ON COMPARING THE BEHAVIOUR OF ZOO HOUSED ANIMALS WITH WILD CONSPECIFICS AS A WELFARE INDICATOR, USING THE GIRAFFE (*GIRAFFA CAMELOPARDALIS*) AS A MODEL

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Abstract *Animal Welfare 1996, 5:* 139-153

*To assess the validity of using wild behavioural data as a welfare indicator for zoo animals, the time budgets of 19 captive giraffe (*Giraffa camelopardalis*), from four zoos were compared with the time budgets of wild giraffe from Hwange National Park, Zimbabwe. Differences were shown to exist between the behaviour of wild and captive giraffe. However, only the duration of lying differed significantly across zoos. Correlations demonstrated that both enclosure size and feed restriction affected the locomotor activity of giraffe. An attempt to quantify observer influence upon the behaviour of wild giraffe was made. Different methods of observation were shown to significantly affect the time budget established. The extent to which wild giraffe behaviour can be used as a welfare indicator for captive conspecifics is discussed, as are the problems inherent in such a study. The difficulties in constructing an alternative welfare measure using prevalence to veterinary problems, are briefly considered. Methods by which captive giraffe welfare can be improved are discussed, particularly concerning the provision of browse to allow more natural feeding patterns to be established.*

Keywords: *animal welfare, behaviour, captivity, giraffe, time budget, wild*

Introduction

It is often assumed that the wild environment is a blueprint for optimal welfare, and as such the welfare of captive animals is frequently assessed in relation to the behaviour of wild conspecifics (Thorpe 1967; Heidiger 1969; Lindburg 1988; Chamove & Anderson 1989; Chamove 1989; Shepherdson 1989; Fraser & Broom 1990; Bayne *et al* 1992). Wild and captive behavioural comparisons may be popular in assessing zoo animal welfare, as the wild data for many species are already published, and the captive data are relatively easy to obtain. However, the validity of such comparisons has not yet been fully vindicated (Hughes & Duncan 1988), but it is likely that these comparisons can be criticized upon both theoretical and logistical grounds: (1) Many wild animals will naturally avoid humans; thus observing animals in the wild to establish an accurate time budget is problematic. Wild

animals are often more visible when carrying out particular behaviours, and as a result a bias may be introduced into the data recorded (Martin & Bateson 1992). (2) The behaviour of a species is prone to temporal and geographic variation in relation to biotic and abiotic factors (see Pellew 1984; Young 1993), consequently it will be hard to generalize across a whole species. (3) Many species are rare in the wild and in the zoo; as a result there will be problems of small sample sizes, and difficulties locating wild individuals in an area that truly represents their original range. (4) The observer is likely to have a considerable influence upon the results obtained (Martin & Bateson 1992; Isbell & Young 1993), as is the method of observation. As a result, the data obtained is unlikely to be a true representation of the animal's wild behaviour. (5) There may be problems in obtaining genetically equivalent wild conspecifics, particularly with domesticated species and animals such as the giraffe for which 37 per cent of the captive population are hybrids (Lee 1993). However, behavioural differences between sub-species may in some cases be small (see Moss 1989; Estes 1991). (6) It is relatively common in such comparisons for the data of wild and captive animals to have been collected by different scientists (see Markowitz & LaForse 1987), as a result, the validity of such comparisons must be questioned.

Even if these and other technical problems are overcome, considerable theoretical problems remain. For example, it is insufficient to assume that because a difference exists that welfare is inevitably reduced. A reduction in welfare associated with that difference should be demonstrated, for example, by correlating feed restriction with cortisol levels. However, in the zoo environment such invasive techniques are problematic (Shepherdson 1989).

The present study attempted to overcome all such foreseeable problems by using the same observation procedures and the same observer (JSV) in both wild and captive studies, and by using a large yet relatively common animal to facilitate the collection of data in the wild as well as in the zoo. The aim of this study was to locate the problems in such comparisons so that they can be considered in future studies, and attempt to construct an alternative welfare measure based upon wild and captive comparisons.

Animals, materials and methods

Animals and environment

Giraffes were observed at four representative UK zoos. Edinburgh and London Zoos are typical of the more intensive zoo system with giraffe housed in a hardstand yard, whereas Whipsnade Wild Animal Park and Marwell Zoological Park are typical of more extensive zoos with large grass paddocks. These zoos contained a mixture of sub-species and hybrids (Table 1).

