FACTORS AFFECTING VIGILANCE IN THE JAPANESE SIKA DEER (CERVUS NIPPON NIPPON) OF LUNDY ISLAND

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INTRODUCTION

The Sika Deer is one of six species of deer found in a wild state in Britain. These include the Red Deer *(Cervus elaphus),* the Fallow Deer *(Dama dama),* the Roe Deer *(Capreolus capreolus),* the Muntjac *(Muntiacus reevesi),* the Sika Deer *(Cervus nippon),* and the Chinese Water Deer *(Hydropotes intermis).* All but the Red and Roe Deer have been introduced to this country, starting with the Fallow Deer, which was introduced by the Normans to provide better hunting in the British forests.

The Sika Deer originate from eastern Asia where this species inhabits areas of deciduous woodland including the south east corner of Russia, the mainland of China, the island of Taiwan (Formosa), and various Japanese islands.

A large herd of Sika Deer which during the 1920's numbered about seventy-five head, together with three hundred Fallow Deer, were kept in Surrenden-Dering Park in Kent (Whitehead 1964). It was from this herd that seven Japanese Sika Deer *(C. nippon nippon)* were taken and liberated on Lundy Island in the Bristol Channel on the instructions of Mr. Martin Coles-Harman in 1927.

Sika Deer seemed to be better suited to the conditions of Lundy than Fallow or Red Deer, both of which were introduced to the island at the same time as the Sika Deer in 1927. By 1960 the Sika Deer population had risen to about ninety head while the Fallow Deer were extinct from the island by 1950 and the Red Deer followed a few years later. During the winter of 1961/62 a major cull was undertaken, reducing the herd of Sika Deer to thirty of forty head. This number did not rise to any great extent over the next decade, and the deer were found to be in a poor condition.

A further cull was undertaken in 1973 in an attempt to reduce the island population to twelve animals:- two stags and ten hinds. This number was never reached and in 1975 the population was estimated at thirty beasts, nine of which were stags (Bathe & Scriven 1975).

In 1987 the population was found to have diminished to approximately twenty animals, seven of which were stags. The condition of the Lundy Sika Deer is still thought to be poor (Eaton & Boddington 1987 unpublished).

It has been observed (Horwood & Masters 1970), (Putman 1986), (Kiddie 1962) that Sika Deer frequent areas of dense vegetation, such as low bush thickets, conifer plantations and heavy undergrowth in deciduous woodland during the day time. This provides the deer with a great deal of cover and protection from predators; the only example of which in this country is man. The rhododendron thickets on the eastern slopes of Lundy provide ideal cover for the deer during the day. These shy animals may be seen to emerge from their lairs just before dusk, in order to feed on the open slopes, and return to the thickets a little while after sunrise.

During the summer months the general body colour of the Japanese Sika Deer is a reddish brown, with creamy white spots on the back and sides. A prominent white cordal disc may be seen, which may be fanned out when the deer is aroused. During the winter the coat assumes a uniform greyish brown colour with the spots becoming almost invisible. The old stags develop very dark hair in the winter, particularly around the neck. The size of an average adult stag is approximately 32-34 inches (81-86 cm) at the shoulder, while a hind measures approximately 30-32 inches (76-81 cm). The antlers of a mature stag are of about eight points.

The Sika Deer are said to be some of the least social of the British species of deer (Putman 1986). Often the deer are seen as solitary individuals, or as hind and calf pairs. However, around the period of the rut (September and October) group sizes may increase, with a maximum of five or six per group recorded in the New Forest (Mann 1983). The largest wild group recorded in Europe was of twelve individuals (Putman 1986), and up to forty individuals have been observed as a group in Russia (Prisyazhnyuk *et al* 1974). In Japan the average group size was

recorded as two to three individuals (Miura 1974). On Lundy the largest herd observed during this study was of six hinds and one fawn. The average group size was calculated to be 2.12. These groups have been shown to be very fluid in their composition (Horwood & Masters 1970), with independent members forming a loosely knit community. If home ranges are held by the deer there is a considerable degree of overlap between the loosely related clan or 'superherd' (Putman 1986). However, it seems to be fairly unusual for stags and hinds to remain together, except during the rutting season.

