneous lesions were submitted for histological examination. The coat colour was noted.

BONE SAMPLE

A two inch cross section of right forelimb was taken centrally from the metacarpus. Three measurements were taken in centimetres from the centre of this sample as shown using a steel tape. Measurements A, B and C were recorded.



REPRODUCTIVE SAMPLES

The sex of the deer was recorded, and the following specimens were taken depending on the circumstances.

Testis—
One or both testes split longitudinally (to allow penetration of the formalin) was supplied. The organs were sectioned and stained with haematoxylin and eosin and the tubules of the testes and epididymis was examined histologically.

Ovaries—
Both organs examined grossly and histologically using the above tissue stains.

Uterus and Fallopian Tubes—
These organs were selectively sampled histologically and all examined grossly. Whole reproductive tracts were occasionally inspected.

Mammary Gland—
The presence or absence of milk was noted within the gland and any abnormalities noted.

Foetus—
The presence or absence of such was recorded. The intact foetus or a forefoot was supplied, for examination and assessment of relative development, and in some cases for weighing and measurement of the crown rump length. The sex was recorded where possible, and the date when the pregnant hind was taken was recorded.

BODY MEASUREMENTS

The following body measurements, as shown on the diagram on the back of the hunt report were recorded in inches:

Height at the shoulder—was measured from the tip of the toes of the forefoot to the tip of the dorsal process of the thoracic vertebra seated between the dorsal margins of the scapulae with the forelimb extended in the normal standing position.

Girth—The thoracic circumference as measured just posterior to the olecranon (elbow).

Total length as measured from the tip of the nose dorsally to the lowest coccygeal vertebra, following the contours of the back with the animal in lateral recumbency and the neck extended.

Pes length as measured from the tip of the toes (hoof) of the hind leg to the tip of the tuber calcis (point of the hock).

Body size index. This was calculated by addition of the above four measurements in order to compare the overall differences in body dimensions between animals.

For the purpose of classification, the deer were divided into three age categories:

0 - 9 months	calves (juveniles)
9 - 20 months	immature (sub-adults)
20 months onwards	mature (adults)

These categories were selected for reasons which will become obvious from later data.

ANTLER DATA

Because the measurements were recorded in the field, Douglas scores were not made, data being confined to total length of the right and left antlers in inches and the stage of development. The following classifications were made: hard, velvet, freshly cast and/or malformed.

For the purpose of antler comparison three groups were recognized:

Spikers-simple two point first antlers
Second heads-four or six point second (small) antlers
Mature heads-any subsequent racks

The date when the stag was taken was recorded

AGE DETERMINATION

The mandible was supplied from many of the deer sampled. These were boiled in water containing any household washing powder (one tablespoon per half litre of water) for about 40 minutes and was stripped clean and fat free by hand to facilitate storage and molar extraction. The eruption chart by Challies for red deer was modified by Humphries *et. al.* (1976) to suit sambar and this was used to determine the age of those animals less than 30 months of age (see appendix B). This eruption chart was verified by the method of sectioning the first molar and counting the layers of cementum deposit as used for animals over thirty months of age by Humphries and Rowler in this project also. The cementum age determination method of many mammals including deer is a recognised method used by game biologists (Mitchell 1963, 1967).

The first molar is carefully removed from the mandible using a hacksaw and side-cutting pliers. With the molar free from any bone a vertical cross-sectioned is commenced, grinding the front cusp and root away using a flat rotating lapping tool with 80 grit carborundum. On the line midway between the two roots the widest area of cementum is located by intermittent grinding and inspection through a binocular dissecting microscope, keeping the section wet for easier identification of the layers. The section was finished with 220 grit carborundum and polished with 600 grade wet and dry paper.

Most teeth were easily read at this stage and further etching and staining proved to be of little advantage. Occasionally split annuli were encountered in which case a field further along the section was chosen or in difficult cases the central incisor was also sectioned and it's cementum examined, due allowance being made for its eruption time difference of one year when assessing the results. The date and month the deer was taken was correlated with the section. Occasionally the cementum was of an amorphous nature and in particular jaws stored in formalin show a fatty infiltration which is difficult to remove with solvent, rendering them difficult during sectioning (Humphries pers. comm.). Tooth wear in age estimation has also been tried with less accurate results.

HUNTING METHOD

This was recorded for each animal taken, being either stalking or with the use of trailing hounds.

OTHER ABNORMALITIES

Selected issues, abnormal organs etc were preserved for examination and observations were recorded.

HUNT REPORTS (see APPENDIX C)

These were used to record habitat data as shown, giving an idea of deer activity in the area hunted. This section of the data has not yet been processed.

EXPERIMENTAL FINDINGS

RUMEN CONTENTS SAMPLES

From the gross qualitative studies to date, the introduced blackberry (leaves) seem to be the predominant winter diet where these are presence in the habitat. Other species regularly encountered are:

Various wattles	*Acacia* spp.
Blackwood	*Acacia melanoxylon*
Wild hazel	*Pomaderris aspera*
Golden tip	*Goodia lotifolia*
Musk and blanketleaf	
Native grasses:	
Wire grass	*Tetrarrhena juncea*
Mountain grass	*Glyceria dives*
And others	

Sambar are principally thought to be browsers but adapt readily to different food plants. Reports of them grazing alongside cattle or feeding on crops are frequent (Bentley 1978), who's findings agree with the above. Similar results were obtained from 12 ruminal samples examined by R. T. M. Prescott (1966 National Herbarium) for the Sporting Shooters Association Victoria. Other plants used by sambar (from the above two sources) are given below:

Blackberry	*Rubus fruticosus*
Dogwood	*Helichrysum dendroideum*
Water milfoil	*Myriophyllum elatinoides*
	M. propinquum
Drooping she-oak	*Casuarina stricta*
Hop wattle	*Acacia stricta*
Swamp paperbark	*Melaleuca ericifolia*
Mountain Correa	*Correa lawrenciana*
Christmas Bush	*Prostanthera lasianthos*
Woolly tea-tree	*Leptospermum lanigerum*
Tree violet	*Hymenanthera angustifolia*
Wirilda	*Acacia retinodes*
Australian Clematis	*Clematis aristata*
Varnish wattle	*Acacia verniciflua*
Common ground fern	*Calochlaena dubia* (formerly *Culcita dubia*)
Common raspwort	*Haloragis tetragyna*
Prickly bush-pea	*Pultenaea juniperina var. planfolia*
Eucalyptus spp.	

Seasonal variation in diet does occur, a lot of the listed plants are browsed only during the times when the more favoured species are available in lesser quantities. Quantitative analysis of paunches from a variety of areas at different times of the year will be necessary to complete the picture. This is an expensive procedure, which is beyond the scope of the present project.

Gross specimens recovered from the rumens in this project were in agreement with the above list. In addition one stag in late velvet had been found to have consumed a significant quantity of an unidentified light green lichen such as is often seen growing on dead wattles in damp areas. The main contents of most samples appeared to be grass fibres which tends to suggest that grazing is the most important feeding activity, contrary to what is generally believed by hunters at this time.

FAECAL SAMPLES

A total of 40 preserved faecal specimens from different sambar have been examined to date, and further samples are being held for future examination. The methods used, as given below are all quantitative. Five fresh intact intestinal tracts and abomasi have been grossly examined for parasites with negative results. Faecal egg counting techniques are limited to the facts that an adult worm burden exceeding 500 per animal must be present before significant egg numbers are seen in the faeces but such worm parasite levels are not considered clinically significant till they reach figures over 5000

(Presidente 1978) in most animals. Plasma pepsinogen levels were not looked at because of the difficulty in obtaining good quality blood serum samples from sambar taken in the field, however these again require significant worm burdens to be present before detectable increases occur (Armour 1970). Very light numbers of Eimerian oocysts were seen in a number of specimens and single ova of a strongyloid type, usually embryonated and measuring 100 x 60 u (K. Slee pers. comm.) which were probably Ostertagia species or Spiculopteragia asymetrica, (Presidente pers. comm.) were seen in 5 (12.5%) of the specimens.