Observations of the wild subjects were made within the Sinamatella Intensive Protection Zone (IPZ) of Hwange National Park in north-western Matebeleland, Zimbabwe, approximately 18° South and 26° East. The vegetation in this area is mainly woodlands and scrubs of *Colophospermum mopane* and *Acacia sp*, interspersed with patches of grassland. The study was carried out during the dry season to facilitate the collection of data: as visibility is greater at this time with foliage cover being minimal, and because all animals including giraffe are easier to locate as they are concentrated around sources of water. The sub-species in this area is *Giraffa camelopardalis angolensis* (Skinner & Smithers 1990).

Table 1 **Factors that may affect the behaviour of giraffe in each of the five study areas (x = unavailable or inappropriate. Feed restriction ranks: 1 = most different from wild feeding situation to 4 = wild. Enclosure size ranks: 1 = smallest to 5 = largest. See statistical analysis for classification of ranks.**

	Wild	Edinburgh	Whipsnade	London	Marwell
Ranked 'paddock' size	5	3	3+2[1]	2	4
Ranked night-quarters size	x	1	1	1[2]	1[2]
Ranked feed restriction whilst in the paddock	4	2	1	3	1
Ranked feed restriction whilst in the night-quarters	x	2	2	2	2
Substrate/environment	Scrub/ woodland	Hardstand	Grass/ hardstand	Hardstand	Grass/ hardstand
Number of individuals	x	3	4	4	8
Giraffa camelopardalis *sub-species*	*angolensi s*	*rothschildi*	*reitculata* + hybrids	hybrids	*rothschildi* + hybrids
Clinical condition index	x	0.53	0.56	0.90	3.44

[1] At the time of study, the giraffes at Whipsnade were separated into two enclosures due to the lameness of one of the females.

[2] Male separated into a smaller section at night.

Data collection for captive giraffe

The behaviour of individual captive giraffes was recorded using instantaneous time sampling (Martin & Bateson 1992). A sample interval of one minute was chosen as this was sufficiently long to ensure that the behaviour of up to eight giraffes could be accurately recorded simultaneously. However, this sample interval was short enough in relation to the average duration of a giraffes' behavioural pattern so that the measure attained would give an accurate estimate of the proportion of time spent performing particular behaviours (see Martin & Bateson 1992). Behavioural categories were selected from an ethogram of 32 behaviours constructed after a preliminary study at Edinburgh Zoo, and later extended to 34 behaviours during the wild portion of the study as other behaviours became obvious. All data were later compressed into seven mutually exclusive categories for analysis: feeding, rumination, locomotion, standing, lying, stereotypies, other. Observations were spread out evenly between dawn and dusk. Each of the 19 giraffes was observed for 16 hours; spread over at least three days. Attempts to observe the giraffe within their night quarters were complicated by the nervous reaction to the observer at this time. As a result only two hours of observations were made for 14 of the 19 captive giraffe, at the beginning of the period kept in the night quarters when the animals were less agitated by the presence of the observer.

Veterinary records were consulted in an attempt to construct a prevalence to clinical condition index, as an alternative to a behavioural welfare measure. Here the total numbers of entries made on the clinical cards for at least eight giraffe, held by the zoos both past and present, were divided by the number of months for which the giraffes were in that zoo (Table 1). All the zoos had the service of a veterinarian for at least one day per week and all treatments administered to animals were recorded.

$$\text{Clinical condition index} = \frac{\text{Number of entries on clinical cards}}{\text{Giraffe months under veterinary care}}$$

Attempts to locate the more common veterinary problems for each of the different zoos were also made. Details of relevant management techniques were also noted (see Table 1 for a summary).

Data collection for wild giraffe

A dawn to dusk time budget was constructed using essentially the same technique as was used in the captive portion of this study (ie instantaneous time sampling with an interval of one minute). However, sexual differentiation and individual recognition was not possible in the wild as it was in the zoos due to the density of the vegetation, the distance at which some observations were made, the duration of the study and the unpredictability of the herd composition (Dalton 1987; Skinner & Smithers 1990; Estes 1991). As such, the behaviours of all visible giraffes were recorded. This lead to the construction of a general time budget for the giraffes of the Sinamatella IPZ area rather than for individual giraffe within that area. This method also facilitated the collection of sufficient data in a limited period of time (five weeks).