Sika Deer are also known to be fairly vocal animals, emitting shrill whistle-like barks as an alarm signal. The stags are also able to vocalise a high pitched roar during the rut which is drawn out into a nasal scream. It is unclear, as yet, whether the stags maintain a territory during the rut, or whether they try to gather a harem, as there seems to be a certain amount of conflicting evidence (Mann 1983), (Horwood 1973), and (Kiddie 1962).

On Lundy the first signs of sexual activity appear in early September, with the formation of the rutting scrapes or platforms by the stags. These may be found on the eastern slopes of the island, below Tibbets Hill. The stags were observed to leave the rhododendron thickets below the old Hospital, to the south of the quarries, and make their way along the slopes of the east side to the rutting area, a distance of about 1500 metres. Competition between the stags was seen to become more intense as the study period progressed, culminating in the observation of several fairly prolonged encounters between the two largest of the Sika stags. A short time after dawn these animals would return, often together, to the rhododendron thickets, with the victor of the night's contests leading the way.

The feeding ecology of the Sika Deer varies with the flora available in a particular area. However, grasses and heather *(Caluna vulgaris)* seem to provide the major constituents of the deer's diet as has been shown in the New Forest, Wareham Forest and in Scotland (Putman 1986), Lundy (Bathe & Scriven 1975), Askold Island in Russia (Prisyazhnyuk *et al* 1974) and Japan (Furubayashi & Maruyama 1977).

Vigilance, as used in ethology, refers to an animal's state of readiness to detect certain specific events occurring unpredictably in the environment (Macfarland 1981).

Factors affecting an animals's vigilance will be derived from both internal stimuli, such as hunger and fear, and external stimuli, such as the sight of a possible mate or predator. The more important the stimuli, the more time an animal will devote to a vigilant state, actively searching the environment for the target object.

In many animals the vigilant posture is easily recognised from the non-vigilant behaviour. Walther (1968) provides detailed descriptions of vigilant behaviour in the Thomson's gazelle *(Gazella Thomsoni guenther)* which has also been found to apply to a wide range of African ungulates (Underwood 1981). In the wild brown hare *(Lepus europaeus)* two forms of vigilance posture have been observed (Monaghan & Metcalfe 1985). These entail scanning when only the head is raised from the feeding position, and an upright posture where the forelegs are straightened, so raising the animal into a sitting position.

The general characteristic which seems to occur in all these animals is the elevation of the head. This enables the individual to scan a larger area by clearing the view of obstructions such as boulders, grass and shrubs which would otherwise obscure it. In ungulates however, the position of the ears may also help to provide a clear indication of the deer's state of vigilance.

Dimond and Lazarus (1974) highlighted three principal areas in which vigilance is necessary. These involve vigilance towards external danger, environmental resources and intraspecific communication. In this study the first of these three factors is examined as an animal may spend much of its time in an alert state in order to detect any signal which indicates the presence of some external threat or danger. This would occur in the form of predators which rely on surprise for their success. For this reason the prey animal may best avoid capture by an early detection of the potential threat. In evolutionary terms one would expect this threat to be present in the form of large carnivores, but in twentieth century Britain the only true predatory threat to the life of a deer is man.

The Sika Deer on Lundy Island have been left as wild since their introduction in 1927. However, these deer have been subjected to systematic and sometimes indiscriminate culls throughout their history on the island. This has resulted in these animals becoming highly suspicious of human beings, to the point that many visitors to the island are completely unaware of their existance. These deer have been shown to be highly sensitive to the stimulus of a human figure (Eaton in prep.) bounding off to the safety of the rhododendron thickets on the first sight, and sometimes smell, of a person.