Samples Giving Positive Microscopic Parasitology Results				
Year	**Oocysts No. of Samples**	**Ova No. of Samples**	**Total No. of Samples Examined**	**Test Used**
1974	7 4	4 1	13 13	Ether shake Glycerol, sat. sucrose
1975	1	1	4	$ZnSO_4$, Centrifugation
1976	0	0	9	Glycerol Modified Wisconsin $ZnSO_4$,
1977	0	0	7	Modified Wisconsin

No fluke eggs were found in any of the 14 specimens specifically tested for these but lesions of Fasciola hepatica were recorded in only three out of 262 of the deer sampled. Hunters were asked to forward samples from abnormal livers and of all the animals sampled only five organs were submitted for examination because abnormalities were thought to be present. One showed melanosis but was rather autolyzed, one showed gross chronic faciolosis with biliary fibrosis, two showed histopathologic evidence of acute parasitic migration tracts similar to those caused by larvae of Fasciola hepatica (P. Mitchell pers. comm.) and one liver had a few foci of polymorphs and monoculear cells of unknown aetiology. Liver fluke have occasionally been reported in hog deer in Victoria (Taylor 1971, Draisma and Presidente unpubl. data).

Literature cited by Presidente (1971) gives a good background picture of the significance of worm parasites in deer and reports on finding Eimerian oocysts and trichostrongyloid ova in captive fallow (Dama dama) and rusa deer (Cervus timorensis) in small numbers.

From the above findings it is seen that intestinal and abomasal parasitism in Victorian sambar deer in the wild state is of no real significance. In captive deer lungworm (Dictyocaulus spp.) and Spiculopteragia, and Ostertagia can cause mortalities (Presidente 1978). Lungworm larvae have been detected in two samples in penned fallow from Pendleside (samples provided by Bentley, for the Victorian Deer Conservation Cooperative). Presidente (1978) found no direct evidence of lungworm in penned fallow deer during his studies but found indirect histopathological evidence of such in several animals of what could possibly be migrating lungworm larvae in lung sections. Four fresh faecal specimens were subjected to conventional faecal culture and larval separation techniques with negative results. Histopathology in one lung section showed evidence of lungworm with a section of the parasite being visible. No evidence of tapeworms, their segments, eggs or cysts were found on any of the sambar sampled.

AGE DETERMINATION

The actual to sectioning is described previously. The work was developed and carried out by Australian Deer Association members I. Humphries and D. Rowler and was a major step forward in sambar research without which much of the data collection would have been rendered meaningless.

The sambar calf at birth has in the lower jaw one permanent tooth; the first molar, which erupts at one of month of age and is fully erupted at five months of age. All other lower teeth present at birth are deciduous. The first molar is therefore as old as the animal and is carried throughout life. Like all other *Cervidae*, the sambar has no upper incisors, this being replaced by a horny dental pad. Rudimentary canines lacking a socket (dental alveolus) are present on the maxillae of both sexes but are slightly larger (but not near as large as in Red deer- Cervus elaphus) in the male, the dental formulae being as follows: (note that the lower canine has been modified to form the fourth incisor as in other ruminants and the first incisor is particularly broad in the most *Cervidae and not to be confused with the larger permanent incisor structure of sheep- Ovines*).

DECIDUOUS					PERMANENT			
I_0	C_0	PM_3	M_1		I_0	C_1	PM_3	M_3
I_4		PM_3	M_1		I_4		PM_3	M_3

Degree of tooth wear is proportional to tooth quality and type of food and feeding mode. P. Brokx when studying white-tailed deer found tooth wear alone not a reliable method of age determination (Mitchell 1963, 1967). Using eruption data and first molar sectioning the following sambar age data was collected over seven consecutive hunting years. The sample included 97 sambar.

Average Age of Sambar Deer Taken in Victoria 1971 - 1977						
	STAGS		**HINDS**		**TOTAL DEER**	
Year	**Av. Age Years**	**No. of Deer**	**Av. Age Years**	**No. of Deer**	**Av. Age Years**	**No. of Deer**
1971	5.90	4	1.25	2	4.30	6
1972	0.75	1	1.00	1	0.90	2
1973	NIL	Jaws lost				
1974	3.40	7	3.80	4	3.50	11
1975	1.70	4	4.00	4	2.80	8
1976	3.30	16	4.70	15	4.00	31
1977	4.20	24	4.30	15	4.20	39
Combined av.	**3.80**	**56**	**3.80**	**41**	**3.90**	**97**
Range: max.	12.50		11.00		12.50	
min.	0.75		0.75		0.75	

Looking at the overall average age of the hinds taken and taking into account the average conception age (see later section) a hind could produce at least one and quite possibly two calves before being taken. Such information is vital in formulating a game management program. The overall average age of the stags taken is identical and ensures that they also are able to contribute to the breeding population for a reasonable period of time. This coupled with the data on the sex ratio within the herd and the number of trophy class stags present should determine the management policy. A model of such a program is given by G. Moore *et. al*. (1977) based on fallow deer *(Dama dama)*, but could equally be applied to sambar provided the differing breeding habits are taken into account.

At present, in the absence of any management, the annual stag harvest seems to indicate a relatively stable state within the sambar population in Victoria. The fact that these animals are able to do this despite a sustained (no closed season) and increasingly heavy hunting pressure is in itself an insight into the magnificent adaptability of the sambar as a species. In my opinion no other deer species in existence today could survive successfully the pressures that sambar are subjected to in Victoria. The limit of its adaptability has not yet been reached. A sambar distribution map drawn up from hunter sightings by the Deer Advisory Council of Victoria in 1977 provides unquestionable evidence that the sambar in Victoria is still very actively increasing its range. Such is not the behaviour of a declining population!

SKIN SAMPLES

Fifty samples were examined. The following results were obtained:

Coat length was measured in centimetres

	Stags		**Hinds**		**Calves**	**Total**
Age in months	**Mature – Over 20m**	**Immature 9 – 20m**	**Mature – Over 20m**	**Immature 9 – 20m**	**0 – 9m**	
Number	25	7	15	2	1	50
Av. Length (cm)	6.6	7.2	8.9	7.5	8.5	
Range:						
Max.	10.5	11.0	11.0	11.0	8.5	
Min.	3.5	5.0	3.0	4.0		

Sampling error may have contributed to the shorter coat length in the adult stags, as samples were probably taken further back from the shoulder if the capes were required for taxidermy. In all, the coat shows little variation in length and the effect of seasonal variation is not clear due to seasonal sampling bias.

Coat colour

These varied from a slate grey to dark brown, but most were mid brown. There was no means of measuring the colour variations, as the scale of variation was small.

Skin thickness

This was measured in centimetres

	Stags		Hinds		Calves	Total
Age in months	**Mature – Over 20m**	**Immature 9 – 20m**	**Mature – Over 20m**	**Immature 9 – 20m**	**0 – 9m**	
Number	25	7	15	2	1	50
Av. thickness (cm)	0.75	0.70	0.80	1.00	0.50	
Range:						
Max.	0.60	0.70	0.70	0.90	0.50	
Min.	1.00	0.90	1.10	1.10		

Stags showed smaller skin thickness than hinds, contrary to expectations, this again probably due to sampling error. Variation in stags at different stages of antler growth was not examined because of the small numbers sampled which were not in hard antler at the time they were taken. Stag samples were taken further towards the rear of animal since the cape was required for taxidermy, hence a sampling error is probable.