Giraffes were observed using four methods, so that the effect of different observation techniques could be assessed: (1) Giraffe were tracked on foot and the behaviour observed once the animals were located, and followed as they moved. (2) Giraffe were studied from a four-wheel drive vehicle; with observations being made when the animals were within sight of the dirt track. (3) Observations were made at watering holes from within a hide or a four-wheel drive vehicle. (4) Observations of giraffe were made upon the plain below Sinamatella Plateau. The plain was a microcosm for the entire area: with browse, graze, watering holes and so on. Subsequently, there was considered to be little bias in the type of behaviour performed there.

Attempts to construct a clinical condition index for wild giraffe, whereby the number of giraffe with visible clinical conditions is divided by the total number of giraffe seen, was made impossible by the difficulty in recognizing individuals and thereby estimating total numbers seen. Due to the terrain there were also problems in identifying the total of all visible health problems.

Statistical analysis

For the purpose of this study, the diet of the giraffes was ranked as follows: 1 = graze and hay available *ad libitum*; 2 = graze, hay and concentrates available *ad libitum*, with browse occasionally available; 3 = graze, hay, concentrates and browse available *ad libitum*; and 4 = wild environment. Thus, diet was ranked in relation to what the authors believed to be the most different from a wild diet. The availability of *ad libitum* browse was considered to be more important than the provision of graze and *ad libitum* hay, lucerne or concentrates, as browse is the predominant form of feed for wild giraffe (Skinner & Smithers 1990;

personal observation 1994). Enclosure size was ranked as follows: 1 = 0 to 100m^2; 2 = 101 to 1000m^2; 3 = 1001 to 10,000m^2; 4 = 10,001 to 100,000m^2; and 5 = >100,001m^2. All factors analysed are summarized in Table 1.

Potential correlations between ranked enclosure size and ranked feed restrictions with various behavioural measures were investigated using Spearman's rank correlation test. The Kruskal-Wallis non-parametric one-way analysis of variance test was used to investigate potential significant differences in behavioural measures across a number of environmental and animal variables, such as enclosure size, feed restriction, zoo environment, age and sex. A binomial test was employed to investigate the behavioural changes of individual giraffes before and after being placed in their night quarters.

To validate the wild observations, comparisons with other wild time budgets were made. Mean monthly diurnal activity patterns of Masai giraffe (*G. c. tippelskirchi*) are available in Pellew (1984). However, in order to make these data comparable with that collected from Hwange, a time budget was calculated by taking the mean monthly measures for males and females within the dry season and treating them as independent sample points. Since individual recognition was not possible in the present study, or made in Pellew (1984), comparisons of the two data sets were made whereby the percentages of each day of observation in the present study were treated as if they were independent and compared with the monthly averages for males and females from Pellew's dry season data (1984), using Kruskal-Wallis analysis. Analyses were carried out in Minitab for Windows Release 9.2 (Minitab Inc, Pennsylvania, USA).

Results

The mean time budgets of giraffe observed in the four zoos are shown in Figures 1 and 2.

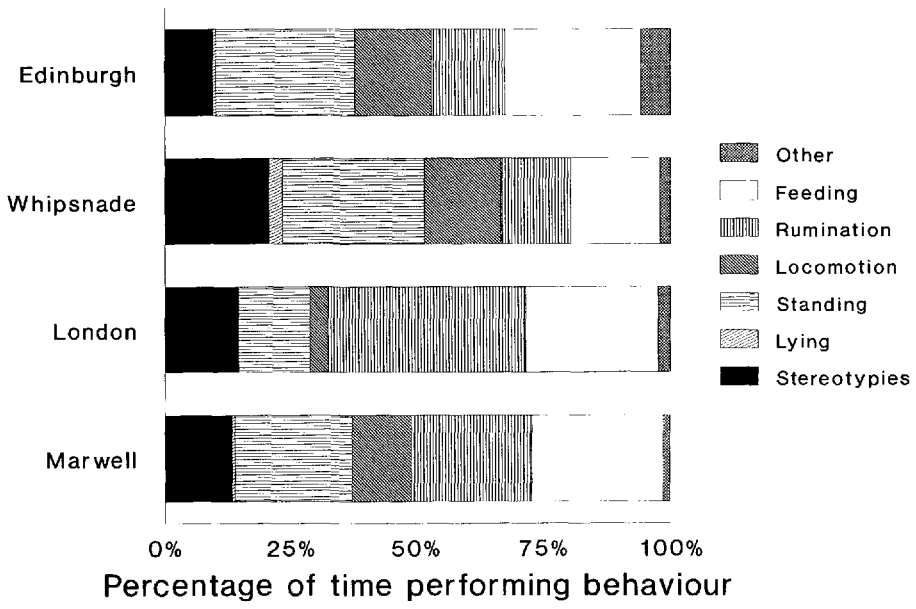

Figure 1 **Time budget of captive giraffes observed whilst in their paddock.**

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The mean time budgets of wild giraffes using the four different observation methods are shown alongside a mean time budget extracted from Pellew's dry season data (1984) in Figure 3. A summary of the statistical tests carried out can be found in Tables 2 to 4.