In this study four possible factors are examined to see whether they play any part in determining the proportion of time these deer spend in vigilant behaviour. These four variables include:-

i — the sex of the deer
ii — the time of day (i.e. early morning or late evening)
iii — the position of the deer on the island (i.e. north or south)
iv — the amount of cover available to the deer.

It was proposed that factors iii and iv were the most likely to play a part in affecting the deer's vigilance. The position on the island at which the deer was found was thought to be important as it is only the south end of the island which is inhabited by humans. Also, it was suggested that the deer would become more wary of predators the further they ventured from the safety of the rhododendrons.

METHOD

This study was undertaken from September 1st-24th 1987. Sika Deer were observed both in the morning and the evening along the east side of the island. Observations were divided into two minute (120 sec.) time periods and the time spent by the deer in vigilant behaviour was recorded for each time period. A pair of field binoculars, a dictaphone and a stop-watch were used by the observer to record the data whilst in the field. A deer was noted to be in a vigilant state if the head was raised. However, if the animal was feeding from a bush or shrub at head height the deer was only recorded as vigilant if not actually in the process of browsing. If the observer, or any other person was detected by the deer the affected data was discarded. Also, if the animal under observation was lost from sight during any given time period, this observation would be abandoned and a new one started on the re-emergence of the deer.

Data was collected in the morning any time after it was light enough to see the deer clearly (approx. 6 a.m.), and likewise in the evening, data collection was ended when there was insufficient light to observe the deer accurately (approx. 8.15 p.m.). Weather conditions were also found to deteriorate very rapidly on occasions so that visibility was dramatically reduced. Observations were terminated in such circumstances. In all fieldwork the utmost care was taken at all times not to disturb the deer, which often involved being in position to observe these animals before their emergence from the rhododendron thickets.

For each set of data collected the following information was recorded:-

i — date,
ii — time,
iii — location,
iv — distance from the nearest clump of rhododendrons,
v — sex of the animal,
vi — number of deer in the group.

When more than one individual was in view at one time the observations were collected from the deer at random.

On returning from the field the data was transcribed from the dictaphone and subjected to statistical analysis using the Student 't' test for unrelated samples.

The number of people observed in the north and south ends of the east side were also recorded over a two week period and this was also analysed for any significant differences using the Student 't' test.

Several night time observations were undertaken using an image intensifier to enhance the observer's night vision and hence identify the deer in the dark.

RESULTS

The results may be seen in figure 1, showing that the two most important factors affecting the vigilance of Sika Deer on Lundy seem to be the position of the deer on the island (i.e. north or south) and the sex of the animals. The findings of the statistical analysis may be seen in table 1.

These show that when the combined data is analysed, all four of the factors seem to play some part in controlling vigilance levels. However, the significance levels indicate the greater importance of 'position' (section 1) and 'sex' (section 4), over the other two factors, 'cover' (section 2) and 'time of day' (section 3).

It is also important to note that a higher proportion of people were observed on the southern half of the study area:- t = 4.577 d.f. = 21 — significant @ p 0.0005. (See figure 2).

Table 1.

Table showing results of statistical analysis

COMPARISON	't'	d.f.	SIGNIFICANCE
SECTION 1:- NORTH vs. SOUTH (1 tailed)			
Female, morning, less 50m. = N < S	2.530	64	signif. @ p 0.01
Female, evening, less 50m. = N < S	4.060	51	signif. @ p 0.0005
Male, evening, less 50m. = N : S	1.009	14	not significant
Combined data = N < S	5.084	67	signif. @ p 0.0005
SECTION 2:- LESS THAN 50m. vs MORE THAN 50m. (1 tailed)			
North, female, morning. = Less < More	1.922	22	signif. @ p 0.05
North, male, evening. = Less : More	0.896	12	not significant
Combined data = Less < More	1.889	19	signif. @ p 0.05
SECTION 3:- MORNING vs. EVENING (2 tailed)			
North, male, more 50m. = a.m. > p.m.	2.414	44	signif. @ p 0.02
North, female, less 50m. = a.m. : p.m.	0.301	33	not significant
South, male, less 50m. = a.m. > p.m.	2.619	34	signif. @ p 0.02
South, female, less 50m. = a.m. : p.m.	0.796	82	not significant
Combined data = a.m. > p.m.	2.175	101	signif. @ p 0.05
SECTION 4:- MALE vs. FEMALE (2 tailed)			
North, morning, more 50m. = ♂ < ♀	3.575	53	signif. @ p 0.001
North, evening, less 50m. = ♂ : ♀	0.342	32	not significant
South, morning, less 50m. = ♂ : ♀	0.687	83	not significant
South, evening, less 50m. = ♂ < ♀	2.474	33	signif. @ p 0.02
Combined data = ♂ < ♀	2.810	119	signif @ p 0.0005