External parasites

No external parasites word detected in the fifty samples examined. Sambar in Victoria appear to be free of external parasites. Ectoparasites which could be expected were:

Lice	*Damlinia* spp.
	Haematopinus spp.
Keds	*Melanophagus* spp.
Mange mites	*Sarcoptes* spp.
	Demodex spp.
Ticks	*Ixodes* spp.
	Rhipicephalus spp.
	Haemaphysalis spp.
Warbles	*Hypoderma* spp.
Screw worms	*Callitroga Americana*
	Chrysomia bezziana

The above external parasites have been recorded in other deer species in other countries by various workers (see McDiarmid 1975).

Skin trauma

This was seen in areas of alopecia on the bodies and necks of a number of adult stags perhaps due to fighting or rapid hunting related escape behaviour. Never, however, were gross wounds recorded. Many deer showed alopecia and hyperkeratosis on the volar surfaces of the pasterns due to trauma, and no mange sites were detected in five such specimens when examined histologically.

BONE SAMPLES

These were taken with the object of attempting to identify the various sub-types still present within the Victorian herds and also to look at sex differences. Sampling error or again caused these results to be somewhat difficult to interpret. Stags with Indian type antlers did not always have heavier set or larger bodies than did Malayan antlered stags.

	Stags		**Hinds**		**Calves**	**Total**
Age in months	**Mature – Over 20m**	**Immature 9 – 20m**	**Mature – Over 20m**	**Immature 9 – 20m**	**0 – 9m**	
Measurements Av.						
A	2.4	2.2	2.1	2.0	1.45	
B	2.6	2.4	2.3	2.2	1.65	
C	1.3	1.3	1.3	1.3	1.15	
No. Samples	**18**	**10**	**20**	**3**	**2**	**53**
Range A:						
Max.	2.1	2.0	1.8	1.9	1.3	
Min.	2.8	2.5	2.4	2.0	1.6	
Range B:						
Max.	2.2	2.2	2.9	2.0	1.5	
Min.	2.8	2.5	2.7	2.3	1.8	
Range C:						
Max.	1.2	1.0	1.1	1.2	1.1	
Min.	1.5	1.4	1.5	1.4	1.2	

The medullary cavity (C) remained almost constant throughout life while the external cortex size (A and B) becomes progressively larger with maturity and stags tend to have larger cortex dimensions than hinds, the relationship of which to Body Size Index is looked at in the graph (APPENDIX D)

Larger bodied deer do not have heavier bone structure of necessity and the relationship of the results closely follows those of the above table. An Indian type stag with a Douglas score 203 had a body size index to cortical size ratio well below (marked by arrow) many of the intermediate type antlered stags. I have personally taken a Malayan type stag with exceptionally large body dimensions with an unofficial (due to being in late velvet) Douglas score of 177 (marked X).

REPRODUCTIVE SAMPLES

TESTES AND EPIDIDYMIS

Twenty-one specimens were looked at, of which one stag was in the early velvet, one had failed to develop antlers at 18 months of our age where normally a set of spikes is carried, eighteen carried hard antlers, and one stag 12 months of age had only two one-inch bumps instead of hard spikes.

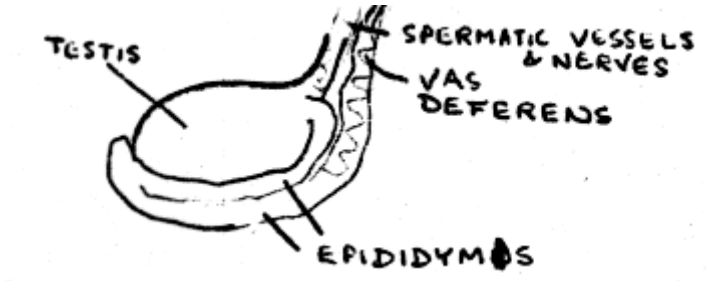
Dr. Peter Mitchell from the Bairnsdale Regional Veterinary Laboratory made the examinations and offered the following comments.

Tubule Diameter.

Ten round or oval shaped tubules in each section of testis were selected. The minimum diameters were measured and an average diameter for these tubules was obtained. Eighteen normal stags were examined; the average diameter was 179 ±23u. From this, diameters less than 133u were significantly ($p > 0.05$) lower than normal. This includes one normal stag in early velvet (001) and two antlerless stags (009 & 013), which most likely were showing hormonal differences to the other stags, which were in hard antler. However the figure for tubule diameter should be seriously questioned because the sample of the tubules was taken from the one section (therefore not truly random) and because varying degrees of autolysis were present with separation of the tubule from the surrounding connective tissue in most samples, and separation of the basal membrane in others. The significance of the muscle hyperplasia and fibrosis in the epididymis in many of the examples is unknown.

A summary of the findings is shown the in the following table.

SAMBAR DEER—TESTIS AND EPIDIDYMIS—Dr. P. MITCHELL						
Stag No.	**Antler Status**	**Month**	**Age Years**	**Tubule Diam. U**	**Sperm Prodn.**	**Comments**
77001	Early velvet	Feb	7½	130	Active	Chronic inflammation of the epididymis and plasma cell and lymphocyte infiltration of tubules
008	?	May	4	201	Active	Mild fibrosis and hyperplasia of epididymis
009	Small bumps	June	1½	135	Nil	Spermatids and spermatogonia in some tubules only
011	?	?	?	192	Active	Muscle hyperplasia in epididymis.
013	Small bumps	?	1	109	Slight	Active but few sperm seen in testis or in epididymis
017	Hard 6pt	Aug	2½	165	Active	Normal
023	Hard spikes	Aug	2½	151	Active	Mild fibrosis in the epididymis
028	Hard 6pt	Aug	Matur e	182	Active	Some muscle hyperplasia in the epididymis
030	Hard 6pt	Sep	Matur e	198	Active	Some muscle hyperplasia in the epididymis
031	Hard 6pt	Oct	matur e	210	Active	Normal
032	Hard 6pt	Oct	6½	192	Active	Normal
034	Hard 6pt	Oct	5½	190	Active	Some muscle hyperplasia and fibrosis in the epididymis
038	Hard spikes	Aug	?	176	Active	Normal
041	Hard spikes	July	?	152	Active	Normal
500	Hard 6pt	Aug	3½	208	Active	Normal
501	Hard 6pt	Aug	6½	193	Active	Normal
501B	?	?	?	195	Active	Some muscle hyperplasia in the epididymis
504	Hard 6pt	July	? (3?)	176	Active	Normal
525	Hard 4pt.	Oct	3½	152	Active	Normal
76027	Hard 6pt	Oct	3½	124 133	Active	Both testes examined. Muscle hyperplasia in the epididymis



Anatomical diagram of a testicle

My comments are as follows:

The spikers seem to have a smaller tubule diameter than the mature stags over three years of our age. The cellular elements in the stag 77001 may be an involuting type reaction as the testicular activity rapidly reduces during early antler formation. This has been reported in fallow deer by Chapman et. Al (1975). More stags in velvet need to be examined, but such animals are only occasionally available.

Taylor (1971) reports that mean testicular weight compared to pes length (other body dimensions vary with nutritional conditions especially in rutting stags) is a more reliable index of testicular activity. Such data may be looked at in future work on this subject.

OVARIES AND UTERI

Hunters have great difficulty in locating non-gravid (non pregnant) uteri and individual ovaries. Ovaries and, in some cases, uteri, from eight non-gravid hinds were examined histologically by Dr.

Mitchell. These were taken between the months of March and October (see hunting bias). All organs showed evidence of active cyclic activity. Two hinds were found to have 3cm spherical cysts on the fallopian tubes (one on one oviduct, this hind was pregnant, the other on both oviducts, this hind being empty). These cysts were considered to be possible remnants of Muellerian ducts (B. Mitchell pers. comm.), which were lined with low columnar epithelium and had thick fibrous walls.