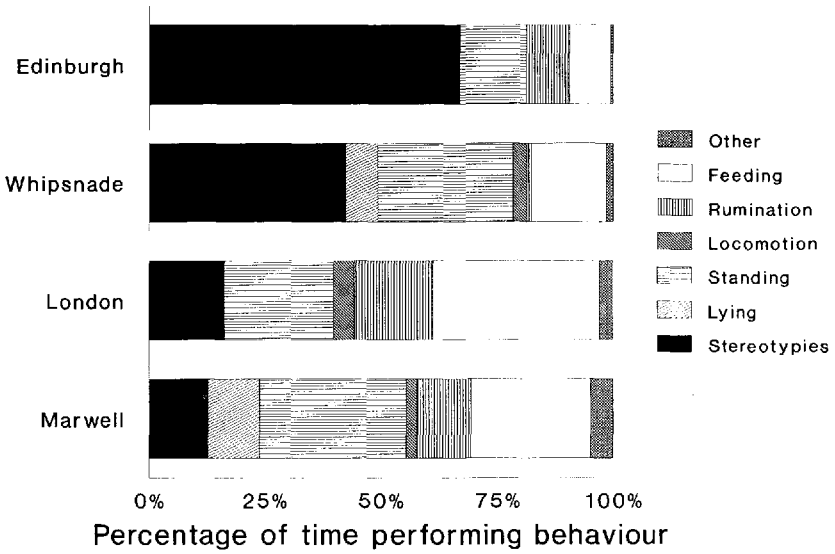

Figure 2 **Time budget of captive giraffes observed whilst in their night quarters.**

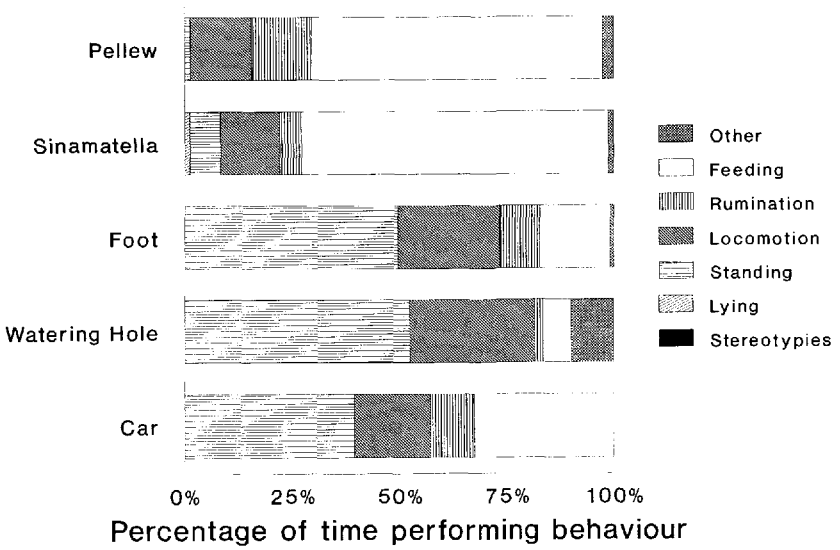

Figure 3 **Time budget of wild giraffe collected by different observation methods (Pellew = data from Pellew 1984; Sinamatella = observations made from Sinamatella plateau; Foot = observations made on foot; Watering Hole = observations made at the watering hole; and Car = observations made from a car).**

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Kruskal-Wallis analysis detected no differences in the behaviour of male and female captive giraffe, in contrast to the findings of Pellew (1984). Kruskal-Wallis analysis showed that only locomotor stereotypies of the nine behaviours tested was effected by age ($H = 3.90$, $df = 1$, $P < 0.05$), with locomotor stereotypies being more common in adults (mean = 1.7%) than in sub-adults (mean = 0.2%). There was, however, no evidence that giraffes are more stereotypic in smaller enclosures (see Table 2), with 8 of 14 giraffe stereotyping more in smaller enclosures ($P > 0.05$).