Figure 1. **Graph showing results of vigilance study.**

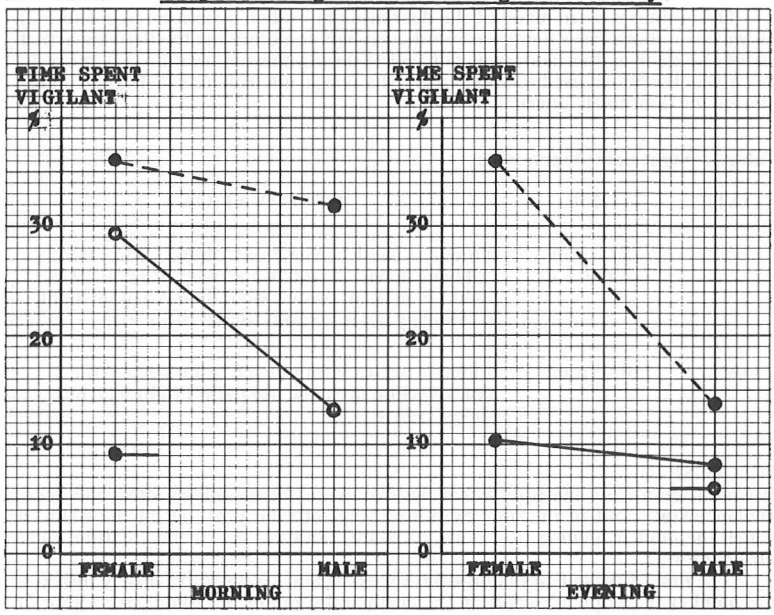
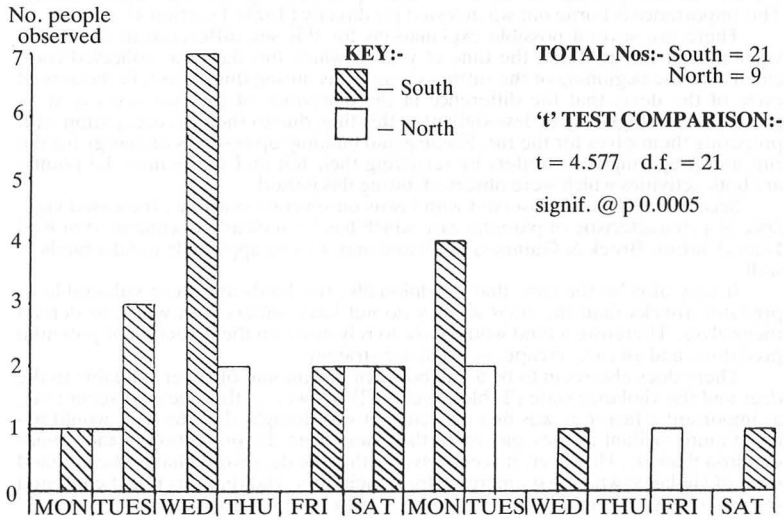


Figure 2. **Graph to show number of people observed in the north and south of the east coast over a two week period.**



Observations were made of the deer at night on two occasions (see Table 2). However, in both cases there was insufficient light to determine the detailed activities of the deer as the moon was not visible during the observations. A powerful torch was therefore used to supplement the image intensifier, which immediately alerted the deer to an 'unusual' presence.