Bentley (1978) considers the minimum sambar hind reproductive age to be 15 months and the average minimum reproductive age to be 19 months. Of 28 hinds (pregnant) which were sampled five young hinds had as age at conception 15, 16, 17 and a half, 20, and 23 months respectively. The oldest recorded hind was 13 years (empty), the second oldest hind was 11 years (±six months pregnant—see film) and out of four hinds between 8-9 years old, half of the group were pregnant. A 17-day cycle is reported by Bentley (1978) for a sambar hind.

THE FOETUS

From the data gathered, the foetus at birth has a crown rump length of circa 100cm and weighs around 12 to 13kg. The period is given by Asdell (1946) and by Bentley (1978) as 8½ months (i.e. 39-weeks). Most foetal growth patterns are similar in mammals, being only different in the final body size at birth and the total time taken to develop to this size. Herbivores tend to be much more developed at birth than carnivores. Some outlines of the development of the fallow deer foetus are given by Chapman and Chapman (1975). This chart was based on a 33-week gestation time. By proportionating this to 39 weeks we have been able to construct a similar chart for sambar development from which (due to the impossibility of attaining verified material) some age estimations were made of sambar foeti and the corresponding weights and crown-rump lengths were noted.

Approximate sambar gestation chart.

Age in weeks	Features
7	Eyes visible but lids absent. Uterus begins to enlarge.
8	Eyelids present, sex determinable.
21	Hairs appear around muzzle and eyes.
27	Growth of short body hair and skin pigment commences.
30	Body covered with a short coat of hair.
34	Hair coat almost fully formed.
39	Birth.

Some age estimations of foeti weighed and measured collected from sambar hinds are given below:

Age in weeks	Crown Rump Length	Weight (grams)
8	8	21
11	15	40
17	35	-
21	45	1200
24	50	-
31	67	-
33	72.5	4000
34	75	-
38	92	11200
39	100 approx.	12-13000

Using this data the month of conception and the expected month of birth was computed for each foetus encountered during the sampling. Some 21 hinds gave the following results, when the month they were taken was considered.

	Month of the Year												Total
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Conception	4	0	1	0	3	0	1	2	1	0	4	5	21
Birth	0	3	0	1	2	1	0	4	5	4	0	1	21

Sambar can be accurately aged by tooth eruption up to 30 months of age. Knowing the month they were taken some 60 sambar between the age of birth to 30 months were processed to reveal their birth months, which are tabulated below.

	Month of the Year												Total
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Birth	3	2	2	4	7	3	1	5	5	9	15	4	60
A similar but probably more complete pattern emerges. Similarly:													
Conception	9	15	4	3	2	2	4	7	3	1	5	5	60

These figures suggest continuous mating activity throughout the year with a peak in the late spring and another peak in the late autumn to early winter with corresponding peaks for calf births.

These results agree only partly with those given by Bentley (1978) who suggests a rut peak between September to October and a calving peak between May and July, and again that these activities occur at all times of the year. Taylor (1971) in his thesis on hog deer (Axis porcinus) found that in this species, which have many behavioural similarities to sambar, that mating occurs at any time of the year with a large peak of activity between May to June and a smaller peak between October and December. The corresponding antler cycle will be discussed under ANTLERS. Hunting bias again influences the results above.

MAMMARY GLAND

Looked at externally the udder of the sambar hind is rather inconspicuous. The gland is situated in the pubic region, is about the size of a man's palm and has four quarters, each with a small (1cm x 0.5cm) single ducted teat. Most of the gland is deeply seated between the medial thigh muscles and is not pendulous, so that the presence or absence of milk is not obvious unless the teats are expressed or the gland is incised. The presence or absence of milk was recorded against the date taken for some 49 adult sambar hinds 9 over 20 months of age).

	Month of the Year												Total
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
In Milk	0	0	0	1	2	1	4	5	2	0	1	0	16
Dry	0	0	1	3	3	5	9	4	3	2	2	1	33

Total number in sample = 49.

Some (3) of the hinds in milk were also pregnant, the smallest interval between parturition and subsequent conception being observed as circa one month. The above table related to the incidence of pregnancy when hinds were taken during varying months of the hunting season as follows:

	Month of the Year												Total
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Pregnant	0	1	0	4	5	4	6	5	0	1	1	1	28
Non pregnant	0	0	1	1	2	3	6	5	5	1	2	0	26
Total	0	1	1	5	7	7	12	10	5	2	3	1	54

A total of sixteen hinds were neither pregnant nor in milk. The above total column reflects again the bias due to seasonal hunting pressure. The oldest that which was pregnant was 11 years of age and the oldest lactating hind was 12-13 years of age.

Weaning seems to take place at a relatively early age, under natural conditions. Two sambar calves aged six and four months showed no evidence of suckling when judged by the absence of milk clots from the abomasum in each case. Both these calves were taken in June.

So it seems that hinds can be found in any sort of reproductive stage from dry and non pregnant through to pregnant and lactating at any time of the year, but that two distinctive peaks in births occur in May and November against a lower level continuous background.

OTHER SAMBAR HIND REPRODUCTIVE DATA

The foetal membranes resemble those of the domestic sheep in that they consist of a cotyledonary type with the epithelial layers of the uterus being in close opposition with the epithelial elements of the chorio-allantois of the foetus. An average of 5 to 12 cotyledons have been found in some seven uteri examined, thus very similar to that described in fallow deer (Chapman et al 1975).

It seems to me that it is not the total number of cotyledons but rather the total functional weight or surface area of these organs that is the important factor to the foetus although this has not been proven in the sambar.

The cotyledon is oblate ellipsoid in shape and in full term pregnancy, if the minimum number is present, achieves dimensions of up to 105 x 75 x 60 millimetres. The foetal elements intrude into the maternal portion with multiple finger-like extensions up to 20 mm in length and very closely attached, being forcibly separated only with some effort.

During pregnancy the endometrial glands, which presumably play an important part in the early nutrition of the embryo, are extensive. The epithelial lining of the non-gravid uterus varies with the state of the oestrus cycle from low pseudostratified during the anoestrus phase to very tall pseudostratified during the oestrus. The endometrial glands correspondingly become more elongated and numerous during the oestrus period.

Twins have not been recorded during the sampling but Bentley (1978) records one case where a hind was sighted in the wild with two young calves of similar age running with her. Bentley also reports on an observed birth of a sambar calf. The hind wars recumbent at parturition. The calf attempted to stand at 35 minutes post partum, and was able to walk in under one hour. I have manually assisted a hand reared sambar hind during parturition with a normal anterior presentation, and have witnessed almost identical events as described above, verifying the normality of the data.

BODY MEASUREMENTS

A total of 134 sambar was measured, the various groups are tabulated. Weight estimations (as they fell) are shown for the record of such only but no meaningful conclusion can be drawn from these weights. As shown from the large body weight variations and with previous hog deer weight estimates (Draisma 1973 Aust. Deer- Data Analysis) , hunters are not very good at estimating deer body weights, and such results are completely unreliable. Hunter measuring error is difficult to gauge from the result but could be significant and no controlled trails were run to determine such error and/or its existence.

CATEGORY		**Estimated Weight (lb)**	**DIMENSIONS (inches)**				
			Girth	**Height**	**Length**	**Pes**	**B.S.I.**
Mature stags							
20 month+	Average	442	55	50	85	21	211
	No.	54	45	55	48	51	
Range	Max.	685	64	55	97	23	239
	Min.	250	42.5	44.5	66	15	168
Immature stags							
9 - 20 month	Average	276	46	45	83	20	194
	No.	25	26	29	29	30	
Range	Max.	400	55	49	97	21	222
	Min.	180	40	40	64	14	158
Mature hinds							
20 month+	Average	367	49	44	78	19	190
	No.	32	31	32.0	32	34	
Range	Max.	600	65	49.5	95	20.5	230
	Min.	180	40	40	64	14	158
Immature hinds							

9 – 20 month	Average	238	38	41	66	17	162
	No.	11	5	10	8	8	
Range	Max.	300	42	45.5	75	18.5	181
	Min.	160	33	34	52	15	134
Calves							
0 – 9 months	Average	95	30	34	54	15	133
	No.	11	6	9	8	9	
Range	Max.	150	38	41	64	17	160
	Min.	80	24	26	43	12	105

These weights and dimensions are however, in agreement with those quoted by Bentley (1978). One confirmed intact weight in an immature stag was recorded as 240lb and having a B.S.I. of 188 (sample No.76032).