Table 2 **Spearman's rank correlation results investigating the effects of environmental variables upon the behaviour of wild and captive giraffes (* = statistically significant results; n = 34 in all cases).**

Indendent variable	Behaviour category	Spearman's rank correlation value	*P* value (two tailed)
Enclosure size	All stereotypies	-0.190	ns
	Lying	0.132	ns
	Standing	-0.122	ns
	Locomotion	0.703	< 0.001***
	Rumination	0.350	< 0.05*
	Feeding	0.131	ns
	Oral stereotypies	-0.153	ns
	Locomotor stereotypies	0.108	ns
Feed restriction	All stereotypies	-0.118	ns
	Lying	-0.239	ns
	Standing	-0.178	ns
	Locomotion	-0.457	< 0.005**
	Rumination	-0.083	ns
	Feeding	0.127	ns
	Oral stereotypies	-0.125	ns
	Locomotor stereotypies	-0.202	ns

Enclosure size was shown to significantly effect and positively correlate with both ruminating behaviour ($H = 15.61$, $df = 3$, $P < 0.005$, and $rs = 0.350$, $n = 34$, $P < 0.05$), with only 1 of the 14 giraffes ruminating more in a smaller enclosure ($P < 0.005$), and locomotor activity ($H = 19.50$, $df = 3$, $P < 0.001$ and $rs = 0.703$, $P < 0.001$; see Figure 4), with only 2 giraffe of 14 being more mobile in a smaller enclosure ($P < 0.005$). Enclosure size did not, however, have a significant effect upon any other behaviour including

the performance of locomotor stereotypies and time spent feeding (Tables 2 and 3), with five giraffes feeding more in the smaller enclosure ($P > 0.05$).

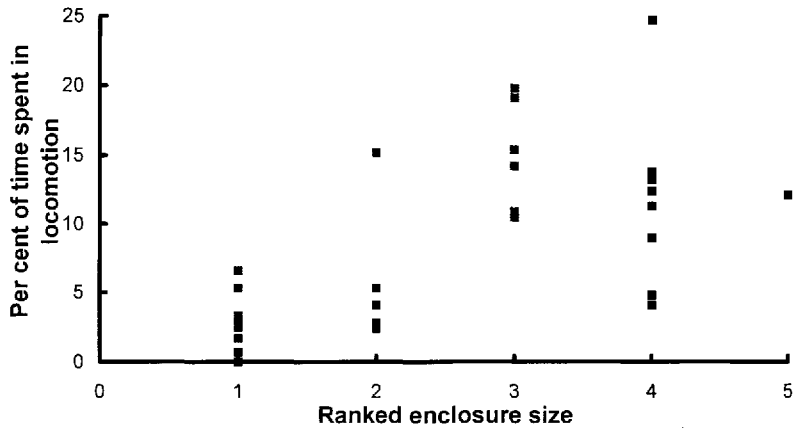

Figure 4 **Graph demonstrating the relationship between enclosure size and percentage of time spent in locomotion.**

Feed restriction was shown to correlate with, and significantly effect locomotor activity (rs = -0.457, n = 34, $P < 0.01$; see Figure 5, and H = 10.05, $df = 2$, $P < 0.01$), but there was no correlation between the proportion of time spent feeding and in locomotion (rs = 0.017, $P > 0.05$). Feed restriction was also shown to effect rumination (H = 15.62, $df = 2$, $P < 0.001$), but had no effect upon any other behaviours (see Tables 2 and 3), including the performance of oral stereotypies.

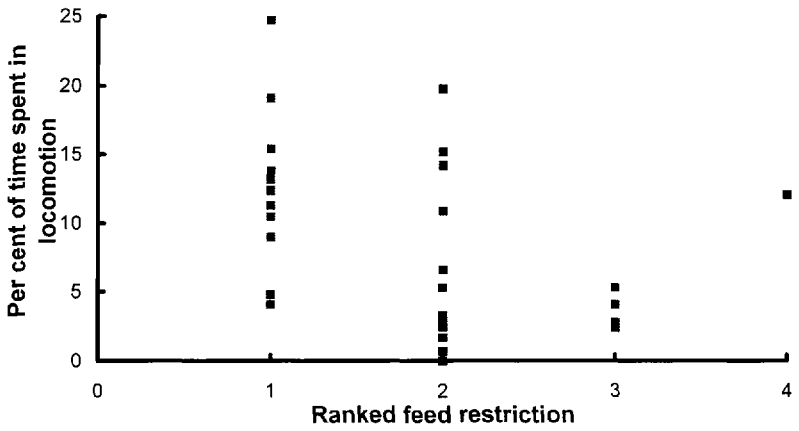

Figure 5 **Graph demonstrating the relationship between feed restriction and percentage of time spent in locomotion.**

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No significant differences were found in any behaviour across the four different zoo environments (Table 3), except for the percentage of time spent lying ($H = 8.96$, $df = 3$, $P < 0.05$).