Table 2. Night time observations

DATE	TIME	OBSERVATION
12/9/87	11.00 p.m. — 12.30 a.m.	4 hinds — south of Sugarloaf, above Ladies Beach. All lying down . . . until we arrived. Remained in sight for an hour, unsure what to make of the light. Eventually ran into rhods. under Sugarloaf.
14/9/87	10.45 p.m.	1 hind — above White Beach — Grazing in the bracken close up to the top path. Frightened into rhods. below.

DISCUSSION

It would seem from the results that the two major factors which affect the deer's vigilance state, out of the four examined here, are the position on the island in which the deer is feeding (i.e. north or south), and the sex of the creature under observation.

The first of these two findings was expected and seems to be closely linked to the number of people observed in the north and south of the island (see figure 2). As stated above, the deer on Lundy are unusually timid and wary of human beings, and this finding adds weight to the theory that the primary object to which these deer are sensitive is the human figure.

It is of interest that the only data which does not produce a significant north-south difference (Table 1, section 1) is also the only male set of data obtained for this section. Likewise there is also a clear sex difference in the morning vs. evening analysis (Table 1 section 3), which would also suggest the importance of the sex of the deer in determining the amount of time spent in a vigilant state while feeding. This importance is borne out when tested for directly (Table 1 section 4).

There are several possible explanations for this sex difference in the deer's vigilance behaviour. First, the time of year at which this data was collected coincided with the beginning of the rutting season. It is during this period, in the annual cycle of the deer, that the difference in the behaviour of the two sexes is at its greatest. The stags may be less vigilant at this time due to their preoccupation with preparing themselves for the rut. Feeding and building up reserves of energy for the rut, and preparing their antlers by removing their felt and sharpening the points, are both activities which were observed during this period.

Second, hinds were observed with fawns on several occasions. Increased vigilance is a characteristic of parental care which has been clearly documented in Red Deer (Clutton-Brock & Guinness 1975) and may well be applicable to Sika hinds as well.

It may also be the case that, traditionally, the hinds are more vulnerable to predator attacks than the stags as they do not have antlers with which to defend themselves. Therefore a hind would have to rely more on the detection of potential predators, and an early escape, as a defence strategy.

There does also seem to be a link between the amount of cover available to the deer and the vigilance state (Table 1 section 2). However, this does not seem to be as important a factor as was first expected. It was thought that the deer would become more vigilant as they moved further away from the protection of the rhododendron thickets. However, it is conceivable that the deer would have a heightened state of vigilance when first emerging from their lairs, and that this might confound the expected gradient of increasing vigilance with increasing distance from cover.

The comparison of the morning and evening vigilance levels shows a definite increase in vigilance during the early mornings by the Sika stags. However, this trend is not found to apply to the data collected from the hinds. Without a further study of this particular phenomenon it is impossible to tell whether this is purely a difference between the two sexes at this time of year, and whether at other times of the year this difference disappears. In this study only the early and late daylight hours were used when recording the vigilance behaviour of the deer. The vigilance state of these animals during the night is, as yet, completely unknown, and it may be that this is where the comparison should be made.

It would seem likely that there would be a certain amount of interaction between the four factors examined in this study. For example, no hinds were observed more than 50 metres from the rhododendrons in the evening. This might be due to a higher degree of timidity amongst hinds than amongst the stags; an interaction between the sex of the animal and its movements. It may be due to the time of year, in that the stags will spend less time near the rhododendrons, and a greater time near the rutting slopes around Tibbetts Hill. Another possible interaction which would explain this absence of data could be between the time of day and the distance from the rhododendrons. In the evening the hinds have just emerged from their lairs and may begin to forage for food near their point of emergence, moving further afield as the night continues.

A second example may be seen in that only one data point was obtained for a stag in the morning at the north end, which was less than 50 metres from cover. Again this phenomenon may well be due to a series of interactions between the various influencing factors.