The average ratios of B.S.I. per pes length and estimated weight per B.S.I. were not constant and in both cases decreased with age:

Sambar (Age Groups as Above)	**BSI/Pes**	**Est. Weight/BSI**
Mature Stags	10.286	2.133
Immature Stags	10.165	1.381
Mature Hinds	10.252	1.718
Immature Hinds	9.545	1.485
Calves	8.683	0.704

SEX RATIO

The sex ratios for the 263 animals in the survey of data between 1970 and 1977 favoured stags to some degree (1.6 : 1).

Age	**Stags**	**Hinds**	**Combined**
Mature 20 months+	101	71	172
Immature 9 – 20 months	54	23	77
Calves 0 – 9 months	7	7	14
Total	162	101	263

HUNTER BIAS

As can be seen from the dates when the sambar deer were taken, as shown below, the bulk of the hunting is done between early autumn and early spring. This biased sampling will affect some of the results and should be taken into account when interpreting data.

CATEGORY	**MONTH OF THE YEAR WHEN TAKEN—1970 TO 1977**													
Age groups as previously detailed	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Undated**	**Total**
Mature Stags	0	2	1	6	11	13	16	17	11	14	5	1	4	101
Immature Stags	0	0	2	2	7	12	7	10	2	5	2	0	2	51
Male Calves	0	0	0	1	1	2	1	2	1	1	0	0	0	9
Total Stags	**0**	**2**	**3**	**9**	**19**	**27**	**24**	**29**	**14**	**20**	**7**	**1**	**6**	**161**
Mature Hinds	0	0	1	5	8	10	12	12	10	3	2	1	9	73
Immature Hinds	1	1	2	2	4	0	4	3	2	1	1	0	0	21
Female Calves	0	0	0	1	1	1	1	0	2	1	0	0	0	7
Total Hinds	**1**	**1**	**3**	**8**	**13**	**11**	**17**	**15**	**14**	**5**	**3**	**1**	**9**	**101**
Total Sambar	**1**	**3**	**6**	**17**	**32**	**38**	**41**	**44**	**28**	**25**	**10**	**2**	**15**	**262**

SAMPLING BIAS

Hunters tended to sample certain specimens of deer more readily than other specimens. This may reflect the amount of effort required or the ease in which a specimen could be identified or both of the above factors. Sampling bias may influence some of the results, and must be borne in mind when interpretations are made.

SAMPLE—1976 ONLY		STAGS		HINDS		TOTAL DEER	
		No.	**%**	**No.**	**%**	**No.**	**%**
Body Measurements	Complete	19	65.3	14	77.8	33	68.8
	Incomplete	2	6.7	3	16.7	5	10.4
	None	9	30.0	1	5.5	10	20.8
	Total	**30**	**100.0**	**18**	**100.0**	**48**	**100.0**
Antlers	Complete	28	93.3				
	Total	**30**	**100.0**				
Ovaries	Complete			7	38.8		
	Total			**18**	**100**		
Tooth or Jaw	Sampled	24	80.0	18	100.0	42	87.5
	Total	**30**	**100.0**	**18**	**100.0**	**48**	**100.0**
Faecal	Sampled	21	70.0	18	100.0	39	81.3
Ruminal	Sampled	22	73.3	15	83.3	37	77.1
Skin	Sampled	20	66.6	11	61.1	31	64.6
Bone	Sampled	23	76.6	16	88.8	39	81.3

SAMBAR ANTLER DATA

Little is known about antler growth in the sambar stag.

Hinds of the species do not as a rule grow antlers, but one such animal is recorded by Bentley (1978) where the possibility of hermaphrodism was not ruled out. Some cases of rudimentary pedicle growth in sambar hinds are more commonly reported and three such cases were encountered out of 101 hinds in the sample:

(1) a 2½-year-old pregnant hind showing a unilateral hydrosalpinx;
(2) a 4-year-old hind was empty and dry; and
(3) a 2½-year-old, which was dry and pregnant.

There may be a hormonal basis to this abnormality but this does not seem to interfere with fertility in two of these cases

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For purposes of classification of antlers, three groups have been devised. Adult stags usually have simple rucinene (six-point) antlers, and very immature animals as their first set of antlers carry a pair of small spikes (two points). Young stags carrying their second set of antlers can be identified because the antlers, although adult in character, are small with poorly developed top forks (six-point) or a four-point rack again rather small in size. Inheritance of antler structure is not a sex-linked characteristic in deer species so that the genes in fallow deer *(Dama dama)* are also transmitted by the female (Chapman 1975). The antlers grow from a foundation area, the pedicles, which develop on the temperal bones of the skull. The endocrinology of the growth process has not been studied in sambar. In red deer castration in early life prevents pedicle formation and adult castration causes casting, growth of new velvet to half development. Such stags are termed Haviers and Perukes respectively. Two sambar stags aged 12 and 18 months were encountered with rudimentary knobs only, at an age when all others were seen to be carrying spikes. Testicular activity in both these animals was poor, but the organs were in their normal location (ie. Fully descended). Unlike hummel red stags these animals would therefore seem to be infertile.

By placing the stags sampled into antler groups of spikers, first full heads (second heads) and subsequent antlers, a series of age groups have been derived from the animals sampled suggesting growth and replacement ages for these groups as follows:

AGE RANGE	**DETAILS** (Draisma 1977)
0-7 months	Knobs

7-9 months	Velvet spikes growing
9-27 months	Spikes hard and very worn at the end of this period
27-30 months	Casting, followed by a growth of small four or six point second head
30-48 months	Small hard antlers with very short tines
45-48 months	Second cast and commencement of growth of third head

This table was constructed using 57 stags aged by tooth eruption time, tooth sectioning or both and in the various stages of antler described above. Of these none were seen with spikes till over seven months, several cases of velvet spikes are seen between seven and nine months and some animals are still carrying spikes at up to 30 months. The second antler stags are seen to appear at between 20 to 30 months of age, three cases of velvet being recorded between 27 and 30 months. These poorly developed and often-deformed antlers (between 10 and 17 inches in length) were seen in stags between 24 and 42 months of age with one instance of a stag in mid velvet with a ten-inch head at 21 months of age to complicate the picture. The proposed table above was based on 57 stags but more data on stags in velvet is required to confirm the theory that casting in the sambar stag is not a regular and annual synchronised affair as in most other deer species. Some reports from the Melbourne Zoological Gardens suggest annual casting (D. O'Bryan pers. comm.). Captive animals cannot always be related to wild ones when mating behaviour is being observed. Observations by G. H. Haggard on sambar kept in a more extensive and less a disturbed enclosure at Pendleside were as follows. Calf was seen growing velvet spikes at nine months of age. Another was observed with more detail.

DATE	EVENT	REMARKS
9/9/1972	Pedicles only.	Estimated age 9/10 months
14/1/1973	Growing spikes	Estimated age 13/14 months
6/8/1973 to 26/9/1973	Rut behaviour	Estimated age 18/20 months
20-21/1/1974	Spikes cast	Estimated age 25/26 months
20/3/1974	Velvet Top fork developing	Estimated age 27/28 months
12/5/1974	Rubbing velvet off	Estimated age 28/29 months
15/12/1975	Antlers cast	Estimated age 47/48 months

All five stags in the enclosure were cast by 12/1/76 and were again seen to be cast between 28/12/77 and 4/1/78 (Bentley pers comm.).