Table 3 **Summary of Kruskal-Wallis tests to investigate the effect of environmental variables upon the behaviour of zoo housed giraffe (* = statistically significant results).**

Environmental category	Behavioural category	H-value	*df*	*P* value
Zoo	All stereotypies	4.02	3	ns
	Lying	8.96	3	0.030*
	Standing	2.33	3	ns
	Locomotion	5.41	3	ns
	Rumination	7.27	3	ns
	Feeding	5.53	3	ns
	Oral stereotypies	4.88	3	ns
	Locomotor stereotypies	4.83	3	ns
	Other	1.01	3	ns
Ranked enclosure size	All stereotypies	0.61	3	ns
	Lying	5.78	3	ns
	Standing	1.72	3	ns
	Locomotion	19.50	3	0.000***
	Rumination	15.61	3	0.001***
	Feeding	0.42	3	ns
	Oral stereotypies	0.41	3	ns
	Locomotor stereotypies	2.73	3	ns
	Other	4.38	3	ns
Ranked feed restriction	All stereotypies	0.04	2	ns
	Lying	4.07	2	ns
	Standing	4.71	2	ns
	Locomotion	10.05	2	0.007**
	Rumination	15.62	2	0.000***
	Feeding	0.11	2	ns
	Oral stereotypies	0.04	2	ns
	Locomotor stereotypies	0.99	2	ns
	Other	3.52	2	ns

Significant differences in the proportion of time spent standing, feeding and in 'other' behaviours were found between the different methods of wild observations. However, comparisons of the data collected from Sinamatella Plateau and from the data extracted from

Pellew (1984), yielded no significant differences, except in the amount of time spent ruminating (Table 4).

Table 4 **Kruskal-Wallis results investigate the effects upon time budgets constructed, of different methods of observation and from different areas (* = statistically significant results).**

Factors	Behavioural category	H-value	*df*	*P* value
Methods of wild observation	All stereotypies	12.74	3	ns
	Lying	3.40	3	ns
	Standing	12.18	3	0.007**
	Locomotion	7.70	3	ns
	Rumination	3.84	3	ns
	Feeding	13.19	3	0.004**
	Other	12.74	3	0.005**
Comparison of data collected from Sinamatella Plateau and from Pellew (1984)	All stereotypies	0.00	1	ns
	Lying	2.00	1	ns
	Standing	3.41	1	ns
	Locomotion	0.06	1	ns
	Rumination	8.66	1	0.003**
	Feeding	0.96	1	ns
	Other	3.16	1	ns
Comparison of data collected from Sinamatella Plateau and from the paddocks at Marwell Zoo	All stereotypies	9.07	1	0.003**
	Lying	1.24	1	ns
	Standing	7.74	1	0.006**
	Locomotion	0.09	1	ns
	Rumination	8.57	1	0.003**
	Feeding	8.57	1	0.003**
	Other	1.41	1	ns

Comparisons of the behavioural data collected from Marwell Zoo and the data collected from the Sinamatella Plateau, showed significant differences in the proportion of time spent standing, feeding, ruminating and stereotyping (Table 4).

Discussion

Contrary to the findings of Pellew (1984), no significant differences in behaviour between males and females were discovered in this study. This is likely to result from problems caused by a small sample size or confounding variables in the zoo, rather than the absence of any real differences.

Similar problems were likely to have affected the comparisons between adult and sub-adult giraffe, with variables masking potential significant differences. Consequently, the

significant differences detected in locomotor stereotypies between adult and sub-adult giraffes are likely to be indicative of a highly significant result. This difference reinforces the view that stereotypies develop as an animal matures (see Mason 1991).

The fact that increased rumination correlated with increased enclosure size may reflect a decrease in stress levels in animals in larger areas, as rumination is believed to occur when animals are unstressed (Trunkfield & Broom 1990). Whilst in smaller areas giraffes were observed to ruminate less. Although feeding behaviour can suppress ruminating behaviour (Pellew 1984), this is unlikely to explain this reduction in ruminating behaviour as giraffe did not feed significantly more in the smaller areas. It is also unlikely to reflect any inherent cycling in ruminating behaviour, as giraffes typically ruminate more towards the evening (Pellew 1984), when captive animals are placed into the smaller night quarters. Increasing feed restriction was also seen to reduce ruminating behaviour, possibly also mediated through stress.