It should also be noted that, as stated in the introduction, animals will adopt a vigilant state for reasons other than detection of potential predators. Vigilance is also required for the location of external resources, and the reception of intraspecific communication. During the study of the Lundy Sika Deer, emphasis was put on predator detection as the main reason for the deer's unusually high levels of vigilance. This has been supported by the findings of this study, as most of the deer's activities seem to be closely linked to the avoidance of, or detection of, human beings. However, it would be inaccurate to suggest that all vigilant behaviour recorded during the observation in this study was based on predator awareness. The detection of intraspecific communication is an important factor in the build up and execution of the rutting season, and the location of external resources such as food, is an ongoing task throughout the year.

Due to the observations of the Sika Deer during the night it may now be stated more strongly that these animals do emerge from the rhododendrons just before dusk, stay out for all, or part of the night, and return to the safety of their lairs as daylight approaches. Whether this is a universal characteristic of Sika Deer, or whether the Lundy deer have adopted this pattern of behaviour as an anti-predator tactic, is still a matter for conjecture. It does not seem that the deer spend the whole of the night feeding, as on one occasion a herd of four deer were disturbed from the bracken in which they were peacefully lying.

It should be stated that many of the suggestions given as possible explanations for the findings of this study are purely conjectural, and would require a systematic investigation in their own right in order to be taken as anything more. A closer examination of each of the four areas tested in this study, as possible factors affecting vigilance, would be of interest. The interactions between the contributing factors affecting vigilance make this whole area a very complex puzzle to be solved. However, the systematic isolation and investigation of the individual variables is a task which will eventually lead to a more complete understanding of animal behaviour, and an organism's interaction with its environment.

REFERENCES

Bathe, G.M. & Scriven, N.J. 1975. *The Japanese Sika Deer of Lundy.* Lundy Field Soc. Ann J. 25, 18-27.

Clutton-Brock & Guinness 1975. *Behaviour of Red Deer at calving time.*

Dimond, S. & Lazarus, J. 1974. *The problem of vigilance in animal life.* Brain, Behav. & Evol. 9 60-79.

Furubayashi, K. & Maruyama, N. 1977. *Food habits of Sika Deer in Fudaka Tanzawa Mountains.* J. Mammal Soc. of Jap. 7, 55-62.
Horwood, M.T. 1973. *The world of the Wareham Sika Deer.* Deer. 2, 978-984.
Horwood, M.T. & Masters, E.H. 1970. *Sika Deer.* Brit. Deer Soc. Publication 3.
Kiddie, D.G. 1962. *The Sika Deer in New Zealand.* Wellington Press.
Macfarland (Ed). 1981. *The Oxford Companion to animal behaviour.* Oxford Uni. Press.
Mann, J.C.E. 1983. *The Social Organisation and Ecology of the Japanese Sika Deer in Southern England.*
Miura, S. 1974. *On the seasonal movements of Sika Deer populations in Mt. Hinokiboramu.* J. Mamm. Soc. of Japn. 6, 51-66.
Monaghan, P. & Metcalfe, N.B. 1985. *Group foraging in wild brown hares.* Anim. Behav. 33, 993-999.
Prisyazhnyuk, V.E. & Prisyazhnyuk, N.P. 1974. *Sika Deer on Askold Island.* Bull. Moskow O-UA-ispyt. 79, 16-27.
Putman, R.J. 1986. *Grazing in temperate ecosystems. Large herbivores and the ecology of the New Forest.* Timber Press.
Underwood, R. 1981. *Vigilance behaviour in grazing African antelopes.* Behav. 79, 81-107.
Walther, F.R. 1969. *Flight behaviour and avoidance of predators in Thomson's gazelle.* Behav. 43, 184-221.
Whitehead, G.K. 1964. *The deer of Great Britain and Ireland:- an account of their history, status and distribution.* London. Routledge & Kegan-Paul.