Perhaps spikes are carried for circa 12 months and subsequent antler sets for two years? Each stag may have a similar casting season once the first has been established. Data from the project agrees with Bentley (1978) that stags may be found in different stages of antler growth at any time of the year. Hunting bias greatly influences the interpretation of the results.

Because of the relative time stags are in velvet as compared to in hard antler and changes in behaviour at this time, few stags sampled were in velvet (8.7%) or cast (0. 6%). Growth time for spikers (4. 8 weeks) and mature older antlers (17 weeks) has been estimated by Draisma (1977)

ANTLER STAGES IN SAMBAR STAGS TAKEN 1970 - 1977													
Details	**Month Taken**												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Adult stags 27 months+													
Hard antler	0	1	0	4	8	11	16	17	10	15	5	1	88
Deformed	0	0	0	1	2	3	2	2	1	3	2	1	17
Velvet antler – Early	0	1	0	1	0	0	0	0	0	0	0	0	2
Velvet antler – Late	0	0	0	2	4	1	1	0	1	0	0	0	9
Antlers cast	Nil												
Total	**0**	**2**	**0**	**8**	**14**	**15**	**19**	**19**	**12**	**18**	**7**	**2**	**116**
Spiker stags 9 – 27 months													
Hard antler	0	0	1	2	3	10	3	11	2	5	1	0	38
Deformed	0	0	0	0	0	0	0	1	0	1	0	0	2
Velvet antler – Early	0	0	1	0	1	0	0	0	0	0	0	0	2
Velvet antler – Late	0	0	0	1	0	0	0	0	0	0	0	0	1
Antlers cast	0	0	0	0	1	0	0	0	0	0	0	0	1
Total	**0**	**0**	**2**	**3**	**5**	**10**	**3**	**12**	**2**	**6**	**1**	**0**	**44**
All stags 1970 - 1977													
Hard antler	0	1	1	6	11	21	19	28	12	20	6	1	126
Deformed	0	0	0	1	2	3	2	3	1	4	2	1	19
Velvet antler – Early	0	1	1	1	1	0	0	0	0	0	0	0	4
Velvet antler – Late	0	0	0	3	4	1	1	0	1	0	0	0	10
Antlers cast	0	0	0	0	1	0	0	0	0	0	0	0	1
Total	**0**	**2**	**2**	**11**	**19**	**25**	**22**	**31**	**14**	**24**	**8**	**2**	**160**
Bentley (1978)													
Hard antler	6	0	1	1	6	7	16	11	5	3	2	4	62
Velvet antler – Early	2	1	1	6	1	4	0	0	0	2	0	2	19
Velvet antler – Late	1	0	7	6	3	3	2	0	0	0	0	2	24
Antlers cast	0	1	0	0	0	0	0	1	0	2	1	0	5
Total	**9**	**2**	**9**	**13**	**10**	**14**	**18**	**12**	**5**	**7**	**3**	**8**	**110**

When hunting bias is taken into consideration no clear picture emerges. Many hunters claim a summer cast more likely and that a peak of wallow use and tree rubbing (rut?) is seen in late autumn to early winter (May to June) which to some degree fits in with the hind breeding activity table calculated previously (see also Bentley 1978).

Breeding habits in European deer species has been regulated by a very harsh natural selection factor (winter) hence there is a very narrowly delineated breeding season. Sambar deer being a subtropical species are possibly closer in origin to the earlier Cervid ancestral stock which has been much less selected for seasonal breeding. Calf survival was possible at all times of the year, but somewhat more favourable in the spring and summer hence the year round breeding pattern with faint cyclic overtones. The effect of latitude and length of daylight on subtropical deer has been observed to some extent with Chital (Axis axis) in Hawaii but how this affects sambar deer is unknown.

ANTLER DIMENSIONS

Group	**Average Length (inches)**		**Average of Pair (inches)**		**No. of Stags in the Sample**
	Right	**Left**	**Maximum**	**Minimum**	
Mature stags—6 points	20.9	20.9	29.8	9.8	71
Second heads—4 points	14.3	14.3	15.0	13.0	3
First heads—2 points	5.1	5.1	9.1	2.0	31

					105

Note that the above table does not include deformed heads that will be examined later. Averages of the right and left antlers tend to be even. Further analysis shows the following:

ANTLER BIAS IN SAMBAR STAGS 1970 - 1977				
Group	**Right Antler Longest**	**Left Antler Longest**	**Both Antlers Equal**	**Total**
Mature stags 4 and 6 points	30	28	19	77
Spiker stags	9	7	12	28
Combined	**39**	**35**	**31**	**105**

The antler bias follows a normal biological distribution pattern. Further results taken from the Antlered Trophy Register of the Australian Deer Association covering 90 stags most of which are not included in the Sambar Project samples and also 53 stags from the New Zealand Deerstalker's Association Sambar Register gave results as follows:

ANTLER BIAS IN SAMBAR STAGS 1970 - 1977								
Group	**Right Antler Longest**		**Left Antler Longest**		**Both Antlers Equal**		**Total**	
ADA – 90 stags	33	36.7%	49	54.4%	8	8.9%	90	100%
NZDA – 53 stags	23	43.3%	27	50.1%	3	5.6%	53	100%
Sambar Project – 105 stags	39	37.1%	35	33.3%	31	29.5%	105	100%

The large figure for stags with equal antler measurements from the Sambar Project suggests that many antlers measured as equal by the hunters are in actual fact the slightly unequal. The New Zealand (NZDA) stags of the top 53 trophy heads give very similar results to the Victorian sambar stags.

ANTLER SPREAD

It has long been suspected that the Victorian sambar stags tend to be overspread i.e. the length of the longest antler is less than the greatest width between the antlers. On examination of the ADA Trophy register (antler spread was not recorded in the Sambar Project) the following data came to light:

SAMBAR ANTLERS 1970 - 1977								
Group	**Under spread**		**Even**		**Overspread**		**Total**	
ADA trophies	24	26.6%	1	1.1%	65	72.3%	90	100%
NZDA trophies	27	50.9%	1	1.9%	25	47.2%	53	100%

The percentage under spread or the percentage overspread was calculated for each of the above groups (Draisma 1978 unpublished data) and the mean percentage over or under spread was calculated. The average New Zealand sambar was found to be under spread by a 3. 8% while the Victorian stags were found to be overspread by 6.6%, showing definite racial differences between the two groups.

ANTLER DEFORMITIES

A host of antler deformities/deficiencies have been recorded in the data collection. The figures indicate that antler abnormalities are not as rare as is generally thought. Of the 160 stags sampled 23 (14. 3%) showed deformities. Of these 23 deformed racks, 2 had no pedicles or antlers at all, 2 in first heads, 12 were seen in second heads, 2 in third heads, 3 in old stags over 8 years of age, and three were unspecified as to age and type. Poorly developed top forks in second heads have not been classified as deformities and are also common especially in Malay type heads (Bentley pers. comm.). Of all the deformities recorded 16 (69.5%) were seen the in stags less than three years of age.