The reduction in mobility correlating with a reduction in enclosure size is not due to an increase in time spent feeding, as feeding did not correlate with locomotion, and giraffes were not more likely to feed in the smaller areas. The decrease in locomotion cannot be accounted for by an increase in stereotypic behaviours as there was no increase in such behaviours with a decrease in enclosure size. It is likely therefore that enclosure size directly affects the locomotor activity of giraffes.

The correlation between locomotor activity and feed restriction, implies that feed restricted animals are motivated to seek out food and consequently become more mobile, as has been demonstrated elsewhere (Young *et al* 1994). Thus, the ability to perform appetitive behaviours in adverse conditions (ie walking due to feed restriction) may be enough to diminish the occurrence of oral stereotypies, which did not correlate with feed restriction. The finding that a reduction in enclosure size and an increase in feed restriction did not result in an increase in locomotor or oral stereotypies is surprising, as both can be considered to be indicative of sub-optimal conditions and therefore conducive to the development of stereotypic behaviours (see Mason 1991). It is possible that stereotypies in giraffe are not influenced by these factors, but by other unidentified factors such as social tension, or that these behaviours are not true stereotypies. Alternatively, the small sample size and unavoidable confounding variables may have obscured any potential correlations.

Comparisons made between the zoos showed significant differences in the lying behaviour of captive giraffes. This difference undoubtedly reflects the substrate upon which the giraffes were kept, with no lying seen at zoos with hardstand paddocks but as much as 15.7 per cent for one individual kept in a grass paddock. The finding that other differences across the zoos were not detected may reflect the small sample size rather than a lack of differences.

The differences in standing, feeding and 'other' behaviours between the different methods of wild observation are likely to reflect a difference in observer influence, combined with a bias introduced by giraffes behaving differently across the four methods of wild observation. Observations made from a four-wheel drive vehicle and on foot enabled the observer to get sufficiently close to allow qualitative behavioural measures to be made, such as whether wild giraffe exhibited tongue playing behaviour or not. However, the observer had a considerable influence upon the behaviour of the giraffe at this distance, with the animals spending 4.9 per cent of recorded time watching the observer if the observer was in a car, and 30.9 per cent if the observer was on foot. More subtle behavioural differences

are also likely to occur across the four methods of wild observation. It is possible that a larger proportion of time will be spent walking in response to the observer when on foot or in a vehicle. For example, from Sinamatella Plateau where the giraffes were not noted to watch the observer, 11.9 per cent of the giraffes' time was spent walking and 0.2 per cent spent galloping. In contrast, observations made whilst on foot recorded 21.9 per cent of the giraffes' time spent walking and 3.6 per cent galloping, almost yielding a significant difference across the four methods of observation (Table 4). Consequently, time budgets constructed from observations made from a vehicle or on foot will not be a true representation of the wild behaviour of giraffes due to the observer's influence.

The differences in the behavioural data collected from watering holes reflects the behavioural changes that occur whilst a giraffe is at a watering hole rather than the influence of the observer. A reduction was noted in the time spent browsing and an increase in time spent standing and a fifteen-fold increase in time spent drinking, with respect to the actual time budgets of wild giraffes recorded from Sinamatella Plateau.

Thus, only the behaviour recorded from the Sinamatella Plateau is likely to give a useful measure of giraffe behaviour since it was not influenced by the observer or a source of water. Its similarity to Pellew's time budget (1984), although these observations were made on *G. c. tippelskirchi*, seems to support this argument. Only the proportion of time spent ruminating was significantly different from Pellew's time budget (1984). This is likely to reflect the distance at which observations were made rather than any difference in behaviour. At approximately 500 metres, using 16X magnification binoculars, behaviours such as standing, walking, feeding, lying and social behaviours could all be seen, but more detailed observations were difficult, thus rumination may have been underestimated and subsequently standing behaviour overestimated.