INCIDENCE OF ANTLER DEFORMITIES IN SAMBAR STAGS 1970 – 1977				
Group	**Deformed Antler**			
	Right	**Left**	**Both**	**Total**
3rd head or more	0	2	4	6
2nd head	2	5	5	12
1st head (spikes)	1	0	3	4
Combined	3	7	12	22
Unspecified 1. Total 23				

Deformities of both antlers are more common than those of one of the pair, in which case the left antler is more likely to be malformed than the right antler. The abnormalities recorded consisted of almost every conceivable combination as shown by the following table:

TYPES OF ANTLER DEFORMITIES SEEN IN SAMBAR STAGS 1970 – 1977		
Type of Deformity	**Number of Stags**	**Comment**
1x1 pt & 1x3 pt	1	
1x2 pt & 1x3 pt	4	
1x1 pt & 1x1 pt	1	Not a spiker. Two stumps
1x1 pt & 1x2 pt	1	
1x1 pt & 1x2 pt	1	Twisted
Stump & 1x3	2	One broken (acquired abnormality)
Stump & 1x1	1	
Stump x2	1	
1x1 pt & 1x1	2	Twisted
2x2 pt & 2x2 pt	4	Not normal full head
0x1 pt & 0x1	2	12 and 18 months old, smallnobs
No details given	3	
Total	**23**	**Out of 160 stags**

CAUSES OF ANTLER DEFORMITIES (Draisma 1977)

There are many baseless theories associated with antler malformation. Deformities may be acquired or inherited, and may also be temporary or permanent.

1. Injury to the pedicle area (acquired) may cause a permanent and recurrent deformity in subsequent antlers that grow from this pedicle.
2. Injury to the growing velvet antler itself (acquired) may cause a temporary deformity, which is not duplicated in subsequent antlers growing from that particular pedicle.
3. Hereditary factors, either hormonal or structural, can cause permanent recurrent deformities, which can be passed on to the next generation.
4. Acquired hormonal abnormalities through disease or injury to the gonads or other endocrine glands can cause temporary or permanent generalized deformities, which essentially are never unilateral.
5. Nutritional factors cause temporary unilateral or sometimes bilateral deformities or deficiencies in antler development, as is seen in many stags growing second heads. Lowered skeletal mineral reserve due to body and antler growth demands coupled with nutritional impairment because of concurrent molar eruption and premolar replacement could well be the cause of most of the malformations seen in these young stags. In old stags, adrenal mineralo-cortical deficiency and reduced skeletal mineral mobility is most likely the dominant factor with tooth wear as an additional aetiological factor for antler deformities (degenerative).

STAG BREEDING AGE

From the antler data and the testis section studies it appears that the minimum breeding age could be as a low as 15 months of age in stags, similar to the minimum age in hinds. Bentley records a case of a 19-month-old stag successfully breeding. More data needs to the gathered to clarify this point.

OTHER ABNORMALITIES

An assortment of abnormalities was recorded but the relative incidence of these was very low. Out of a total of 262 sambar sampled in some way the following abnormalities were recorded:

Semi-albinoism
One stag had one white hind foot.
Mummified foetus
One case was reported in a mature hind. The foetus was circa 30cm long and was unfortunately unavailable for further examination.
Pedunculated fat tumour
This lesion was found attached to the wall of the rumen and was spherical with a diameter of 1.5cm. Structurally and histopathologically it was unremarkable and its cause remains unknown.
Melanosis of the liver
A normal sized and shaped but autolyzed liver, heavily infiltrated with melanin like pigment was found in an apparently healthy adult stag. Similar livers are occasionally recorded in sheep and cattle. Their significance is unknown.
Failure of testicular descent
One stag, mature and carrying a four point head was reported with this condition. The testes were not available for examination, the lesions were bilateral, and it is generally accepted that such cryptorchids are sterile but produce testosterone as per normal.

OTHER ORGANS EXAMINED FOR HISTOPATHOLOGY FROM SAMBAR DEER

The following organs were examined microscopically by Dr. Peter Mitchell of the Regional Veterinary Laboratory, Bairnsdale, Victoria.

Tarso-metatarsal gland
Many sebaceous glands were present in the dermis at the level of the shafts of the hair follicles, with ducts opening into the hair follicles. Around the bases or the hair follicles were glands consisting of tubules and alveoli lined by a simple squamous or cuboidal epithelium and surrounded by myoepithelial cells. These glands resemble sweat glands. From this description the TMT gland would as suggested in other species have some kind or scent secretory function.

Sacroiliac lymph nodes
The nodes contained fibrous trabeculae extending from the capsule. Their significance is not known.

Reticulum)
Omasum)
Pyloric and fundic abomasum) These organs were found to be normal and
Small colon) unremarkable
Spleen)

Kidney
This has the same gross appearance as the ovine kidney. Several normal ones were examined and one, although grossly normal, showed a focus of interstitial nephritis, with a few pink staining casts, being present in the tubules. This kidney was taken from a four month old female calf. Interstitial nephritis is a common finding in Hog deer (Axis porcinus) in Victoria and may be a result of their saline water consumption in this habitat Draima and Presidente (unpublished data).

CONCLUSION AND SUMMARY

A study was made of Victorian sambar deer using data are collected by hunters when taking these deer in the wild. A brief description of the sambar's origin and physical characteristics is given and their ecological impact is touched on. The methods, materials, and the nature of the sampling are given.

Age determination, diet studies, parasitology, hair coat and skin data, body morphology, reproduction, antler morphology and deformities, and any other abnormalities noted during the studies, were discussed.

Much of the data is of a limited nature due to the limitations set by the method of the research. The material collected and processed on the most part by untrained but nevertheless enthusiastic persons cannot compare with that taken under more auspicious circumstances.

Its value in the absence of other data however remains and is a testimony of hunter dedication in expanding the knowledge of this species. No other so-called conservation group in the community has shown such drive. The fact that our own wildlife authorities have done little in this direction since the introduction of the species into this country is in itself regrettable to say the least.

There is a great need for a large body of intensive work to be done with sambar deer particularly on population dynamics and reproduction where many hazy and blank areas in our knowledge still exist. This will be a difficult task given the nature of the sambar. These data are essential before proper scientifically based management of this valuable and unique game resource can proceed.

Bentley has called the sambar "Australia's newest native" mammal, and in terms of their overall impact on their habitat since their introduction, this cannot be denied. Their future, presently appears to be guarded only by the hunting community. As world wildlife resources continue to be depleted by loss of habitat and other human activities, perhaps the value of the sambar in Australia will eventually be realised by the authorities and professional research will be initiated.

ACKNOWLEDGEMENTS

This paper is a tribute to Arthur Bentley B.E. M. who has in his own way provided much of what we know about the Victorian sambar deer today. Ian Humphries and Dennis Rowler provided the springboard with their sambar aging technique, without which this project would not have been possible. I am also indebted to Doctors Peter Mitchell, Ian McCausland and M. Barton and Ken Slee of the Bairnsdale Regional Veterinary Laboratory for their invaluable assistance, Ken Dunn, Stuart White and Graham Keath of the ADA Research Committee, hunters Mike Harrison, Len and Bob Bingham, Colin L. Cervi, Len Young, Jim English, D. Monaro, H. Aberl, John Robinson, Mike Bowden, Cyril Bennett, Barry and Kevin Lees, Geoff Freeman, and many others for their contributions. Also to my wife Gabrielle for her patience and understanding and to my partner Dr.Bob Amott for his consideration, during the years of data collection and during the preparation of the paper. The greatest thanks go to the deer-minded pioneers who with their foresight provided the Victorian sambar population of today.

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[1] Should this read 'In preparation?)

APPENDIX A

SPECIMENS

Please forward full kit to any A.D.A. Meeting and hand to Secretary.

A fresh kit will be provided the same night.

BEAUFORT SCALE*

For measurement of wind speed

0. — Smoke rises vertically.
1. — Smoke drifts in air.
2. — Wind felt on face, leaves rustle.
3. — Leaves and small twigs moving.
4. — Small branches sway.
5. — Small trees sway.
6. — Large branches sway.
7. — Whole trees sway, walking against wind difficult.
8. — Twigs broken from trees.
9. — Large branches torn down.
10. — Trees uprooted.
11. — Severe damage to forests.
12. — Hurricane - violent destruction.

* For use with data card.

A.D.A.

INSTRUCTIONS FOR COLLECTION OF SCIENTIFIC DATA & SPECIMENS IN THE FIELD.