In this study observations in the wild showed that similar behaviour patterns to those classified as stereotypic (Sato & Takagaki 1991) occurred in situations unlikely to be conducive to stereotypies. 'Tongue-playing' behaviour was often seen after a giraffe had fed or drunk, implying it had a purpose. It is possible therefore, that this is not an abnormal behaviour per se, though it may occur at an abnormal frequency in some captive animals. The mean occurrence of this behaviour in the wild was 0.8 per cent when observed from a vehicle, whereas a mean occurrence of 0.9 per cent and a maximum occurrence of 16.2 per cent were recorded for captive giraffe. The performance of potential 'mane biting' (Sato & Takagaki 1991) took up 0.1 per cent of the observation time from Sinamatella Plateau, and a mean of 1.1 per cent and a maximum of 5.8 per cent in captivity. Thus, the duration of these behaviours may be abnormal in captivity, although they may have a function. The finding that the proportion of time spent performing stereotypic behaviours did not correlate with feed restriction or reduced enclosure size, may indicate that the classification of these behaviours as stereotypies was incorrect, or that such stereotypies are not feed or enclosure size related.

Comparisons of the Sinamatella wild data with that of Marwell Zoo were made to assess the extent of the differences between the most representative wild giraffe time budget, with that of giraffes in a zoo most closely approaching the wild condition in terms of enclosure size and number of individuals present. Significant differences in time spent standing, feeding and stereotyping are likely to reflect real differences in the time budget of wild and captive animals, whereas differences in the time spent ruminating are more likely to reflect

the limitations of observing such behaviours at a distance in the wild. The significant difference in standing behaviour between Marwell (mean = 24.8%) and the wild (mean = 5.6%), is likely to be due to differences in feeding time (wild mean = 76.9%, Marwell mean = 26%), combined with the lack of behavioural opportunities in captivity.

Analysis of veterinary records revealed health problems in captivity that are likely to compromise welfare (eg lameness). Although it was not possible to obtain such precise measures of health for wild giraffe, numerous problems were noted. Tail loss and scars upon the rump were relatively common, presumably resulting from predator attacks or intraspecific aggression. The latter is likely to explain the missing horns and deformed necks seen in a number of male giraffe. Perhaps most surprising was the occurrence of claw overgrowth in the wild, thus reinforcing the view that it may be a partially hereditary condition (Benbow 1985). Attempts to quantify health problems in the wild and in the captive environments as an alternative indicator of welfare, proved impossible. It was observed, however, that physical suffering at least is relatively common for wild giraffe in Zimbabwe.

Animal welfare implications: general

Although, this study attempted to minimize foreseeable technical problems in making wild and captive behavioural comparisons, the following remained: (1) the impracticality of establishing time budgets for individual wild animals; (2) wild animals need to be observed across all seasons; (3) observing animals from a great distance results in under-representation of subtle behaviours, conversely observing animals from close proximity may significantly alter their behaviour. Despite these limitations, real differences were detected between wild and captive giraffe behaviour, though it is questionable that these inevitably indicate a reduction in welfare.

Attempts to establish a less subjective estimate of animal welfare, avoiding previously noted theoretical and technical problems, by using veterinary data, failed as a result of the variations in record keeping in the zoos, combined with the difficulties of collecting wild veterinary data. It should be noted that not all apparent physical conditions indicate suffering (Mason & Mendl 1993), and not all conditions likely to cause suffering will be apparent.

During this study the weaknesses of two methods of assessing animal welfare became apparent. However, this does not mean that they are without use. By combining these and other methods, and attempting to correlate the resultant welfare indices, the extent to which they co-vary can be ascertained. Thus, the welfare indices may be validated.

Animal welfare implications: specific to giraffes

Where possible captive giraffe should be provided with browse, at least in the morning as this coincides with a natural feeding peak (Pellew 1984). Ideally, browse should be offered from an enrichment device based on stimulating natural feeding contingencies. In large paddocks resources such as water, salt licks, browse feeders, etc should be spread throughout the paddock so that the giraffes use the full area available to them and thus benefit from the increased level of exercise. Mixed species exhibits are likely to be a source of sustainable enrichment for all species concerned. In this study giraffe and Sable antelope (*Hippotragus niger*) were seen together at Marwell, although in the wild interactions between these species were rare. Observations made in the wild showed that giraffe and zebra (*Equus* sp.) were

commonly seen together. As a result, it is possible that giraffe and zebra could successfully be housed together in zoos.

During this study a captive giraffe was observed for two hours before calving. This animal exhibited locomotor stereotypies (pacing) that took up 66.7 per cent of the two-hour observation period. This is common in giraffe at this stage of labour (Lee 1993), and may be due to the stress of being confined and separated from their conspecifics, or due to the pain of labour. Research into the implications of isolating expectant giraffes is required, as the stress of forced isolation may protract the labour, causing the high level of still births in captive giraffe (18% in 1989, Lee 1993).

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