FILL IN DATA CARD WHETHER DEER SEEN OR TAKEN OR NOT.

SAMBAR PROJECT

PLEASE OBTAIN THE FOLLOWING:

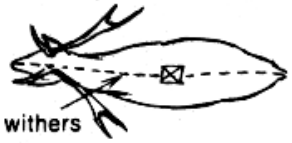
(PRINT)

1. LOWER JAW

Cleaned or boiled or 4th lower cheek tooth.

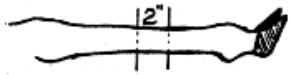
2. 3" x 2" SKIN SAMPLE

From top of withers at point shown. If area damaged take sample as close as possible to this area. Place in Jar "A".



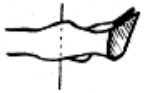
3. 2" SECTION OF BONE

Taken from centre of shin of right fore-leg. Don't include tendons or skin. Place in Jar "A". Hacksaw blade provided.



4. FOETUS (Calf) if PRESENT

Remove right forefoot at Fetlock and place in Jar "A".



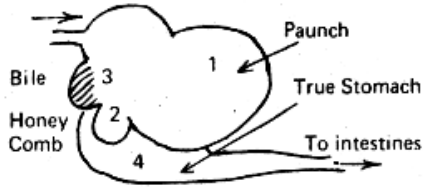
Foetus is quite safe to handle

5. FAECAL SAMPLE

Take several Pellets of manure from rectum (last part of lower bowel near anus) place in Jar "B".

6. PAUNCH CONTENTS

The paunch is the largest of the four stomachs. Take half jar of the least chewed contents by careful selection. Collect any recognisable vegetation and place in Jar "C".



7. IF NO FOETUS PRESENT

Take both ovaries and place in Jar "D".

8. TAKE ANY ABNORMAL GROWTHS

Wounds etc. or parts thereof and place in Jar "A". Specify area on label.

9. IN EACH JAR

Place label with date and name of contributor printed in pencil.

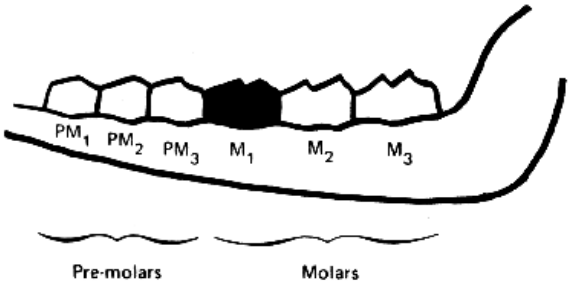
WARNING

SAMPLES are preserved in formalin. Keep out of eyes. Poisonous if swallowed. Keep out of reach of children.

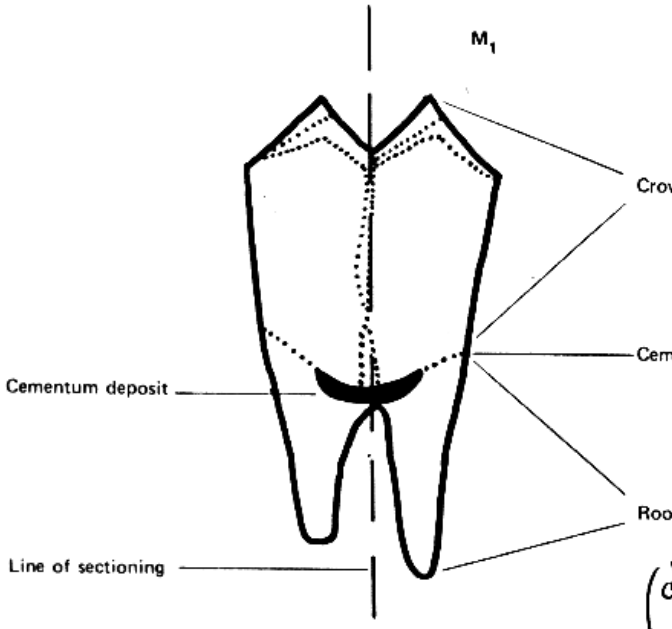
APPENDIX B

TOOTH SECTIONING PROJECT

If for some reason the jawbone is required for the build-up of a mount, the following tooth (M_1, the first permanent molar) should be forwarded complete with the date of death.



M_1 THE FIRST PERMANENT MOLAR



First permanent molar showing cementum deposit, and line for vertical sectioning.

also included: tooth eruption chart and photostats of red deer jaws.

HUNT REPORT

SAMBAR PROJECT

AUSTRALIAN DEER ASSOCIATION

NAME ..... **DATE** .....

Time Started _____
Seen _____
Shot _____

LOCALITY OF WATERSHED _____

☐ **NORTH**
Slope of Dividing Range
☐ **SOUTH**

WEATHER Windspeed _____ Temperature _____
Direction _____ Date Last Rain _____

CONDITIONS

☐ Fine
☐ Overcast
☐ Sunny
☐ Wet
☐ Frost
☐ Snow
☐ Fog
☐ Other

DEER SIGN ☐ Abundant Deer ☐ Mediocre ☐ Scarce Rubs Height _____ Tree Species _____

Specify Fresh / Recent / Old
Appropriate Space

Topography	Deer Seen	Start	Shot	Tracks	Droppings	Rubs	Wallow
High							
Midslope							
Low							
None							

DEER SEEN

☐ Calf
☐ Young
☐ Mature
☐ Old
☐ None

☐ Stag
☐ Hind — Calf at Foot

ANTLERS

☐ Spiker
☐ No Top Forks
☐ Velvet
☐ Full Head
☐ Clean
☐ Deformed
☐ None

APPENDIX C

AUSTRALIAN DEER ASSOCIATION **SAMBAR PROJECT** **REMARKS**

DEER SHOT: Species.....

STAG: Antlers Hunting method used .....

- ☐ Hard
- ☐ Velvet
- ☐ Freshly cast
- ☐ Malformed

Length in Inches

Right....." Left ....."

HIND

- ☐ In milk
- ☐ Dry
- ☐ Calf seen at foot

FOETUS

- ☐ Early development
- ☐ Fully developed
- ☐ Male
- ☐ Female

Total length.....ins.

MEASUREMENTS

Girth....."

Height....."

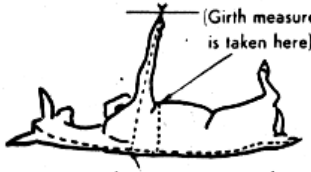
Total length....."

Hock....."

WEIGHT..... lb. (as it fell)

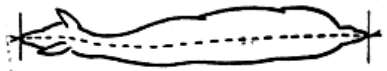
☐ Actual..... ☐ Estimated.....

HEIGHT AT SHOULDER



Measurement begins at point on line of spine between shoulders, along leg to point of hoof.

TOTAL LENGTH



The line of measurement follows curves of dorsal surface from tip of nose along spine to last vertebra of tail.

LENGTH OF REAR FOOT

APPENDIX D

Relationship of BSI to external cortex size of the central portion of metacarpus I in Victorian sambar deer.

Co-ordinates

A & B	BSI	A & B	BSI
10 Mature Stags		***9 Immature Stags***	
4.6	217.5	4.9	
5.1	208.0	4.4	
5.2	230.0	4.4	
5.0	204.5	4.3	
5.1	224.5	4.5	
5.2	217.5	4.7	
5.0	212.0	4.5	
4.9	198.5	4.5	
5.3	209.0	4.7	
5.6	224.5		
10 Mature Hinds		***3 Immature Hinds***	
4.6	171.0	3.9	141.5
4.3	157.0	3.9	167.0
4.4	218.5	4.3	172.0
4.7	195.0		
4.3	186.0		
4.6	193.0	***2 Calves***	
4.3	187.0		
4.4	198.0	3.4	121.5
4.7	193.0	2.8	105.0
5.1	191.5		